# soil and water

JOURNAL OF THE SOIL AND WATER MANAGEMENT ASSOCIATION LIMITED

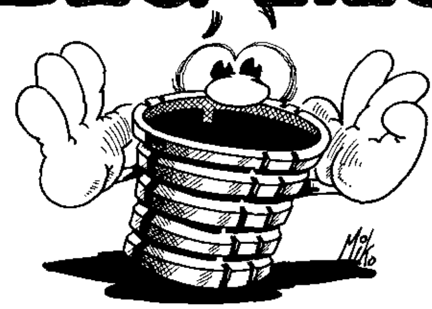
NATIONAL AGRICULTURAL CENTRE · STONELEIGH · WARWICKSHIRE CV8 2LZ

Autumn 1982

Volume 10, No. 2

WATER FLOW INTO MOLES

# BIG MOUTH



# BIG PERFORMER

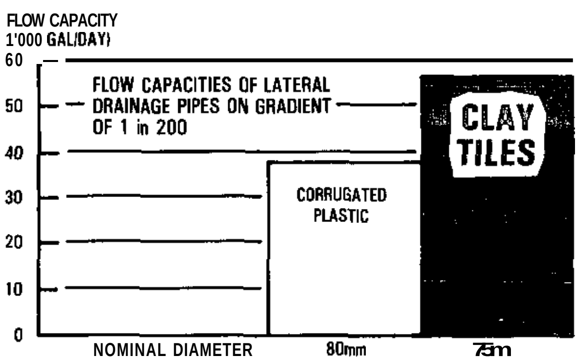
You can fool some of the people all of the time – but don't try it on farmers.

They know that 3 inch clay tiles **carry** twice as much water as **60mm** plastic tubing – so a **clayware drainage** scheme can last twice as **long.**

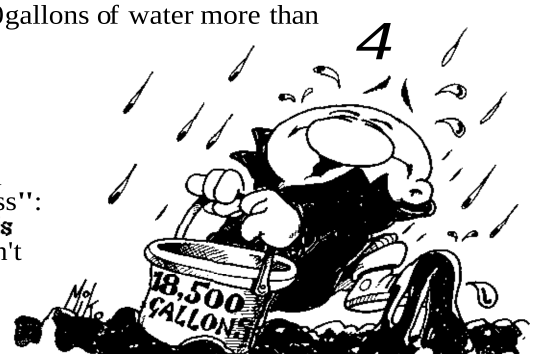
But some salesmen will try to tell you that because **80mm** plastic is a fraction bigger than 3 inch tiles, it will carry more water.

Like so much sales patter, that is quite simply untrue – and there are Ministry figures to prove it.

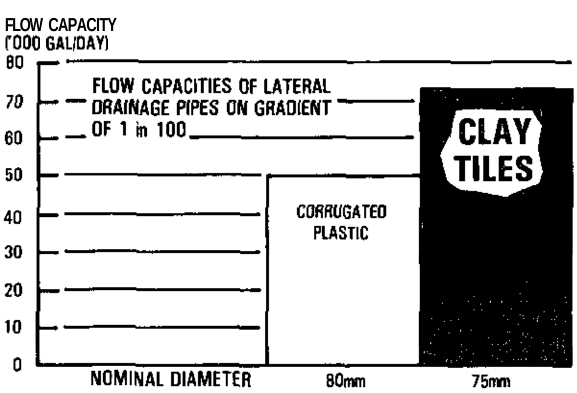
On a **1** in **200** slope, for example, 3 inch tiles carry 18,500 gallons of water more than **80mm** plastic – each and every day of the year.



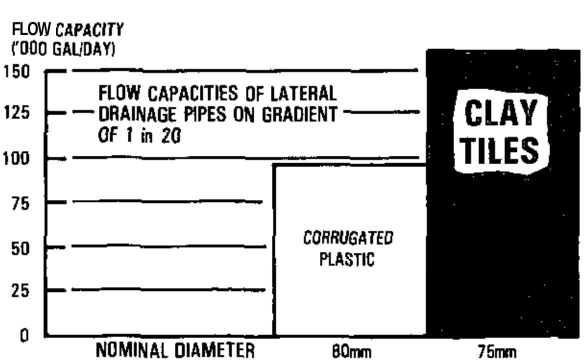

This is because the **corrugations** in the plastic tubing cause what the boffins call "hydraulic roughness": in farming **terms, this** means the water can't flow as easily.




On steeper gradients **the comparison is** even more striking, as the charts show: at **1** in 100 the difference is nearly 25,000 gallons a day, and at **1** in 20 the advantage to clay is a staggering 60,000 gallons a day.




**So** when you choose clay tiles, you won't just get a strong, proven, long-lasting, **vermin** proof, chemically inert, British product: you'll also get one which **shifts** more water from your land.




## CLAY TILES FROM OAKLAND. BIG ONES FROM THE BIG ONE

**Henry Oakland & Sons Ltd.,**
Escrick, York YO4 6ND.
Telephone: (090 487) 666 Telex: 57645

The natural excellence of **clayware**

Source:
The Design of Field Drainage Pipe Systems HMSO.

VOLUME 10, No. 2 ISSN 0309 023 X



SAWMA
NAC, Stoneleigh,
Warwickshire CV8 ZLZ.
Telephone: Coventry (0203) 555100

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 good soil husbandry.

The editor welcomes offers of editorial material and advertising requests; details on application.

Copy date for the January edition, end of November.

Printed in Great Britain by Avon Litho Ltd., Stratford-upon-Avon, Warwickshire.

*Further copies available upon request.*

**COVER** PHOTO: Mole plough bullet and expander

# soil and water

**£2.00 £1.00 RASE Members**

In May this year, farmers, consultants, advisers and their friends discussed the contentious subject of straw disposal at the Associations 'Burn or Bury' conference (see feature article), held at the excellent St. Ivo Recreation Centre, St. Ives, Cambridgeshire. As well as giving a much needed airing to the subject the conference gave an update of research and advisory information at a time when talk is of a possible ban on burning. The overwhelming feeling of most was that such an outcome would be a tremendous setback especially if the actions of a few cause the rest to suffer. So far this year it is apparent that a much more positive view has been taken by farmers to burning. This must in part be due to the NFU's revision of the straw burning code backed up with an excellent video (first shown to the public at the St. Ives conference), but also the barrage of public criticism expressed last year through the popular media.

This year various organisations have taken a much more responsible attitude. I recall the *Sunday* Observer producing a well balanced article based largely on ARC Letcombe laboratory comments. The 'Farming Rags' have brought the subject to the fore and the constant reminders must have driven the message home. Furthermore as I travel around the countryside I have seen very few incidences where flames have caught hedges or caused a hazard to road users. I also would suggest that the popular press waiting to point an admonishing finger have not had the opportunity to do so.

Farmers attending the SAWMA conference must at the end of the day have left somewhat frustrated as alternatives to burning straw such as incorporation, still need further research. Letcombe, NIAE and ADAS stressed a 'horses for courses' message but there appeared to be a lack of recent up to date information. Possibly this is due to the length of time needed to compile enough conclusive evidence. However I am pleased to report that research establishments and in particular EHF's and ADAS regional offices are planning trials looking at methods of incorporation over the next few years. SAWMA also is not standing still — plots are being prepared in collaboration with the RASE for the Royal Show in 1983 and with ADAS Eastern region at the June Wheat '83 demonstration in Cambridgeshire.

The conference indicated that we may not know all the answers, but farmers should not despair as evidence from experiments and :rials recentl' established can only help produce a more complete solution. All credit to farmers and research workers alike, for responding to public criticisim — Keep up the good work!!

## CONTENTS



## ADVERTISERS INDEX

# EVENT DIARY

| | |
|---|---|
| 2nd December 1982 | 'Good Establishment – the route to higher cereal yields' – NAC Conference |
| 14 – 16th December 1982 | Irrigation Short Course – **NCAE/SAWMA/UKIA** |
| 4 – 7th January 1983 | Soil Management Short Course – **NCAE/SAWMA/ADAS** |
| 4 – 7th January 1983 | Drainage Short Course – **NCAE/SAWMA/ADAS** |
| 26 – 27th January 1983 | Living Land Drainage – Workshop – **Hilton** International, Stratford-upon-Avon, organised by SAWMA |
| 2nd February 1983 | 'Identifying and Managing chalk soils.' A conference organised by the Chalkland Cereal Group in conjunction with **ADAS** & SAWMA. – High Post Hotel, Salisbury |
| 8th February 1983 | Restoration of Land to Agriculture – **SAWMA/RASE/ADAS** – at the NAC. |
| 16th February 1983 | 'Making Irrigation Pay' – UKIA Spring Conference at the NCAE |
| 1 – 3rd March 1983 | Soils Workshop. A practical field based Workshop for farmers and farm managers. – NAC organised by **RASE/SAWMA/ADAS** |
| 6 – 8th April 1983 | 'Soil Water' – organised by the B.S.S.S. – Nottingham University |
| 15 – 16th June 1983 | Wheat '83 – organised by RASE. SAWMA will be present looking at the soils of the site and effective **moling.** – **Trumpington,** Cambridge |
| 4 – 7th July 1983 | Royal Show |
| 4 – 8th July 1983 | Biological Processes and Soil Fertility – BSSS Meeting |
| 15 – 20th July 1983 | World Water '83. Congress, conference and exhibition – Royal Festival Hall, London – details from Institution of Civil Engineers, Great George Street, London. |

MORE DETAILS OF ALL EVENTS CAN BE OBTAINED FROM – **MIKE** SAULL AT SAWMA
Tel. 0203 555100 – PLEASE CHECK WITH SAWMA OR THE ORGANISERS FOR CONFIRMATION.

## SHORT COURSES AT THE NCAE

Once again Soil Management, Irrigation and Land Drainage are being covered in the form of short courses at the NCAE. Organised by NCAE, SAWMA, ADAS, and in the case of irrigation the UKIA, bookings are already being taken.

| | |
|---|---|
| Irrigation – Principles and practices – 14 – 16 December 1982 | intended to assist farmers and growers in the UK to improve their management techniques, advisers, equipment manufacturers and distributors will also find the course of value. |
| Drainage – Principles and practices – 4 – 7 January 1983 | usually a well attended course, it is aimed at contractor and manufacturer, consultant or farmer requiring more information on water movement, scheme design and secondary treatments. |
| Soil Management 4 – 7 January 1983 | Repeated for a second year the Soil Management course is sure to be well supported by farmers. Covering all aspects from crop requirements, soil assessment, implement usage, tyre choice and approaches to farm operation planning. |

For more details contact SAWMA on 0203 555100, or Pam Cook Short Course Secretary at the NCAE, on 0525 604 28.

V10-2

## SOIL ASSESSMENT — A SELL OUT

The Association produced booklet, released this May has already sold 3,000 copies. As SAWMA's first steps in the specialist publication market, Soil Assessment must be hailed as an unqualified success. The booklet (at the time of writing) is being reprinted in time for the new years influx of college students. However perhaps the September 13th Daily Telegraph indicates a wider applicability when it describes Soil Assessment as "A most excellent booklet (it only costs £1.00) — it should be studied by every arable farmer". Send a cheque now for your copy!

Please send____copy/ies of Soil Assessment to:

______________________________

______________________________

______________________________

I enclose cheque *to SAWMA* Ltd. *for*

£ _______.

## SOIL AND WATER

1983 holds exciting developments for Soil and Water. Over the past couple of years the quality of 'Soil and Water' has increased, next year using the services of two professional Agricultural journalists, the journal will be released quarterly. This will be of obvious benefit to members and provide more up to date knowledge on people, events and research on soil and water topics. Potential advertisers will be contacted in due course, but as always we need quality editorial. Why not use Soil and Water as a platform for your views or products. Contact Mike Saull on 0203-555100 for more details.

*Well structured soil.*

## SOILS CENTRE — ROYAL SHOW 1982

Much credit is due to organisers and exhibitors at this, a new centre. Space does not permit a full report here, but results of trials will be published in the next 'Soil and Water'. As co-ordinators for the event SAWMA thanks the following for their support.

RASE, ADAS Soil Science, Soil Survey of England and Wales, Rothamsted Experimental Station, University of Nottingham, SIAE, GRI, Society of Ploughmen, ARC Letcombe Laboratory, Reading University, NIAE, NVRS, NCAE and the U.K. Irrigation Assocation.

The Soil Centre will be a regular feature at the Royal — so make sure you visit us next year!

## BREAK CROPS '82

Soil compaction trials at the RASE/Yorkshire Agricultural Society organised Break Crops event provided an excellent contrast to trade and research plots at Bishop Burton College of Agriculture earlier this year. Plots illustrated an almost complete pea crop failure on a compacted seedbed induced by tractor wheelings and with oil seed rape a 70% reduction in establishment. The photos opposite show how rooting of rape is clearly restricted by compaction. The main tap root on the compacted plot has 'corkscrewed' upon meeting the pan and side roots have spread out horizontally. The well structured example shows good rooting.

SAWMA, ADAS and Soil Survey provided the input and visitors included H.R.H. Duke of Gloucester who expressed an active interest in soil conditions and the profiles on show. Conclusions from the event must be, that early sowing avoiding compaction is a must for better yields of oil seed rape.

*Compact soil.*

**SOILS WORKSHOP**
for more information on compaction
2nd – 3rd March 1983
NAC, Stoneleigh
Phone:
Mike Saull (0203) 555100

*Eyes dawn, look in at Breakcrops.*

**THE CHALKLAND CEREAL GROUP IN CONJUNCTION WITH A.D.A.S. & ASSISTANCE FROM S.A.W.M.A.**

present a *conference*

**"IDENTIFYING AND MANAGING CHALK SOILS"**

***High Post Hotel, Salisbury, Wednesday 2nd February 1983.***

***Delegate rate to include lunch £9.00 per person.***

10.30 Introduction
10.35 1st Session — Chairman: R. Russell, A.D.A.S., Bristol
10.40 Paper 1: "The properties and distribution *of* chalk soils" — M. Jarvis, Soil Survey, Farnham
11.25 Short Discussion
11.30 Paper 2: "Root Development, and Tillage Practice" D. Christian ARC Letcombe Laboratory.
12.15 Discussion
12.30 Lunch — Buffet/Bar Displays etc.
2.00 2nd Session
2.05 Paper 3: "Machinery for *chalk soils"* — R. Godwin, N.C.A.E., Silsoe
2.40 Short Discussion
2.45 Paper 4: "Identifying and *correcting problems* on chalk" — A. Whorton, A.D.A.S., Bristol
3.30 Short Discussion
3.35 *Paper 5: "Solving soil problems* — a *case study"* — P. Russell, farmer, Nr. Marlborough
3.55 Panel Discussion

**More details and booking forms will be available from the SAWMA office in November.**

RIDGES FOR RECLAMATION — A LETTER TO THE EDITOR

Dear Sir

In his recent article on reclamation of sand and gravel workings to agriculture, Peter Gagen makes a plea for greater slopes, to improve drainage gradients and to cope with subsidence.

Foresters are also faced with the same problem and on the SAWMA outing of 10 June 1981 to the Bramshill Forest gravel workings, visitors were shown land formed into ridges 30 m wide × 1.5 m high. These are cross-ripped, to lead water entering the loosened material to the furrow, which on impervious materials is deepened to form an open drain. On sites over porous strata, the furrow is deep-ripped to encourage downward percolation.

This landform has been used on several reclamation spoils over the last four years and we find that it drains well, even in winter. With a back-filled drain in the furrow and slightly reduced gradients, the ridge form would eliminate several of the defects mentioned by Mr. Gagen, though not those associated with poaching. Regarding recompaction after ripping, a common phenomenon on poorly structured spoils, we are studying methods of establishing pure swards of legumes, capable of deeper rooting than grasses and independent of fertiliser nitrogen.

Ridges have been constructed on several sites: after gravel working at Bramshill (Hants) on sands and clays, after open-cast coal at Dean (Glos), Parc Slip (Mid Glam), Dunraven (West Glam) and Clydesdale (Lothian). In addition, the Boughton Estate (Northants) had independently arrived at the same conclusion and have constructed some 50 m × 3 m ridges from ironstone hill-and-dale.

We look forward to hearing of ridge construction on land being returned to agriculture and offer our sites as models to any visitors who wish to see them.

W O BINNS, D F FOURT, Forestry Commission, Forest Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

*Reference: Grassland problems on restored land. Soil and Water 10 (1) 23–24, Spring 1982.*

RESEARCH AWARD TO NCAE

Water Authorities can carry out work on rivers to improve land drainage and reduce flooding, but this will not necessarily increase agricultural production. Increases in output depend largely upon how the farmers i o e d respond to th improvement opportunities prese te . The nature and rate of theresponse have a major influence upon the economic value of the river improvement works i.e. whether farmers intensify livestock systems, or change to arable systems and to what extent they improve the in-field drainage of riparian land.

NCAE has been awarded a research contract by the Severn Trent Water Authority to study a number of existing land drainage schemes to evaluate the improvement that has occurred and identify the factors that have influenced the nature and rate of farmers' response. The results of the study will be known by May 1984

For further information, contact:

*Mr. J. Morris,*
*NCAE.,*
*Silsoe,*
*Bedford MK45 4DT.*
*Telephone: 0525 60428*

FILTER-WRAPPED TILES AT FARMERS WEEKLY

Filter-wrapped clay tiles were laid at the International Drainage Event for the first time anywhere in Europe, and probably the world.

Contractor Bob Hutchinson, who was demonstrating his purpose-built Mountford trailed tile layer, has been experimenting with filter wrapping for some months. He said, "It took some time to perfect the techniques and the equipment, but we can now lay filter-wrapped pipes as quickly as we can conventional tiles".

British Clayware Land Drain Industry's Chairman Richard Sturdy welcomed [illegible] "Filter-wrapping is onlv relevant to a minority of schemes, there is no doubt that it is popular with some farmers, contractors and Ministry officials.

GRI NEW REPORT ON GRASSLAND IN ENGLAND & WALES

The Grassland Research Institute has just published the report of a sample survey of grassland in England and Wales 1970–72.

The Agricultural Census gives us basic information on the distribution of grass and of grazing livestock. Sample surveys of grassland, carried out from time to time by the Institute, amplify that information. They provide a more complete picture of changes in land use and in the condition of swards. They also enable us to identify the more important problems attached to grassland improvement and utilisation.

This report describes a survey of some 1300 farms in England and Wales, which was completed in 1972. In every grass field the surveyors recorded the age, intended duration and botanical composition of the sward and physical features of the land, including relief, soil texture and drainage status.

*"A Sample Survey of Grassland in England and Wales 1970–1972" by J. O. Green (A4 letterpress, 39 pages, with figures in colour) is obtainable from: The Librarian, The Grassland Research Institute, Hurley, Maidenhead, Berks., SL6 5LR, price £2.00, postpaid.*

# THIRSTY FOR KNOWLEDGE?

A limited number of back copies of Soil and Water are available from the SAWMA offices, — price £1 each.

| Volume & No. | Contents |
|---|---|
| Vol. 8, No. 1 | Irrigation Special — *Application/Programmes/equipment.* |
| Vol. 7, No. 2 | *Cultivation/Soil/Plant* relationships: Loaded wheels; Soil survey; *Gravel* tunnel drainage. |
| Vol. 7, No. 1 | Irrigation economics; Grassland soils; Essex soils. |
| Vol. 6, No. 3 | *Lightland* organic matter; Lime + *fertilizers;* Cultivation *problems;* Stone windrowing. |
| Vol. 4 No. 2 | How and where to apply water; Drainage machinery review. |
| Vol. 6, No. 1 | Groundwater Special. |
| Vol. 5, No. 4 | *Compaction* under wheels; Powered *subsoiling;* Straw burning. |
| Vol. 5, No. 3 | *Practical* soil management; Soil compaction; Workability; *Subsoiling* mechanics. |
| Vol. 5, No. I | Draught and soil structure; Irrigation machinery; Water sources and storage; Heavy land management. |
| Vol. 4, No. 4 | Slurry; *Clayland* drainage; Organicfarming. |
| Vol. 4, No. 3 | The rotary digger; Direct drilling; Stones and potato seed *beds;* Thinking about drainage. |
| Vol. 4, No. 2 | Water weed control; Irrigation equipment; *Grassland* production. |
| Vol. 4, No. 1 | Drainage in New Zealand; Land resource management; Subsoiling developments. |
| Vol. 3, No. 3 | Drainage research; Better *backfill;* Crop rotations; Water abstraction; Hydrological catchment studies. |
| Vol. 3, No. 2. | Livestock manures; Irrigation *systems;* Direct drilling. |

V10-2



# STRAW — BURN OR BURY?

220 people attended SAWMA's Eastern counties based topical conference earlier this year. It could not have come at a better time and certainly helped farmers polarize thoughts before the coming harvest.

Ken Hubbard, Regional Agronomist with ADAS at Cambridge set the scene, and thought straw disposal to be an acute problem particularly in the east — where 75% of wheat and about 45% of barley straw is surplus to requirements. Most of this burned.

In the past ten years Mr. Hubbard said, the national cereal crop has moved from about 33% being autumn sown to about 55% in 1981 — corresponding figures for East of England would be 60% moving to 80%. In order to achieve this particularly on heavier soils, sowing has to commence earlier, hence increasing the logistical problems of dealing with straw residues.

Straw disposal methods

Mr. Hubbard quoted the following factors of importance.

*1. Value of straw residues*

*Results of long term experiments on straw disposal at 4 Experimental Husbandry Farms in the 18 years between 1951 – 68 proved that there were no significant differential changes in soil organic matter content on any site. These facts were also reflected in the crop yield responses from this series of trials; method of straw disposal had no effect.*

*2. Weed control*

*Delay in removal of straw after harvest can hinder rapid rejuvenation of some perennial weeds such as couch grass and can delay effective herbicidal or cultivation treatment. Burning of straw, however, can bring about considerable kill of weed seeds.*

*3. Straw residues, disease and pest incidence*

*Straw and stubble can be an important source of innoculum for several cereal diseases, but there is rarely a simple relationship between the amount of innoculum and the incidence of disease. However, diseases which are likely to be worse when straw trash is retained are Rhynchosporium, Septoria and Netblotch.*

*4. Straw toxicity*

*The early products of decomposition of straw in the soil can have severe effects on developing seedlings.*

*5. Straw residues as a physical hindrance to cultivation and establishment*

*Complete removal of above ground residues by an adequate burn gives considerable freedom in cultivation techniques which tend to provide a good surface filth in addition to the benefits already mentioned such as weed seed effects and control of trash borne diseases. Incorporation of the whole straw residues is bound to have a hindering effect on cultivations and establishment when compared with burning.*

Mechanical aspects

David Patterson of the NIAE continued the machinery theme, and looked mainly at current thought concerning incorporation. He said that little work has been done at the Institute on incorporating the whole crop of straw, but a current development project studying different cultivation mechanisms will provide some clues.

He quoted German work by Koller and Stroppel using heavy cultivators at Hohenheim They conclude that:—

a) For cultivators there needs to be a minimum clearance distance of 30 in (750 mm) between cultivator points and the base of the frame. The distance between tines in each direction should be about 30 in (750 mm) and the number and arrangement of tines should be chosen so that there is a distance of it 10 in (250 mm) between the cultivator furrows.
b) The ground should be cultivated twice, the first operation at 4 – 6 in (100 – 150 mm) depth and the second deeper between 8 – 10 in (200 – 250 mm) depth.
c) The spring tine cultivator did not maintain the set depth of work as well as the fixed tine cultivator.
d) To achieve good incorporation and mixing throughout the depth of the profile, straw needs to be finely chopped. Experiments show that material chopped to lengths between 0 – 2% in (0 – 50 mm) can be mixed into a greater depth of soil than material chopped in the range 0 – 4 in (0 – 100 mm).
e) The greatest amount of straw decays when it is uniformly distributed into depths up to 8 in (200 mm). It is likely therefore that tines need to operate between 8 – 10 in (200 – 250 mm) so that the straw concentration may be evenly distributed.

Effect of straw on crop yield

Work at Letcombe confirmed that yield is repressed in the presence of straw residues. In experiments carried out since 1975, the average yield of winter wheat and winter oats direct-drilled in the presence of stubble was reduced by 10% and 25% where chopped straw and stubble remained compared with the yield after burning. When seedbeds were wet the effect was greater.

The main effect of straw is to reduce plant numbers either by poor germination or death of seedlings at about the time of emergence. Straw keeps the topsoil wetter which in wet autumns may lead to the development of an anaerobic environment. In such conditions microbial decomposition of straw can produce toxins to which seed and young seedlings are vulnerable.

Steven Harper considered the subject in more depth: he said that although straw presents agronomic problems and therefore today burning is probably the wisest action by the farmer, it potentially provides a substrate for microbial activities which are beneficial to plant growth. The biotechnology work at Letcombe is in part aimed at understanding the degradation of the lignocellulose and harnessing the process to act as an energy source for nitrogen fixation and as a substrate for the production of soil stabilizing agents and plant growth regulating chemicals. As degradation of straw in a low-grade technology on-farm process is a route to minimise phytotoxicity and pathogen problems, the concurrent gain of valuable products may provide a satisfactory economic and environmental alternative to burning in the long-term.

Straw burning code

John Maxwell presented a light hearted, Fire Officers view. He said that provided the straw and stubble code as set out by the National Farmers' Union is followed by every farmer there should be no need for public concern. If there is good supervision of the burning-off areas and more important, there is widespread advance information given to the local community during the few weeks of burn-off, it will allay public anxiety. Just as the Royal Air Force give warnings on low flying aircraft he recommended that with local radio on both Radio Heraward and Radio Cambridgeshire covering most of the Cambridgeshire area, and other local radio stations at Norwich and Ipswich beaming messages over the whole of East Anglia, it should be possible to give advance warning during the peak periods of burning-off. He also recommended the use of citizens hand radio for rapid communications when it becomes necessary to call for reinforcements.

Farmers' view

Two farmers drew the meeting to a close with their own options to straw disposal. Nick Fiske from Ipswich concluded that burning was the safest way to dispose of waste material, he like many others in the audience, could not find a suitable method of incorporation and found no market for his surplus straw.

Peter Hepworth on the other hand, admittedly on a much 'kinder soil', had spent 20 years attempting to incorporate. Although he still burns in places, with the assistance of pig slurry and the 'Glencoe soil saver' he has improved his soils structure and got rid of straw through chopping and burial. His policy is to chop and spread then apply slurry and use the Glencoe to incorporate. Mr. Hepworth believes that this system is helping increase soil organic matter, and although he claims no gain in yield, there is a bonus due to savings from a 30 – 35% reduction in nitrogen need.

All in all the conference focused ones attention to the problem. The audience enjoyed the day and were able to put researchers on the spot. However one left with the ironic feeling that straw could be put to so many better uses, if only economic difficulties could be overcome; this is perhaps the subject of a completely separate conference?

We thank: British Farmer and Stockbreeder, East of England Agricultural Society, The Cereals Unit at the NAC and ADAS for their assistance.

**STRAW**
**BURN OR BURY?**

Copies of the papers of this conference are avnilnble from the SAWMA Office price:

E3.50 — SAWMA Members
£5.00 — Non members

V10-2

# WATER FLOW IN MOLE DRAINED SOIL

The use of mole drainage in the heavy clay lands of the eastern counties has **be[illegible] re[illegible] ti[illegible]** as [illegible] **most economic way [illegible] r[illegible] ving excess winter water. The alternatives are to install close spaced plastic or tile drains. The optimum** performance of the drains requires **an installation** which will allow the rapid removal of excess water. To achieve this optimum performance it is important that the mechanism **by** which water reaches the mole channel is well understood. Work at the National College of Agricultural Engineering, funded **by** the Agricultural Research Council, has concentrated on assessing the relative importance of soil fissures created **by the** mole plough to the performance of the mole drain. Dr. Peter Leeds-Harrison outlines the results of this work below.

Successful moling can take place in soils with high cohesion and this means soils having a high clay content. In these heavy soils the size of the pores in the clay peds is extremely small hence ped hydraulic conductivities are very low. Many of these soils, however, will have natural structural cracks, often formed by the shrinking of the soil as it dries. These cracks are hundreds of times bigger than the small pores in the peds and it is these structural cracks that determine the rate of water movement in undisturbed clays. Two important characteristics of UK soils that influence drainage are firstly that the structure of many soils becomes coarser with depth and secondly that the natural swelling of these clays during the winter can result in the width of these natural cracks becoming very small, both tending to reduce flow rate.

The important drainage requirement in clay soils is to remove water as quickly as possible from the upper layers. Long wetting periods in these upper layers results in the strength of the soil decreasing, damage to crop growth and an increase in the risk of soil damage by trafficing.

The mole drainage operation can create localized fissures in the vicinity of the leg slot at the same time as creating the drainage channel, see fig 1. It should be noted that soil disturbance of this type is different to that created by effective subsoiling where a more **general** loosening occurs.

*Fig. 1. Section through Mole Drain showing Leg Induced Cracks.*

Drainflows

At NCAE an experiment was set up to investigate the effect of these fissures on the speed of response of mole drains to a rainfall event.

For the experiment two types of mole drain were installed. The first was a conventional mole drain installed using a Miles long beam mole plough. The second was installed by hydraulically jacking the expander of the mole plough from the face of one trench to another.

In this way two identical channels were installed, one having well developed leg fissures and the other no leg fissures at all. Hence any difference in response of the two drains could be attributed to the leg fissures; natural structure determining the rate of water movement where these were not present.

Fig. 2 shows the drainflow from the two different drains in response to a discrete rainstorm. Both systems yield water, but the fissured drain responds very rapidly and drainflow ceases within twelve hours. The unfissured drain takes between five and six hours after the storm to reach a peak and drainflow continues for a considerable time after the fissured system has ceased to flow.

Measurements of the soil moisture tension taken at the same time showed that a perched water table developed in the top 0.25 m of the soil in both cases. This perched water table declines very rapidly where there are large leg fissures which allow it to drain into the mole channel. Without these fissures the whole of the top 0.25 m of the soil becomes saturated and remained so for several hours.

These results clearly demonstrate the importance of leg fissures to the rapid removal of top water from heavy clay soils.

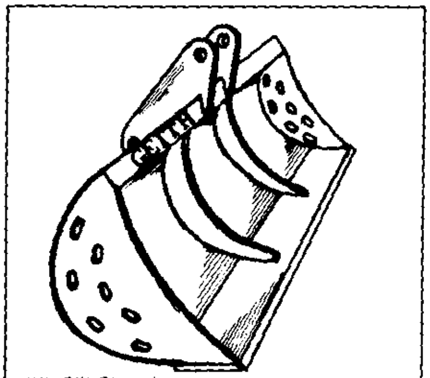
It is therefore important to conside the **nature of the leg slot fissures and the factors influencing them**.

The nature of soil disturbance

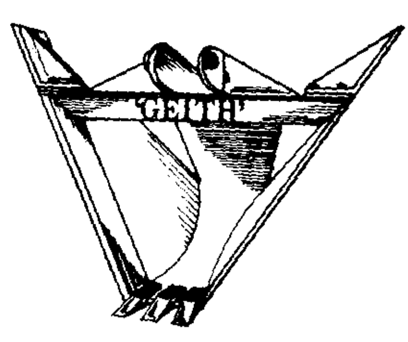
The vertical mole plough leg produces a narrow slot with little upward heave. The little heave that does occur with mole drainage is due to the plastic deformation of the soil around the mole plough foot and expander.

Cracks radiate from the leg slot and are inclined at 45" to the direction of travel. The lateral extent of

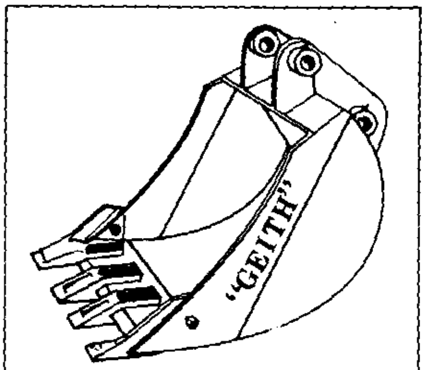
# EVERYTHING FOR LAND DRAINAGE



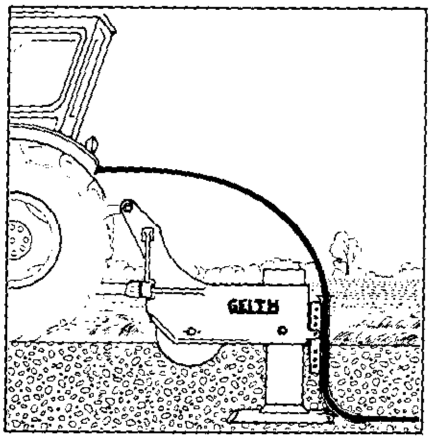

5ft. Silt Cleaning
only £139.



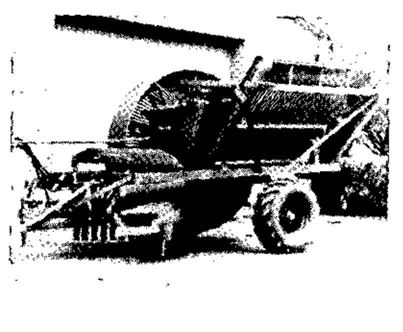

Ditching
Bucket.



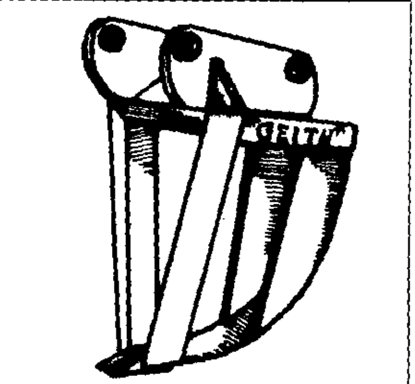

24" standard Trench
Bucket only £140.




"Geith" Mole/Subsoiler
Plough with tube laying
attachment.



"Geith" Stone/Rock
Picking Machine.




Tile Drain
only £98.

**THE PERFECT TEAM**
"Geith" Gravel Tunnell Plough filling mole drains with gravel and "Geith" Gravel Trailer with power driven axle.

# P.F. DOGGETT

**P.F. DOGGETT (ENGINEERING) LTD.**
"Geith" Works, Tredegar, Gwent, Wales.
Phone Tredegar 3571/3572. Telex 497380
"Geith" Works, Tillicoultry,
Clackmannanshire, Scotland.
Phone Tillicoultry 50179. Telex 777695.

**"GEITH" EXCAVATOR BUCKETS.**
Every type, and every shape, for every make of Excavator. 1,000 Buckets in stock. Lip plates/cutting Edges, Teeth and sidecutters ex. stock. Repair/Rebuild service available.
Land Drainage Pipes all types supplied. Nationwide delivery.

V10-2

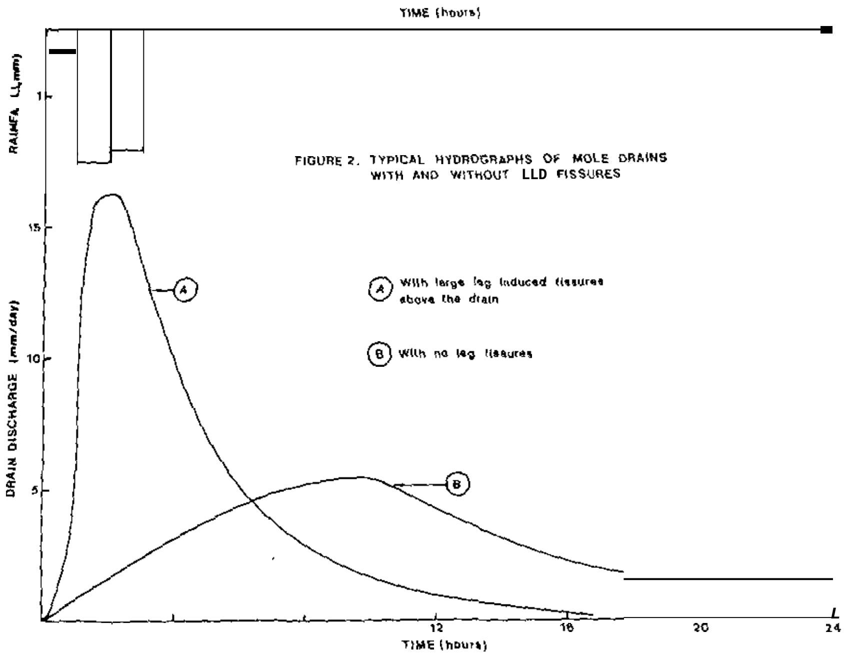



**Fig. 2.** ***Typical Hydrographs*** **of Mole *Drains* with *and* without Leg Fissures.**

these cracks is typically **0.2** m either side of the leg slot for a 25 mm wide leg pulled through a clay soil with a 50 mm soil moisture deficit. If mole drains are spaced at m apart then this means that 1.6 m of soil remains undisturbed between them. (This is in contrast to subsoiling where the aim is to achieve a uniform shattering of the soil, resulting in both horizontal and vertical cracks.)

Table 1 shows the localized effect of the soil fissures on the surface infiltration rate above and between mole drains. Analysis of this data shows that the only significant improvement in the water flow characteristics of the sub-soil is confined to a zone close to the Leg slot.

This indicates that rainfall infiltrating at the surface can move into the fissures readily from the top soil layer and so move to the drain. The fissures thus provide a direct route to the mole channel from the top soil. Where these fissures do not exist the perched water table must recharge a deep water table to allow drainage to take place. This process is very much slower than the short cifcuiting mechanism provided by leg fissures.

Fig. 3 shows two possible mechanisms for the operation of mole drains.

Continuity of fissures and cracks

Not all natural cracks in soil carry water. The only cracks which carry water are those which are continuous having an input level and a drainage point. A crack at the soil surface which cannot drain will fill but not conduct water. Only where cracks are continuous and inter-connected do they contribute to water flow.

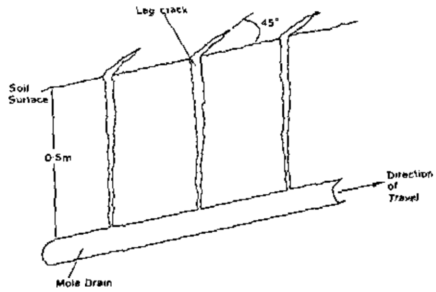
Cultivation often provides many continuous and mter-connected cracks in the topsoil. The mole drainage operation provides a direct connection between the layer and the drain.

If the mole drainage fissures do not connect with the cultivated layer then this dis-continuity will prevent water reaching the mole channel.

Maintenance of the continuity between the topsoil and mole drain fissures is of extreme importance. Ploughing in wet conditions can easily smear the fissures over. Even a very thin layer of smeared soil over the mole drain cracks could seriously reduce the effectiveness of the mole drain system.

In any event it is likely that material will fall into cracks in dry weather and cause blockage on re-wetting. Natural soil processes such as swelling and shrinking may also cause dis-continuities.

Subsoiling in the correct conditions over mole drainage systems may re-




*Diagrammatic representation of* **Fig. I.**

establish continuity. There is some evidence that subsoiling to within 100 mm of the top of the mole channel will not damage the channel.

The concept of continuity must also be followed through with respect to the mole channel which must remain continuous, to the gravel outfall and thus into the lateral drain. A free uninterrupted flow of water must be available if the drain is to respond as shown in fig. **2.**

Conclusions

Mole drainage is a viable means of draining many clay soils. The requirement of the mole drainage system is to take away excess water as quickly as possible in order to allow maximum drying times for these soils. For this rapid response, fissures must connect the mole channel with the top soil and surface layers. The continuity of such fissures must be maintained. Such fissures can be created by the leg of the mole plough and allow the effective drainage of clays with poorly developed structure in the subsoil.

Good fissuring in the soil must be combined with the presence of a stable and continuous mole channel which can easily discharge into gravel above a deeper lateral drain.

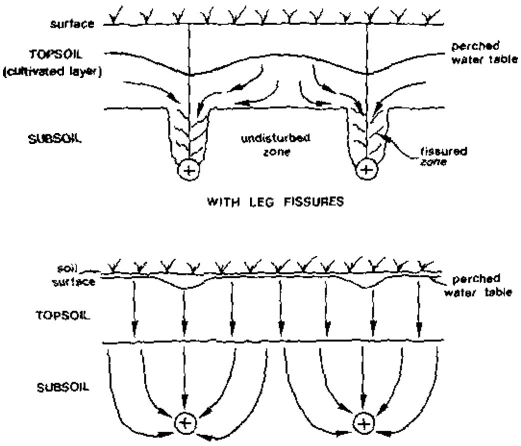



**Fig.** ***3. Two*** **possible modes of** ***Water*** **Flow to Mole** ***Drains.***

| TREATMENT | Position relative to drain: Overdrain | 0.5 m from drain | I m from drain |
|---|---|---|---|
| Mole **drain with leg slot and fissures** | 2325 | 25 | 23 |
| Mole **drain without fissures** | 41 | 18 | 13 |

**(diameter of infiltration ring 0.25 m)**

*Table* **I.** *Surface infiltration rate (in mm/hr) or different positions* **relative** *to mole drains at 2 m* **spacing.**

V10-2



Shallow moling ar Hirwaun Common Site brings a boulder to the surface.

# LAND DRAINAGE AND RESTORATION OF LAND AFTER NCB OPENCAST MINING

Opencast coal mining was originally introduced as an emergency powers measure, to meet energy demands **during** the Second World War. It was never envisaged that the operations would continue after the cessation of hostilities. However, when the National Coal Board Opencast Executive was formed in 1952 opencast mining was still expanding, and continued to expand to a maximum production in 1958 of 14.02 M **tonne/year.**

Between 1958 and the early 1970s successive Governments cast shadows over the industry's future to the extent that in 1966 production fell to 5.59 M **tonne/yr** which was the minimum economic level of operation. In the light of various energy crises since the early 1970s Government policies have been towards increased coal production and the current opencast production figure is 15 M **tonne/yr.** In this article Neil **Bragg** from the MAFF Field Drainage Experimental Unit summarises current advice and research in this specialist field of operation.

**Typical** methods of site operation

Once a site has been prospected and selected as suitable by the NCB an application for authorisation to work the coal is submitted to the Secretary of State for Energy. The Secretary of State may then defer immediate authorisation pending the results of a public enquiry which the Secretary may consider necessary.

In some cases this authorisation is deferred, pending the results of a public enquiry however and when sites become available for working the following procedure is usually followed. The first major operation is the removal and storage of all topsoil and subsoil into separate storage mounds. Care is taken to prevent the mixing of topsoil and subsoil but because of the variability of depth and nature of soil, it is not always possible and some mixing may take place. There are at present no easily available guidelines as to when and under what conditions the movement of soil is best undertaken, but ADAS soil scientists are examining the problems under various experimental headings. At present advice to avoid serious compaction is to ensure that soil is only moved when it is at a moisture content 5% drier than the lower plastic limit. The determination of such a moisture content and the lower plastic limit are carried out in the laboratory. Problems which are being examined in relation to these limits are: How typical is the sample? What practical constraints do the arbitrarily defined soil moisture limits put on the contractor? Can field measurements correlate with laboratory methods?

Soil may remain in the storage mounds for upwards of ten years, and often on opening up the mounds, which may be 10–15m high, the internal conditions may be anaerobic. Little investigation on the long-term aspects of storage has been done. Some work in the early 1950s by MAFF microbiologists and entomologists suggested changes in bacterial and **faunal** species, although recovery was apparently quite quick on respreading (Barkworth and Bateson 1964).

No work was done on the physical aspects of soil structure in storage, and organic matter changes. Only now is research effort being directed at the problem of soil storage. This work is being undertaken by various soil scientists of ADAS at regional centres.

Methods of reinstatement

The method employed largely depends on the size of site being operated at the time and can be broadly split into two classes. On the larger sites it is possible to undertake a progressive reinstatement od, though often some soil on t sites has to be stripped and stored so that an initial void can be made. Subsequently as the coaling void moves across a site, fresh areas to be worked are stripped and the material carried immediately round to the void which has just been reinstated. This method of working a site means that a minimum of soil needs to be stored for long periods and if the soil conditions are correct little physical damage to structure should take place when the soil is moved.

The second category of sites is where all the soil material is stripped and stored in mounds until mining has finished. Damage may easily have taken place to much of the material during stripping, and depending on the weather and the soil, may also continue to deteriorate while in storage. Respreading usually carried out within one season may again, damage the soil. Significant variation in the soil's physical condition may be observed from one storage mound to another depending on the climatic conditions under which they were erected.

Return to agriculture

If a site was in agriculture prior to mining then with few exceptions the conditions attached to the authorisation will normally require that it be restored to agriculture.

The Ministry of Agriculture, Fisheries and Food (MAFF) is consulted by the Department of Energy before authorisation is granted for opencast coal working and advises on the conditions which should be imposed to ensure restoration for agriculture.

In order to do this a comprehensive survey and repori is made on the soils, agricultural land quality, land drainage and existing condition of the land. Detailed recommendations on the handling and replacement of the available soils are made to the NCB.

When the earth moving works necessary to achieve the restoration of a site have been completed MAFF, acting as agents for the NCB, carries out a 5 year agricultural management and aftercare programme on the land. This will normally include cultivations, fertilising, seeding, fencing, planting of hedges and trees, installation of water supplies, excavation of ditches and installation of underdrainage schemes and secondary treatments such as subsoiling and moling.

**Land drainage**

As part of the pre-authorisation consultation, ADAS drainage specialists assess the existing and future drainage requirements of the land. The advisers are also responsible for the design layout of the site drainage after reinstatement and this will often be much influenced by traditional local practice of scheme spacing and depth. Within the 5 year aftercare programme, drainage has tended to be left until year 4 or 5 in order to allow settlement to take place and has usually been carried out prior to reseeding with the permanent ley mixture.

Arguably, as many of the sites have had much of their overburden replaced as long ago as 2 years prior to final topsoiling, much of any likely settlement should have occurred. Consequently drainage could therefore be installed much earlier in the 5 year period. Also without underdrainage in the early stages after reinstatement, erosion risk is increased, and removal of excess surface water will be left to evapotranspiration only.

Current research and development by the Field Drainage Experimental Unit and LAWS officers is aimed at the following broad categories:-

*1)* The earliest suitable time to enter a site and at least *establish* some form of underdrainagesystem, accepting that someparts of a system may *be sacrificial if major settlement* does occur.

2) Identification of soil physical porameterswhich willaffectdrainage of water down through both the natural soil profile and the disturbed profile.

*3)* Consideration of the type, nature and number of times *secondary* treatments over the drainage scheme will be necessary to alleviate compaction. Compaction and horizontal layering of the soil imposed during respreading are the two major problems encountered on reinstated soils.

4) The advantage and necessity of *the use* of permeable *backfill on* drainage schemes where secondary treatments are to be used to facilitate drainage and *relieve compaction.*

*5)* Long-term effectiveness of drainage on reinstated land and the economics of differing designs.

Experiments which have so far been set up are as follows:

a) In South Wales and Shropshire large-scale (0.3 ha) block experiments are monitoring drainage design performance. The design philosophy of treatments is such as to give initially as large a contrast between mere skeletal systems and possibly over-elaborate systems of drainage. Wherever possible and desirable the local practice is incorporated in the system for comparison. The South Wales experiment has so far yielded two years of hydrological data, before and after secondary treatment (see fig 1 for layout). From the first year's results on the most intensive drainage interception system available, 95% of incidental rainfall was drained away from the surface. The surface was thus apparently acting as a 'paved area', i.e. compacted and sealed, and caused sheet runoff.

Work in Wales has also been undertaken on soil physical parameters which might affect drainage, and some questions are raised as to whether the methods used really allow or give a true assessment of the actual nature of drainable pores on a reinstated soil. Further, design work by colleagues in the Welsh Office on new deep cultivation tools has been carried out and a full account of this work will be available later in 1982 (Bragg et al — in preparation).

b) Two pieces of work on soil physical parameters and drainage have been attempted on a number of sites of varying age since reinstatement. The work has been aimed at looking at drainage schemes, their efficiency in control of watertables, the physics of the soil and biological indicators of soil fertility. Again papers on both subjects are in preparation (Armstrong and Bragg).

c) Re-examination of a previous FDEU site in Northumberland called 'Radar' has now allowed us to examine the use of permeable filled (PF) drains and non-permeable filled drains, which have been in the ground for just over 15 years. The previous experimental report was compiled by FDEU workers who were then considering plastics pipe vs. tiles (Trafford and Twocock 1972). The site after certain catchment modifications has been successfully monitored over two winter periods, and drainflow recorded from gravelled and non-gravelled drains. Also, following identification of soil compaction at 30–35 cm depth, the site was subsoiled in 1981 for the first time since 1969 and therefore the effect of the secondary treatment has been recordable on drainflow traces. This work is now being presented as a paper (Bragg and Arrowsmith — in preparation).

Figures 2 and 3 show the drainflow response under two similar rainfall events before and after subsoiling at Radar. Peak flows PF and non-PF drains are noticeably different and total drainflows are markedly different. The advantage of the use of PF over drains under such circumstances for the removal of excess water quickly and efficiently would appear obvious.

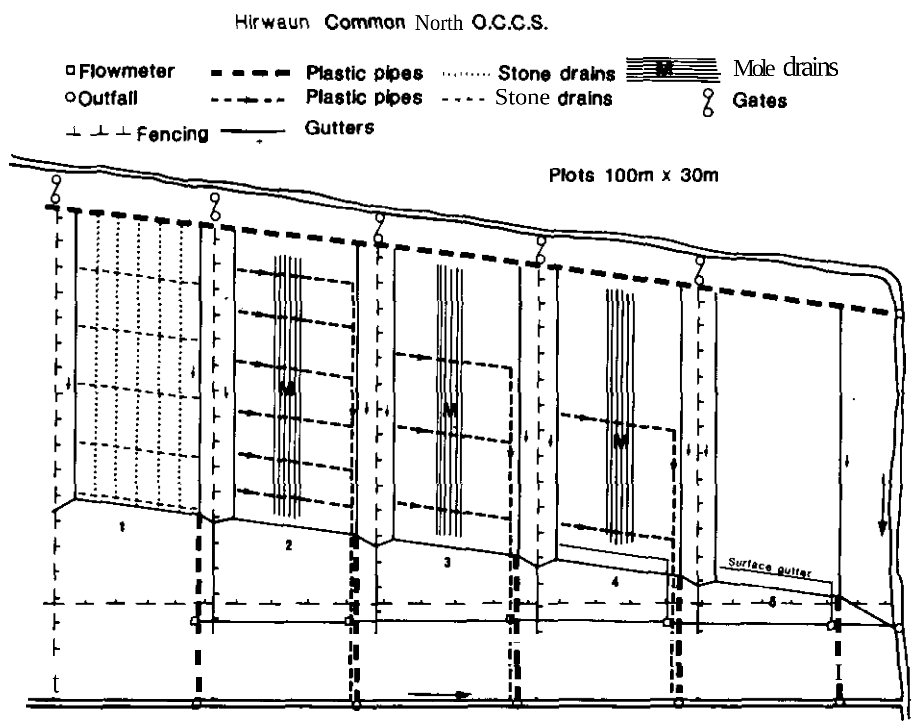
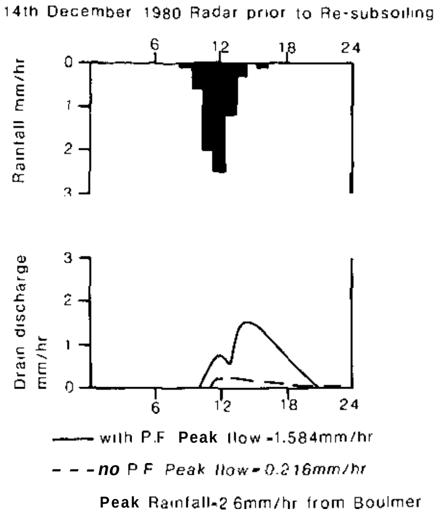



*Figure 1. Plot layout.*

V10-2




## Conclusion

So far the work has been aimed at identifying the problems of reinstated soils and how these affect drainage design. The physical soil examinations have indicated that the soils on reinstated sites are very different from their undisturbed neighbours. The monitoring of drainage on sites of differing age from reinstatement indicates that where a true control is established there are significant differences between the worked and unworked land.

The drainage experiments indicate that for drains to be responsive to rainfall incidents they should have a PF connection with the surface layers. This connection will initially intercept sheet runoff from sealed and compacted soils and will then provide a true connection for secondary treatments.

Further work is needed to look at the long-term effects that storage may have on soil structure and particularly on whether existing drainage can be revitalised by timely secondary treatments. Also the effectiveness and number of times secondary treatments are undertaken needs investigating.

From the work reported in this article it is apparent that comparisons between worked and unworked land are probably meaningless. The future lies in experimentation aimed at differing management levels — drainage, cultivations, cropping, husbandry — being compared with reinstated land, hence to establish its potential.

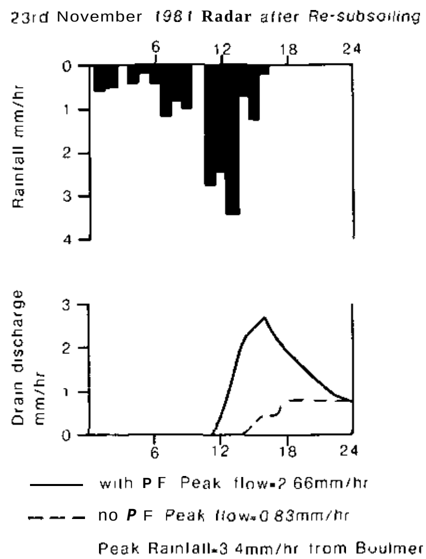



*Figure 2 & 3. Drainflow response, before and after subsoiling at Radar Experimental Site.*

## Acknowledgements

The Author acknowledges the assistance of Mr. J. Craig, Principal Surveyor, Nottingham for his help in writing the paper.

## References

*Armstrong, M. J. and Bragg, N. C. (1982) — in preparation. Examination of soil ferrility levels using biological indicators.*

*Arquile, P. T. (1975) Colliery Guardian vol. 223 no. 2. Opencast Coal Mining in Britain. The first 32 years.*

*Barkworth. H. and Bateson, Mary (1964) Plant and Soil 21.3. An investigation into the bacteriology of topsoil dumps.*

*Bragg, N. C. and Arrowsmirh, R. (1982) — in preparation. Final report 'Radar'.*

*Bragg, N. C., Bell, S., Griffith, C. and Jones, A. (1982) — in preparation. Paper to be presented at the North of England soil discussion group, September 1982.*

*Davison, D. J. (1971) Colliery Guardian Annual Review: Restoration and reclamation of opencast sites.*

*Trafford, B. D. and Twocock, J. G. (1972) MAFF FDEU report 'Radar'.*



## NEW BOOKLETS

Recently a whole range of excellent additions to ADAS leaflets have been published.

### Design of Field Drainage Pipe Systems

***A must for all contractors this publication provides the essential design elements for determining pipe sizes. The booklet, No. 345 price £2.50 available from HMSO bookshops comprises a range of charts for speedy day to day use.***

### Conservation in Practice — Field Drainage and Water Storage

***Giving information on planning and performing drainage operations in areas of natural beauty — with advice on the use of herbicides, canalisation and establishment of niches for wildlife.***

### Farming and the Countryside

***A quality booklet with excellent colour photographs, available for the first time at the Royal Show, now obtainable from Divisional Offices.***

### Soil Examination for Autumn Cultivations

***Produced by ADAS soilscientists this simple but effectiveguide will be of interest to all involved in soil management. Colour photographs illustrate a range of profile conditions and must help the farmer in his assessment.***

**FOR MORE DETAILS CONTACT YOUR LOCAL MINISTRY OFFICE.**

# STEAM POWERED CULTIVATIONS

Michael **Williams** of Howard Rotavator takes a nostalgic trip down **memory** lane and reveals how the pioneers of steam powered cultivation equipment fought against tremendous technical and economic problems to help keep British Agriculture ahead of our competitors.

Victorian engineers were fascinated by the Dower of the steam engine. Steam had already brought enormous social and economic chan ge ith a new way of life for millions in the factories and towns of the Industrial Revolution, and a transport revolution on the railways and across the oceans. Steam appeared to have almost unlimited possibilities as a source of power, and Britain was far ahead of any other country in the development of steam engine technology. There were even some quite promising experiments with a steam powered flying machine.

Progress was less rapid on e farm where there were siderab t cal economic problems in making effective use of steam power, especially for cultivating the soil. The problems and the possibilities were a challenge to Victorian ingenuity which resulted in an extraordinary assortment of theories, patents and contraptions. Few of the engineers and landowners whose names appear in the patent records made much profit from their efforts, but they often showed great technical skill and imagination, and a determined optimism that most things are possible if one tries hard enough.

## Power Farming

The earliest record of steam being used on a farm comes from an estate near Wrexham. North Wales, where an engine was' installed in 1798 to Dower a threshing machine. This was almost certainly the beginning of power farming, but there appears to have been little interest in the idea at the time and others were slow to follow the Wrexham example.

The hesitation was probably a problem of economics rather than of technology. The owner of the Wrexham estate also had substantial industrial interests and operated several Boulton and Watt engines in his factories. The factories may have encouraged his interest in using a steam engine on one of hrs farms, and they probably helped to pay for the engine.

In 1805 it cost £325 to buy and install an engine on a Northumberland estate. At that time a skilled ploughman might earn £12 a year, plus his bed over the stables and his food. The Northumberland engine was rated at 5 hp, but its owner claimed it replaced six horses when powering a threshing machine. The running costs were considerable, including 10/- (50p) for the 24 bushels of good coal burned in six hours. The work rate was 1.000 sheaves an hour through the thresher.

All the engines installed on farms before 1841 were stationary, providing the power for threshing machines and for barn equipment such as root pulpers and chaff cutters. The fact that the engines could not be used for field work was a considerable limitation, as the horses no longer required to operate the threshing machine were still needed to pull the plough.

## Portable Engines

Some progress was made in 1841 when portable engines were developed. These were mounted on wheels and pulled by horses from place to place on the farm, or from one farm to another when operated by contractors. The portable engines, of which Ransomes Sims and Jefferies, then known as J. R. & A. Ransome, were the first manufacturers, were however of limited value for turning the soil. Self-propelled traction engines arrived soon after the portable and brought renewed interest in ideas for cultivating by steam power.

The most obvious idea was to hitch the plough or cultivator to the back of the traction engine. This rarely achieved much success, mainly because of the poor power to weight characteristics of the early steam engines and the difficult conditions on the heavier soils in Britain. Ploughing and cultivating by direct traction became important at a later stage in some of the wheatland areas of North America where soil and weather conditions are more favourable and reliable, and where there was greater economic pressure to develop more efficient engines. Some of the biggest American traction engines developed well over 100 hp and handled 12 Furrows, ploughing more than four acres an hour in the early 1900s. Several manufacturers also offered four-wheel drive.

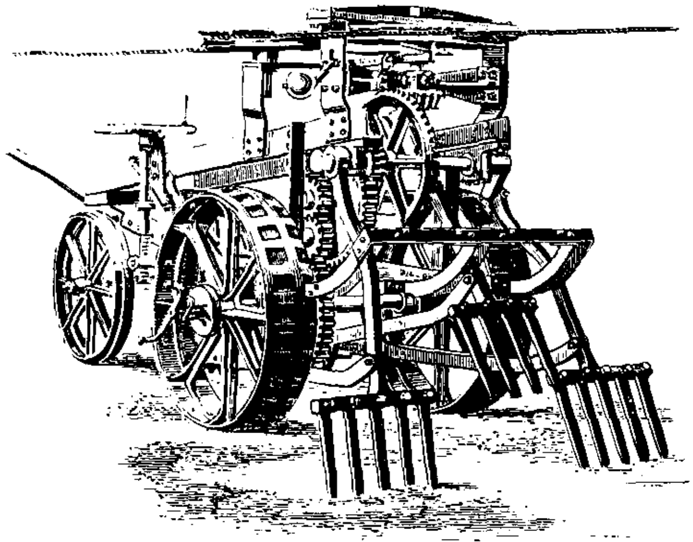
## Underground Steam Pipes

For British conditions a more promising idea was to keep the wheeis of the steam engine off the soil. This was the approach which eventually succeeded, but the successes were outnumbered by the failures. Henry Pinkus in 1839 took out a patent for a system of pipes to be laid beneath the soil surface, through which steam could be forced under high pressure from a boiler. According to Mr. Pinkus, the steam would be used to power a 'ploughing apparatus', the details of which were not revealed. Mr. Pinkus may not have been entirely convinced of the success of his own idea, for in the following year he filed another patent, this time for using electricity to power various equipment in the fields.

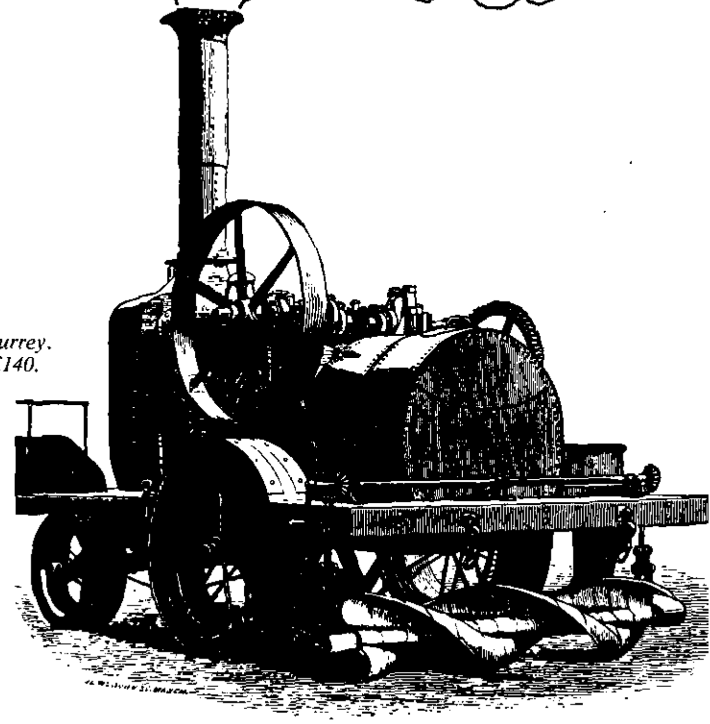
Mr. W. Bridges Adams, also relying on a network of underground steam pipes, revealed even more exciting possibilities in a paper read on his behalf in 1856 at a London meeting of the Society of Arts. He suggested that steam forced into the soil under pressure would 'fissure the ground', thus avoiding the cost of ploughing. As the steam was released

V10-2

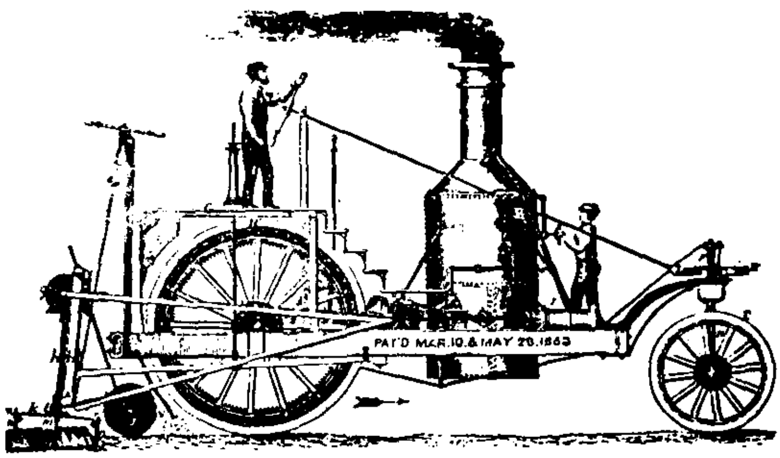
# . . . STEAM NOSTALGIA



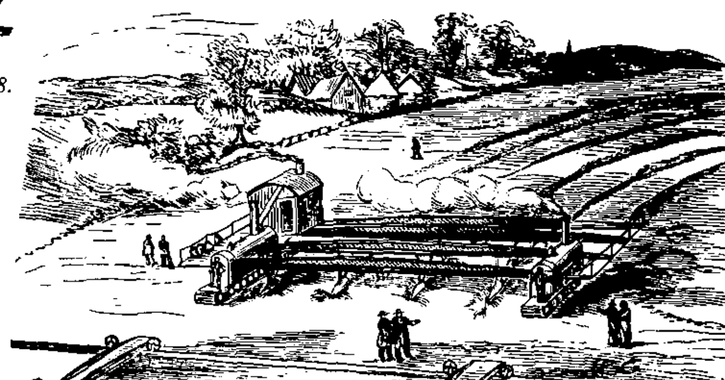
*A digging machine designed for hop gardens by John Knight of Farnham, Surrey. The machine was powered by a cable system and the list price in 1876 was £140.*



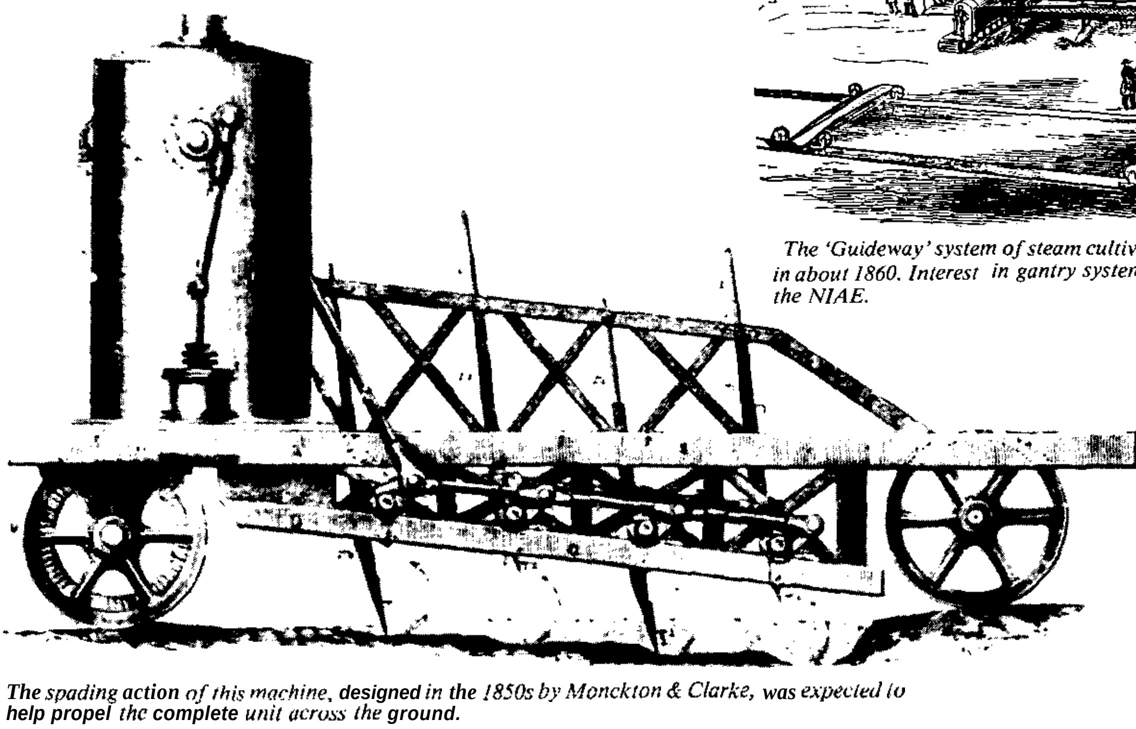
*This rotary cultivator, built in 1858 at the Castle Foundry, Buckingham by David Rickett had a 7 ft. rotor driven against the direction of travel.*



*Philander Standish of America demonstrated this steam powered cultivator in 1868. He named it 'The Mayflower'.*



*The 'Guideway' system of steam cultivation as improved by Henry Grafton in about 1860. Interest in gantry systems has recently been revived by the NIAE.*



*The spading action of this machine, designed in the 1850s by Monckton & Clarke, was expected to help propel the complete unit across the ground.*

into the soil through the pipe system, it should be used to carry plant nutrients in gaseous form. He advised, that this would do away with the job of hauling and spreading farmyard manure. A further, and slightly unexpected benefit of the system, would be an increase in the temperature of the soil as steam was released; this would encourage crop growth in winter and also make the ground more pleasant to walk on!

Most of the ideas and inventions were more realistic than these, and they often included developments which were simply years ahead of their time. Gantry systems, rubber tyres, powered implement lifts, crawler tracks and rotary cultivators all made a brief appearance between about 1820 and 1870, long before the technology had become available to allow them a chance of success.

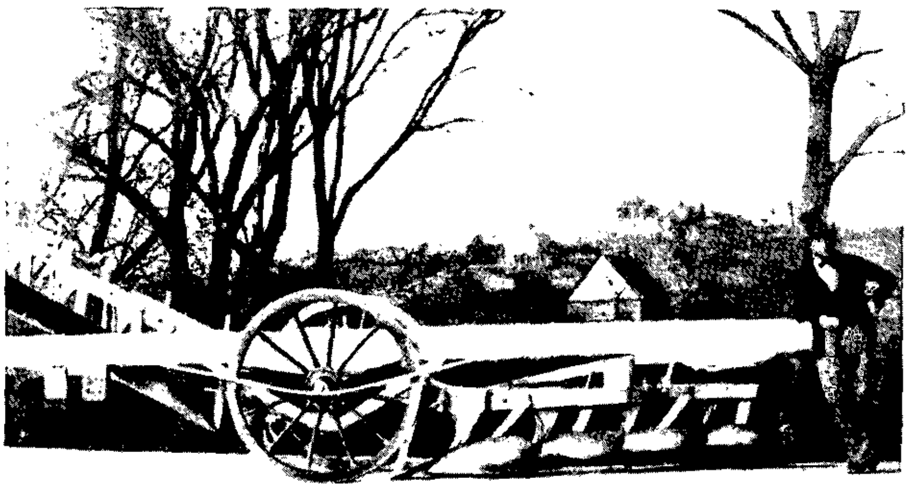
## Cable Ploughing

From a confusing assortment of different ideas, it was the cable ploughing system which eventually became a commercial success in Britain and Europe. There were several attempts ro dev p a cable system, dating from abc 1810, but the first evidence of success came in reports of a demonstration at the 1829 ploughing match of the West Kent Agricultural Association. This demonstration seems to have been a modest affair and attracted surprisingly little interest at the time; a stationary engine was used to power a winding drum pulling a cable or rope with a mole plough attached to the end of the cable.

John Heathcoat, Member of Parliament for Tiverton, Devon and ith substantial interests in the textile idustry, was much more ambitious in his experiments. He took out his first patents in 1832, and demonstrated his cable ploughing system for marshland in 1835. It was reported at the time that he had sunk £12,000 in developing his equipment, a very large sum of money at that time. The word 'sunk' is appropriate, because his huge machine embedded itself firmly in soft ground during its second public appearance near Dumfries, and according to one report the entire contraption disappeared from view.

A Scotsman, Alexander McRae, working as the manager of a British owned sugar estate in Guiana, built what is described as the first successful cable ploughing apparatus. Part of the sugar estate was laid out with a series of parallel irrigation canals and McRae put a steam engine and winding drum on a barge on one canal, with an anchor point on another barge on an adjacent canal, and a cable running between the two. A plough was attached to the cable, and wound towards the steam engine as both barges moved forward at a very slow pace. This system sounds highly improbable, as it must have been difficult to keep the plough straight and avoid pulling it into the canal, however it seems to have worked reasonably well, and a demonstration was organised in Scotland, with the steam engine mounted on the headland.

There were many attempts to develop the idea of cable ploughing. William Smith, a Buckinghamshire farmer used a portable engine and a reversible winding drum or windlass to power his 'Roundabout' cable system. The winding drum, with a cable mounted on a series of special posts or carriers, could pull a plough to and fro. This system was suitable for irregularly shaped fields, and could use existing portable engines which were relatively inexpensive. J. & F. Howard of Bedford marketed the 'Roundabout' system for several years, helping to bring steam ploughing within the reach of some smaller estates and farms.



*One of the first balance ploughs built for the Fowler double-engine cable systems.*

John Fowler is the name which is most closely associated with cable ploughing. His success started with a Silver Medal at the 1850 Royal Show for a mole plough pulled by a cable. The cable was attached to a drum which was turned by muscle power at first, and later by steam. A major breakthrough came in 1856 when the two-way balance plough was developed with help from Ransomes who built and tested the prototype. This led to the development of the single and double-engine cable sets which helped Fowlers to become one of the most successful and famous farm equipment manufacturers in the world.

## Powered Cultivations

The only competition for the cable system of ploughing and cultivating came from the many determined and ingenious attempts to design some form of rotary cultivator. The experimental machines came in a great variety of shapes and sizes. Most were built around the idea of a rotor on a horizontal axis – similar to the modern Rotavator and Rotaspike.

An American engineer, Philander Standish of California, designed a self-propelled machine with a powered vertical rotor at the rear, similar to a Gyrotiller or large Roterra cultivating unit. This machine was demonstrated in 1868, but failed to find a market. There were also the powered diggers and the rotary ploughs, which had little lasting impact on the progress of farm mechanisation.

## Conclusions

There was a widespread belief that steam power would take over from the farm horse. Francis Moore, one of the first steam enthusiasts, sold his own farm horses and advised his neighbours to do the same, after he had patented a new system of powered cultivations in 1769. His advice was based on the belief that his new equipment would make the horse redundant. A Farmers' Club audience in 1855 heard J. A. Williams from Baydon, Wilts., forecast that steam could replace almost 2 million horses on British farms, with enormous economies in feed costs. At about the same time a Smithfield Show Society meeting heard how the deeper cultivations then possible with steam power would so benefit the drainage of clay land that the ground conditions would be greatly improved for *foxhunting!*

The enthusiasm and determination brought modest results. The steam engine made only limited progress as a replacement for the horse, in spite of the ingenuity of many of the inventors and the support of some of the great landowners. The farm horse remained unchallenged as the most important source of power until about 1917 when Henry Ford announced the first really low-priced farm tractor. This first Ford tractor was a threat to the farm horse, and helped to finish the steam engine as a power on the land.

# IRRIGATION U.K.: COSTS AND BENEFITS

Joe Morris.

"In October 1981, the U.K. lrrigation Association held a one-day workshop at the National College of Agricultural Engineering, Silsoe, to consider the Economics of U.K. Irrigation. Twenty-four representatives of various interested parties (farmers, advisers, consultants, manufacturers, water authorities, academics) attended, about half of whom presented short papers, followed by discussion. The purpose was to collate the existing state of knowledge on the feasibility of U.K. irrigation, the adequacy of the existing data base for feasibility assessment, and the most appropriate investment appraisal techniques. The workshop was also to make recommendations regarding the need for further study which would aid the irrigation investment decision. An overview of the day's proceedings is given in U.K.I.A.'s lrrigation News (3) Summer 1982 (Economics of U.K. Irrigation, J. Morris). Below, the Chairman of that UKIA workshop briefly considers the costs, benefits and worthwhileness of U.K. Irrigation."

At present about 7000 farm holdings in the U.K. have irrigation, covering a total of about 123,000 hectares. The Advisory Council for Agriculture and Horticulture (1980) predicted an increase to over 300,000 hectares by the year 2000 (ACAH: 1980). The pressure to increase productivity in order to protect farm incomes, and market developments which reward improved quality, uniformity, and regularity and reliability of supplies, are factors which will encourage an expansion of the irrigated area. The biggest predicted increases are for potatoes, sugar beet, vegetables and grassland. Whilst there appears to be sufficient water generally available to support the predicted expansion, local shortages could develop, and winter storage will be a common feature of future irrigation investment.

lrrigation Costs

lrrigation costs vary according to individual farm circumstances particularly concerning the type of water source, the features of the irrigable land, and the irrigation requirements of the crop. Two major investment decisions relate to water supply and infield equipment.

(1) *Water* Supply Costs:

With respect to water supply costs, the main components include water abstraction charges, pumping, storage, and mains pipeline. Water abstraction charges vary between Water Authorities. All Authorities charge differential rates for winter and summer abstraction. Where summer abstraction is permitted, charges may exceed winter rates by a factor of five or six times. The Anglia Water Authority, for instance, currently charges £1.65 and £10.24 per 1000m³ in winter and summer respectively.

Where direct abstraction is not possible, natural conditions, combined with irrigation needs, determine the most technically and financially appropriate water supply option. The choice is between boreholes which exploit natural storage opportunities and artificial reservoirs which consume land. A comparison of water supply costs compiled by Hawes (1981) shows that in terms of £ per 4550 m3 (1 million gallons) equivalent yield, wellpoints and boreholes cost around £750, and reservoirs, depending on the need for lining, cost about £1,500. These figures rise to about £4,000 where impounding is necessary. Over recent years, the real cost of reservoir construction per million cubic metres has declined, mainly due to economies of scale in the construction of larger reservoirs, and improvements in earthmoving techniques.

Additional expenditure is required for main pipelines at approximately £1.50 per metre of 25 millimetre diameter pipe.

***(2) Infield Equipment:***

A wide range of infield irrigation equipment and systems are available which vary in terms of capital cost, labour requirements, and flexibility of use. Developments in irrigation equipment largely reflect attempts to economise field labour, although this has been achieved by increasing capital costs. More recently, low pressure systems have been developed with fuel economy in mind.

A comparison of irrigation system costs per hectare millimetre are given in Figure 1. Conventional hand move systems appear to have the overall advantage, followed by self travellers. Drip irrigation, most suited to fruit crops, demonstrates low labour and fuel costs, but fixed costs are high. Expectedly, centre pivot systems are relatively expensive for small areas. Cost minimisation however is rarely the sole selection criterion. Other considerations will include labour requirements and availability and ease and flexibility of usage.

Total Costs

Total irrigation costs (£/ha mm) for three types of infield system, (conventional sprinkler, self traveller, and centre pivot) and three water supply situations (no storage, borehole, and lined reservoir), are contained in Table 1. These figures assume an application rate of 100 millimetres per hectare over 24 hectares. The least cost system is predictably the conventional sprinkler without storage at £2 per hectare millimetre confirming the "£20 per acre inch" often quoted by irrigators. Centre pivot systems, although expensive on small areas, can demonstrate considerable economies of scale. On the basis of one Norfolk farmer 'pivotting' on 86 hectares, unit costs compare favourably with self travellers. Water storage costs add significantly to this; more than doubling unit costs where a lined reservoir is needed.

Irrigation **Benefits**

Increasing profitability and reducing variations in profitability year to year are two main reasons why

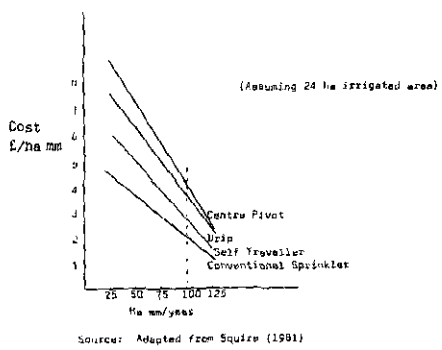



*Figure 1. Comparative costs of Irrigation Systems.*

farmers irrigate. The benefits of irrigation manifest themselves in terms of increased and more reliable crop yields, improved quality, continuity and timing of production and marketing, and an insurance against crop failure in years of drought. Generally the greater the deficit between rainfall and potential evapotranspiration the greater the crop response to irrigation. Crop response, and resultant irrigation benefit are difficult to predict or generalise because they depend not only on uncertain climatic factors but also on crop type and variety, the stage of crop development, the standard of crop husbandry (including fertiliser use), and environmental conditions, especially soil type.

| | Conventional Sprinkler | Self Traveller | Centre Pivot | Centre Pivot (3) |
|---|---|---|---|---|
| | 24 hectares | | | 86 hectares |
| No Storage (2) | 2.0 | 3.0 | 4.4 | 3.0 |
| Borehole/Unlined Reservoir (4) | 2.8 | 3.8 | 5.2 | 3.8 |
| Lined Reservoir (4) | 4.4 | 5.4 | 6.8 | 5.4 |

(1) Net of grants (22½ to 32½%) on water supply works.
(2) Adapted from Squire (1981).
(3) Based on Records by Nelstrop (1981).
(4) Adapted from Hawes (1981).

**Table I. Summary of *Estimated* Irrigation Costs (1981 prices) *£/ha* mm assuming *100 mm/ha* application (I)**

| CROP | AVERAGE YIELD RESPONSES t per ha mm of water (1) | PRICE £ per tonne (2) | GROSS MARGIN RESPONSE £/ha mm (2) |
|---|---|---|---|
| Cereals | 0.018 | 115 | 2.1 |
| Grass Dairy | 0.125 DM | 430/Cow | 1.7 |
| Grass Beef | 0.025 DM | 160/Lu | 0.6 |
| Potatoes Early | 0.08 | 150 | 11.0 |
| Potatoes Main | 0.08 | 60 | 4.3 |
| Sugar Beet | 0.13 | 27 | 3.2 |
| Peas Vining | 0.04 | 150 | 5.2 |
| Runner Beans | 0.05 | 230 | 6.0 |

(1) Source: ADAS 1977
(2) 1981/2 Prices and Gross Margin Estimates

***Table 2.* Average *Irrigation* Responses & Additions to *Gross* Margins**

A surge of interest in irrigation following the dry years of 1975 and 1976, encouraged an ADAS Working Party (1977) to estimate the average yield response per hectare millimetre of water applied based on available experimental data and field experience for well managed crops in areas of established need. These estimates of average crop response and the resultant additions to gross margins (in 1981/2 prices) are contained in Table 2.

The assumptions on which these estimates are based severely limit their usefulness for decision making. A more useful approach would allow crop response estimates for specified weather type years, local conditions (particularly soil) and given farm husbandry situations. Furthermore non-yield factors, such as quality, uniformity and price, need to be incorporated in the benefit assessment.

In the absence of such an approach, the prediction of irrigation benefits is presently limited to generalised averages.

**Worthwhileness**

Within the constraints imposed by the available data, an indication of the relative feasibility of crop and irrigation system combinations can be devised by comparing the estimated costs (Table 1) with the estimated returns (Table 2).

Predictably, irrigation appears more financially attractive and there is more scope for irrigation system choice when responsive crops such as early potatoes and field vegetables are grown. To a large extent, the numbers confirm what farmers do in practice; irrigating high value horticultural and field vegetable crops, whereas cereals and grass are irrigated under extreme circumstances or when surplus capacity exists.

**Summary** Discussion

With respect to costs, actual irrigation costs per hectare millimetre will vary according to the need for water supply investment, and the level of use. Some cods may be more apparent than real. For example, inflation reduces the real cost of interest charges; a water supply improvement often represents an appreciating asset. Generally, once the irrigation investment has been made, operating costs account for about one-third to one-quarter of total annual costs. Where surplus capacity exists, therefore, use on relatively low response crops such as cereals and grass could be justified.

With respect to the foregoing assessment of benefits, the use ,of 'average' response rates is a major oversimplification. Irrigation a hardly concerned with 'averages' and their use is, if anything, likely to underestimate benefits. Furthermore the assessment does not include such benefits such as the value of increased quality, prices (in years of generally poor yields) and regularity of supply all of which irrigation can help to achieve. Another consideration is that operating characteristics of different irrigation systems (such as droplet size, application rate and frequency) may give rise to different benefits, particularly for sensitive crops.

With respect to worthwhileness, Tables 1 and 2 suggest that fruit, vegetables, potatoes and sugar beet represent the descending order of financial feasibility. Irrigated cereals and grass for dairy can be worthwhile at high performance levels or where surplus capacity exists. Criteria other than profitability may be important, notably reducing variations in net farm income, improving the productivity of existing farm resources, especially on small farms, and increasing net worth. An important criterion is that of 'opportunity cost'; whether the resources tied up in irrigation could be better invested in some other aspect of the farm business.

In addition, the cash flow implications of the irrigation investment, namely the size and timing of irrigation costs and revenues, and the need for borrowing, should be identified. Financing capability would consider the whole farm perspective rather than view irrigation in isolation (Manson 1981).

in practice, irrigation situations vary so widely that generalisation on costs, benefits and worthwhileness are difficult and can be misleading. If nothing else, this short paper draws attention to the urgent need for more research into estimating crop/water response for specified irrigation situations classified by soil, climate and husbandry.

REFERENCES


| | | |
|---|---|---|
| *ADVISORY* COUNCIL FOR *AGRICULTURE & HORTICULTURE IN ENGLAND & WALES* | 1980 | '*Water* for Agriculture; Future Needs' MAFF |
| *AGRICULTURAL DEVELOPMENT & ADVISORY SERVICE* | 1977 | 'The Economics of *Irrigation*' Working *Party* Report |
| *RAMANATHAN, G.* | 1981 | '*Grass* Response *to Water*' Unpublished M.Sc. dissertation – N.*C.A*.E., *Silsoe*, *Bedford* |

*Papers presented at* the U.K. Irrigation *Association Workshop on the Economics of* U.K. *irrigation, National* College of *Agricultural* Engineering, *Silsoe, Bedford.* 28th October 1981, by:

| | | |
|---|---|---|
| *HAWES, S. M.* | 1981 | 'Relalive *Costs* of Water Storage *Projects* for Irrigation' |
| *MANSON*, J. *C.* | 1981 | '*Finance* for Irrigation' |
| NELSTROP, *J.* L. | 1981 | 'Irrigation Using Centre pivot' |
| SQUIRE, *M.* | *1981* | 'Irrigation *Systems:* Comparisons & *Development*' |

V10 -2



# SOIL TILLAGE RESEARCH IN YUGOSLAVIA

Dr. **Bruce** Ball of SIAE reports on the 9th International Soil Tillage Research Organisation meeting held in June 1982 in Yugoslavia.

The conference at Osijek, was at the centre of a region of intensive agriculture in the Socialist Republic of Croatia and was sponsored by the Federal Committee of Agriculture, Belgrade, the organisation being led by the President of ISTRO, Prof. dr V. Mihalić of Yugoslavia. It was attended by about 250 delegates from 28 countries, about half being from the host country. The theme was Ameliorative Tillage and the main part of the conference consisted of a series of 10 minute talks delivered in sessions held in the mornings. After the initial sessions on ameliorative tillage the delegates split into morning sessions for detailed study of other specialist topics which included the influence of tillage on soil properties, energy use, weed and disease control, reduced tillage, systems of plant production and new tillage machines. The talks based on short papers, have been bound into a single compact volume of Conference Proceedings. These are available from Prof. dr V. Mihalić, Faculty of Agricultural Sciences, University of Zagreb, Simunska c.25, Zagreb, Yugoslavia.

Afternoon sessions, comprised excursions to field experimental sites containing maize, wheat, soya bean or oil seed rape, at sites where chernozems, rigosols and semigleys were viewed with great enthusiasm by foreign delegates. Several industrial agricultural combines were visited both near Osijek and near Novi Sad, on the Panonia plain. The local managers greeted delegates with enthusiasm and treated them to excellent hospitality. Delegates and their guests were also entertained with sightseeing and theatre visits. One most popular excursion was to Vukovar Agricultural Industrial Plant where many wines and an enormous banquet were provided for sampling. Dancers and musicians in local costume entertained the delegates at their conference dinner and joined them to make a most enjoyable evening!

During the conference an exhibition of "Soil Tillage in the history of Slavonia and Baranja" was staged in the conference centre and several delegates also displayed posters of their research.

The conference revealed the great enthusiasm of the hosts for promoting and encouraging all aspects of soil tillage research and their hospitality and helpfulness was much appreciated by the delegates. All were impressed by the quality of intensive agriculture in Yugoslavia and by the extensive local research programmes.

During the week after the conference, some delegates attended a post conference trip to Dubrovnik where they lazed in the sand, sea and sun.

At the end of the conference, the new president of ISTRO, Professor J. W. Ketcheson, University of Guelph, Ontario, Canada was appointed. The next conference of ISTRO will probably he held at the University of Guelph, Ontario, Canada in 1985. Watch this space for more details!

*Cultivation equipment in Yugoslavia.*

Soil and Water, Volume 10, No. 2, Autumn '82

# WEEDS AND WATERWAYS — A REPORT ON THE FOURTH ADA DEMONSTRATION

The historic Berkeley Castle in South Gloucestershire was the backcloth for the fourth National Demonstration organised by the Association of Drainage Authorities. The two day event was held on the Castle meadows where an extensive display of the latest machinery, equipment, and materials was staged. The demonstration sites were arranged along the rhynes and banks of the Little Avon River, which surrounded the static displays and marquees.

For the first time the event was hosted by the South Gloucestershire Internal Drainage Board which comprises an area extending from Bristol in the south to Gloucester in the north, bounded by the River Severn and the Cotswold escarpment to the east. The Board is responsible for some 220 miles of waterways, and land drainage pumping stations controlling areas previously subject to flooding by either high estuary tides or high river levels.

Tom Hodges was the local organiser, and the planning was by the ADA Technical Committee with the responsibility in the capable hands of their past-Secretary H. 'Joe' Price from South Holland IDB in Lincolnshire. It proved to be the best attended demonstration yet, with some 1,500 visitors, chiefly regional IDB members and staff, and some 40 manufacturers. The latter all reported that the event had been worth attending and that there was positive interest in their displays.

Amongst the Internationally known companies were Barth GB, Mastenbroek International, Bradshaws of Stibbington, Priestmans, K & K Mahtechnik from West Germany, & Sykes Pumps, & Flygt Pumps. There were also several companies who entered this field for the first time.

The site was ideal for many of the working demonstrations. The Little Avon river provided opportunities for the excavators, and weed cutting boats of which there were three on display. The Rolba, the Wilder, & the Italian Netunno showed their paces in cutting and clearing weeds in main channels.

Jetting of drains, water pumps, control of weeds by sprays, and other ancillary equipment to increase the efficiency of work, and to maintain good performance of arterial and feeder drains stressed the extensive responsibilities of the IDB's and a demand for improved efficiency.

The attendance on the second day of the Minister of State for Agriculture (Lords) Lord Ferrers certainly gave the official seal of approval to the event. His enthusiasm for the event soon showed in his discussions with many manufacturers, and there was no doubt that he was most conversant with the problems and the machines on show. With a minimum of instruction he soon was in the driver's seat of the sophisticated Barth C 30 ditch cleaning machine.

At the Press conference Lord Ferrers commented on the news of the Government's decision to abolish the National Water Council. He stated that it would lead to greater efficiency, and in spite of a reduction in Board members it should not seriously affect representation in the regional IDB's. Further, he stressed that the role played by the IDB's was vital, both to agriculture and to the preservation of the countryside.

The soil and its structure is, he said, the most important single factor in agricultural production. Drainage and the dispersal of water on the arterial waterways must be as efficient as can be made.

Lord Ferrers visited marquee displays mounted by ADAS, the National Water Council, the South Gloucestershire IDB, WRO, SAWMA, Wild Life Preservation Society, & the Fresh-water Biological Association.

There is no doubt that this event is set for an established place in the Agricultural calendar, and there are indications that demand requests it should be held every two years. The next scheduled ADA Demo is to be near Thorney, Peterborough.

V10-2

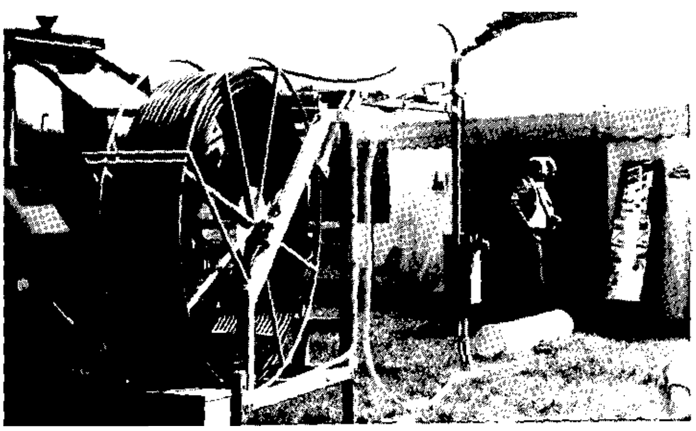
*Left to right:* Mike Darbishire SAWMA; 'Joe' Price ex Sec. ADA Tech. Comm.; David Riddington, Chairman of ADA; Lord Ferrers. Minister of State (Lords) for Agriculture.
*(Photo: J. Monnor Welling & Deeping IDB.)*

*Lord Ferrers dismounts from the Barth C30 wheeled ditcher.*

# WEEDS

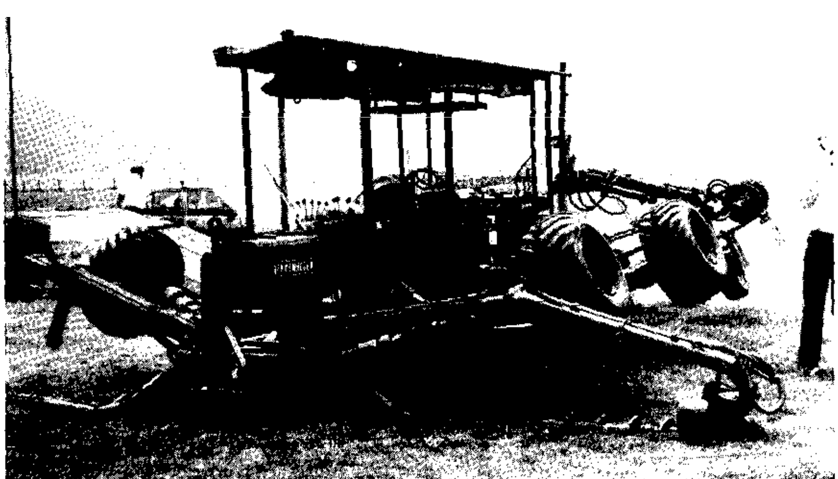
# WATERWAYS

*Visitors watch the progress of weed cullers from the banks of the Little Avon*



*Mastenbroek Drain Jetting Equipment.*

*JKH stand with Berkeley Castle as backdrop*



*K+H Mahechnik — Benkenherger*

*MMG Stand Display Board.*

V10-2

Soil and Water, Volume 10, No. 2. Autumn '82



# "R & D — WHAT'S IN IT FOR ME?" A REPLY BY SIAE RESEARCH WORKER, BRENNAN SOANE.

It is something of a rarity for a farmer with the detailed knowledge of Brian Douthwaite to express his views on R and D (Soil and Water, Vol. **10,** No. **1,** p. 28, Spring **1982).** Perhaps his article will serve as a catalyst to start a debate on a highly important topic — the relevance of current R and D programmes conducted by the Agricultural Research Services to the problems facing British farmers. In the context of the present economic climate it is clearly a topic which those responsible for planning and administering research programmes ignore at their peril.

It is not only the economic basis of agricultural research which has changed in recent years. Gone are the days when individual research workers were largely instrumental in conceiving, planning and conducting their own programmes. There are, however, continuing opportunities for research workers, with their experience and contacts within the international research scene, to participate in and comment on the long-term plans drawn up by the Joint Consultative Organisation. Multilateral consultation arrangements now built into the system allow Research Institutes to have their say as well as farmers and other "customers" who are represented.

The new order of things has, however, introduced several organisational problems for the research worker, or perhaps more correctly, for the research team and its administrators. In particular there is the question of time scales, both for the conduct of research and for the communication of results. I would like to illustrate these aspects with some examples from the context of cultivation research.

## Planning cultivation research

The rate of change in crop management systems adopted by progressive farmers is quite rapid and this can make it difficult to decide the appropriate time scales for research programmes. Mr. Douthwaite mentions the 'continuing arable swing to virtually all autumn sown cereals and oilseed rape' in recent years. Is the research worker to base his plans on the assumption of the retention of this system or should he anticipate or even initiate the next "swing"? This is not an academic question in view of the time needed to set up, conduct and write up a major research project. There have been numerous examples of well conducted research being out-of-date by the time it is completed.

The current swing to continuous winter cereals is not based on the long-term maintenance of soil structure or the need for a balanced system of farming. Rather it is a reflection of the economic forces which have led, in recent years, to greater profitability from an all-cereal system than from mixed farming; even in areas where the grass break had long been established as the key to successful arable cropping. It is just as much part of the role of the research worker to interest himself in the long-term strategy of crop production as in the solving of the day-to-day problems facing the progressive farmer who is pushing his system to the limit. A mix of short-term and long-term projects is clearly required.

What alternative farming strategies might be worth considering in long-term research planning? Although energy saving and alternative energy sources have (perhaps for the moment) lost some of their previous appeal in economic terms, they must surely rank high in any plans for research leading to a possible commercial application in 15 – 20 years time. There are also implications of present and alternative farming systems on manpower and machinery requirements. In the past R and D in agricultural engineering in particular has found ready support if it could hasten the shedding of farm labour. Is this still a tenable objective? The problems of using very large machinery (e.g. compaction, inefficient utilisation) need to be quantified in economic terms in just the same way as are the supposed benefits of such machinery. In the context of current trends to larger farms and larger machines it is not appropriate for government sponsored agricultural research to overlook the technical and economic implications of alternative farming systems which might offer reduced dependence on straw burning, fertilisers and herbicides. Research in West Germany has been active in this subject.

## Communication of research results

When, how and to whom should a research worker communicate his results? Mr. Douthwaite stresses the need for 'a continuing and effective communications policy' and in particular the need for research results to be passed *quickly* to the farmer and grower. This emphasis may come as a shock to the older members of the research community whose training stressed the need for research results to he carefully verified before being written up in minute detail and published in scientific journals; processes which in themselves are incompatible with rapid dissemination of information.

There is no doubt that both the farming community and the excellent weekly and monthly popular agricultural publications which serve it in the UK, are now highly interested in the possibilities of profitable utilisation of work undertaken by research institutes. This situation puts the research worker into something of a dilemma. The persistent agricultural journalist is only too ready to seek out and exploit news of a 'break-through', sometimes when no such event has occurred. The younger research worker, anxious to demonstrate the relevance of his work to the solution of practical problems, is often tempted to reveal the results of preliminary work and is subsequently embarrassed by the lack of opportunity to insert the cautionary phrases into the published version which would underline the tentative nature of his findings. The results of a first year's trial are sometimes found not to apply to subsequent years when weather and soil conditions may be different.

How long should a reduced cultivation trial be continued before a representative number of seasons are included? There seems to be no accepted viewpoint. Anything less than three years might be seriously misleading and five years would not be excessive. Even with a fairly lengthy period there is a risk of a preponderance of seasons which deviate widely in one direction from average. Compaction studies in Sweden during the early 70's are now thought to have coincided with a series of dry seasons and results may therefore be misleading with respect to wet seasons.

There is also the question of cumulative effects. Experiments claiming successful yields from reduced cultivations may overlook a progressive decline in the physical properties below the new depth of cultivation unless the treatments are applied consecutively to the same plots for several years. It has been suggested that results of early trials at Drayton EHF supporting reduced tillage have not been repeated in recent years owing to the cumulative development of a tillage pan which was absent initially.

Cultivation experiments sometimes relate poorly to farming practice because a fully integrated system of soil management is not employed, for instance reduced cultivation treatments may not include occasional subsoiling which is now widely adopted in commercial practice as an economically acceptable restorative or "insurance" operation.

## The form of communication

I turn now to the question of the most appropriate way to achieve the transfer of research information to farmers. Mr. Douthwaite mentions the chain whereby (in England and Wales) research results are tested on EHFs, sifted by ADAS and translated to farmers' language *but* at the same time he wants this process to be quick, to give farmers the "earliest possible access to the results of research" and preferably the opportunity for the farmer "to meet the scientist face to face to talk to each other in a mutually comprehensible language[7]. Such a "face to face" contact may be highly stimulating for a successful innovative farmer and a good scientist with mud on his boots. In other circumstances such contact may be quite unprofitable or even disruptive. The average farmer and the average research worker may share no common tongue or understanding. There is also the question of the role of the advisory services (ADAS and the Scottish Agricultural Colleges) in providing the link between research and commercial application. The research worker has to be careful that he does not contribute to a conflict of confidence between the farmer and the advisory services which might be avoided by a closer integration of research and advisory work.

## Reports

In accordance with current practice in the Agricultural Research Services the career prospects of a research scientist are strongly related to his ability to write papers acceptable for publication in refereed scientific journals. Such journals, though usually commanding world-wide respect among scientists, may be largely out of reach and unread by busy advisory officers and are probably unknown to farmers. Far from being a link in a communication chain they often serve, in the context of commercial practice, as a dead-end or sink for information.

*"Face ro Face" — Former and Research Worker. Doug MacIntyre (right) and visitors discuss the principles of an experimental direct drill at a recent COSAC/SIAE Open Day.*

What alternative pathways exist? Papers presented at conferences and seminars (which seem now to be well established components of the farming scene) are not always available in written form and may cover a subject at a very superficial level. Institute Annual Reports, though useful to gain an over-view of the programme as a whole, may lack the detailed review of long-term work on which farming decisions must rest. Many research institutes seem to stop at this point with no attempt being made to produce reports geared specifically for advisory purposes. This sometimes becomes obvious when Institutes exhibit their work at shows or Open Days. They frequently lack appropriate handout material for the enquiring farmer who wants to follow up what he has seen and talked about.

The two Engineering Institutes (NIAE and SIAE) produce reports termed Divisional or Departmental Notes respectively which are a useful relatively rapid means of presenting results of a limited study, for instance a single year's results in a cultivation trial or limited engineering tests on a new implement. They do not however attempt to summarise a subject in farmer's language in the same way as would an ADAS publication. SIAE produces Notes for Machinery Advisory Officers — as the name suggests these are primarily a digest of recent research reports and intended for machinery advisory officers rather than farmers. For use at shows and exhibitions NIAE and SIAE issue handout sheets (two sides A4 maximum) each giving a brief description of a topic on display, a summary of results in graphical or tabular form, a short list of references for further reading and the name of a member of staff from whom additional information may be obtained. These sheets have been found very useful both at public events and with parties of visitors at the Institutes.

It may be that Research Institutes should make a more positive effort to produce simplified reports which would have relevance to a farming readership. It is possible that the advisory services could offer assistance on the most effective format for such documents.

## What level of significance?

There is a problem with respect to the interpretation of results of cultivation trials when it comes to advising farmers. Research workers are usually trained virtually to disregard differences between the effects of treatments (e.g. yield responses to different cultivation treatments) ***unless*** the differences reach a statistical probability of ***95%.*** This means that if repeated 100 times, one certain treatment will be beneficial ***95*** times. This can lead a research worker to report that there are no significant differences in treatments even though a farmer, prepared to accept a lower level of probability (e.g. ***90%*** or ***9*** times out of 10), might conclude that one treatment is better than the others. For example, in many cultivation experiments in Scotland ploughing has consistently given higher cereal yields than direct drilling or reduced cultivations though the differences are usually non-significant at ***95%*** probability. Of even greater importance is the fact that a treatment difference which the research worker may record as non-significant at ***95%*** probability and

V10 - 2

therefore disregard (perhaps a grain yield of 0.5 t/ha) may, in economic terms, be highly important in influencing the overall profitability of the crop. As a result the farmer may readily gain the impression that the research worker is unappreciative of the realities of commercial practice although standard statistical procedure has been adopted throughout.

The whole subject of reporting research results in economic terms is something which has not been fully exploited although the NIAE has made determined efforts to evaluate the economic costs and benefits of different cultivation systems. SIAE has presented the results of cultivation operations for potatoes in terms of energy efficiency. Presumably such results are more meaningful to the farmer than those in reports in which the emphasis is placed on crop and soil responses only. Factors such as the requirements and costs of herbicides for different cultivation treatments are frequently ignored in research reports yet they strongly influence the commercial acceptability of any treatment. If the research worker himself cannot tackle the economic aspects of his work is there a case for drawing on the services of an agricultural economist to assist in the writing-up of reports?

## Conclusion

Improvements in the relevance and quality of research will be assisted by dialogue between research workers and farmers but changes in research emphasis should not necessarily be made solely in response to ad hoc short-term problems. Much research today is applied first within the industrial infra-structure on which farming depends (machinery, fertilisers, pesticides) and only subsequently and indirectly by farmers themselves. Even a progressive farmer may lack the technological expertise to anticipate such development needs and he is also likely to be strongly influenced by those problems encountered in his neighbourhood or even confined to his farm.

While the farmer may be highly innovative and can inject an understanding of the overall economic significance of research results, the research worker can also make a valuable contribution with respect to long-term problems of land use generally and to the possible role of alternative systems of crop production. Such topics are not necessarily seen as having priority by farmers already committed to a profitable system but may be highly relevant to all sections of the community in the not-too distant future.

## Postscript

**Brennan** Soane is Head of the Agricultural Department at the Scottish Institute of Agricultural Engineering.

# SLIT TRENCHING — FOR INEXPENSIVE DRAINAGE

Slit trench drainage adds a new dimension to the problem of removing excessive soil water; the concept is creating wide interest among 'farmers and drainers'.

In this article David Shelton, who farms in Kent, describes the theory and practise of the system he has developed.

The high cost of conventional piped drainage systems must be a major reason why over 7,000,000 acres of farmland in England and Wales still need to be drained. It was a factor in developing an alternative for our own farm in the Weald of Kent. Slit trench drainage (STD) is proving to be a system that is speedy, inexpensive and remarkably effective on many soils and in many situations.

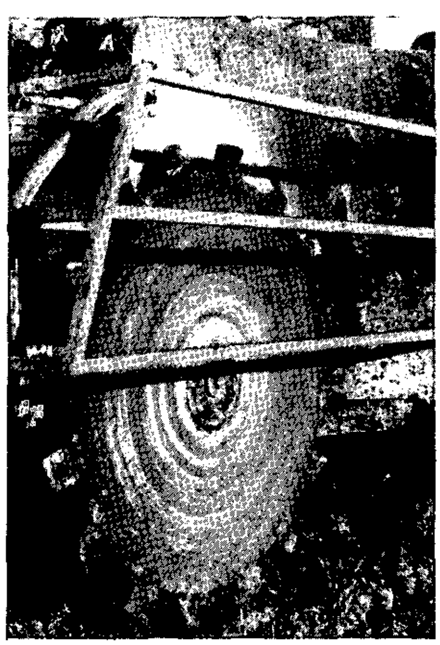
Slit trench drainage is the cutting of narrow U-shaped trenches usually 2½" (60mm) wide and up to 20" (500mm) deep. These trenches lead excess water rapidly to nearby ditches. They may be left open in which case they normally have a life of 1 – 3 years, or in grassland partially closed at the top. Alternatively part or total backfilling with porous fill material such as 12mm Lytag or pea gravel gives a life expectancy of up to 20 years.

*The STS Trencher at work*

Soil disturbance is minimal. The configuration of the cutters spreads the soil from the trenches in a thin layer over a wide area. Consequently drainage in arable crops can be undertaken in the early stages of growth without significant damage to the emerging seedlings. In grassland, in the growing season, little spoil is visible one week after carrying out the operation; the soil surface remains level so that hay and silage making can proceed normally.

Selective or overall drainage may be undertaken. The slit trenches do not have to be straight and selective drainage in those areas of the field known to be wet often produces extraordinary good results at minimal cost.

In overall drainage schemes trenches at 27 feet (9m) spacings are recommended on most soils. This comparatively wide spacing is possible because trench sides are not smeared and water flowing to them is under equal pressure at all levels unlike piped systems.



*Replaceable curlers on the STS Trencher.*

Plough Pan

The trenching operation normally starts at a ditch and the initial depth of working is 20" (500mm). Within six or seven yards the trench depth is reduced to 12" (300mm) or 2" – 3" (50 – 75mm) below ploughing depth whichever is the greater. The trenches begin operating within minutes of being made carrying away surface water as well as water lying on the plough pan.

Slit trench drainage may be undertaken at almost any time of the year unlike subsoiling or mole ploughing where soil moisture content is critical. Water in the soil acts as a lubricant for the cutters on the machine and it is possible to drain satisfactorily in very wet or even waterlogged situations.

Machine design

The system was conceived as an inexpensive one and consequently the design of the trench cutting machinery had to be simple and yet robust. The STS Trencher now being marketed is carried on the three point linkage of a tractor and the cutting wheel is driven by the pto. A slip clutch and cushion drive protect the mechanism from obstructions encountered in work. As supplied the sixteen replacable cutters are set to dig 2%" (60mm) wide trenches, but may be switched to cut 4¼" (105mm) width simply through repositioning on the disc. Spacers are available enabling trenches up to 6" (150mm) wide to be dug with the same machine. This versatility enables large amounts of water to be removed in hours rather than days.

The rate of work depends on the depth of working, soil type and moisture content and tractor capabilities. In general terms up to 2% acres (1 hectare) per hour is possible with trenches dug 9 yards apart.

The STS Trencher enables farmers and growers to carry out their own field drainage. It may be used as a drainage tool in its own right or for secondary treatments across permanent land drains.

As a secondary treatment carried-out across drainage pipes the STS Trencher frequently gives a new lease of life to an old system; in such cases it may be done selectively or overall. Grassland farmers can often extend the grazing season by several weeks with drainage improvements, and increase yields of crops for conservation. Both the equipment and the drainage operations may be eligible for MAFF grants if certain criteria are met.

For recreational areas a more intensive system of trenches filled with Lytag or pea gravel is recommended; considerable financial savings over conventional techniques are proving possible.

*Shelton Trenching Systems of Underriver Farm, Underriver, Sevenoaks, Kent (Tel 0732-833647) is now marketing the STS Trencher direct throughout the United Kingdom. The price currently under £2,300, includes delivery on the U.K. mainland and training in its operation and use.*

V10-2

# NYLON MATTING HALTS EROSION

An increasing number of soil erosion problems in civil engineering and agriculture are being tackled with a nylon mesh material new to the U.K. but already widely used on the Continent.

Called Enkamat and manufactured by the large Dutch Chemical Company, Enka, the material consists of crinkly, high-tenacity nylon threads that are melded where they cross to provide a three-dimensional structure which holds filling materials such as soil, sand and

Introduced to the U.K. last year by MMG Erosion Control Systems, a division of the Miln Marsters Seed Company, the material has already been used to solve a variety of soil erosion problems — ranging from stabilising a perimeter bank at the North Sea Gas Terminal site at St. Fergus, to preventing a road from being undermined by a fast-flowing stream on a farm in Co. Durham.

St. Fergus Gas Terminal

At Shell's Gas Terminal site, the main contractors, Ralph M. Parsons, decided to use Enkamat to stabilise **250** metres of banking with a 1:2 slope where soil washing down in increasing amounts during wet weather was threatening to engulf pipework and a cable trench.

A cost comparison showed that the Enkamat which could be laid in **2 – 3** days at a material cost of about **£2.30** per square metre was [illegible] half the cost of an alternative c[illegible] tional rip-rap construction estimated at around £20,000.

Supplied in **60** metre long rolls, the Enkamat was laid from top to bottom of the banking in 5 m. widths with a 10 cm. overlap along the sides. The top edge of the matting was let into a **30** cm. deep cut-off drain running along the shoulder of the bank, and then secured with steel pegs and backfill. The overlaps were secured with steel pegs at 15 m. centres down the slope and along the bottom edge of the matting.

Grass seed was broadcast into the open matting at a rate of 15 gms. per square metre, together with about 35 gms. per square metre of a compound fertilizer. A fine-screened, stone-free, sandy loam back-fill was then spread and surface-raked to the same level as the matting. A final application of **30** gms. per square metre of grass seed was applied and lightly raked in.

According to Mr. Malcolm Davis, Senior Civil Engineer on the site for the main contractors, Ralph M. Parsons, the Enkamat immediately reduced t[illegible] topsoil during wet weather which h[illegible] threatened the cable trench and pipework serving the vent and flare area of the site.

The Enkamat also provided a good seed bed for grass root establishment these are now linked in with the three-dimensional structure of the threads to create a permanent stable surface.

Co. Durham.

The challenge facing Enkamat in Co. Durham was to stabilise a fast-flowing stream with banks up to **2½** metres high which were eroding and undermining a farm road running alongside.

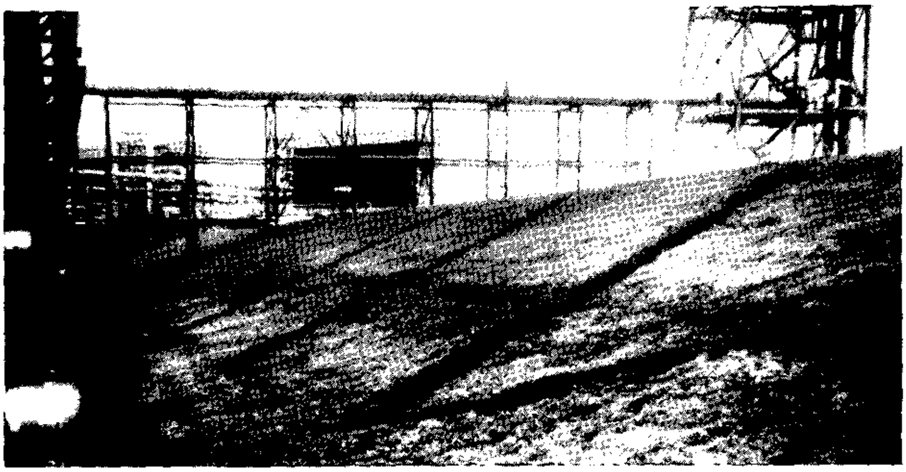
The main problem was that the depth and rapid flow of water during the winter together with the steep, sometimes vertical, nature of the banks, prevented the permanent establishment of grass to stabilise the soil.

Before laying the material, the bed of the stream was cleaned out with a hydraulic bucket and the banks roughly graded. Supplied in rolls 4.85 metres wide and 60 metres long the Enkamat was laid by a 4-man team in the bed of the stream and up the sides of the banks, with a ½ metre overlap between rolls.

Although up to 1′ of water was flowing through the stream at the time, the operation of laying the Enkamat and broadcasting of grass seed was completed quite easily within **3** days.

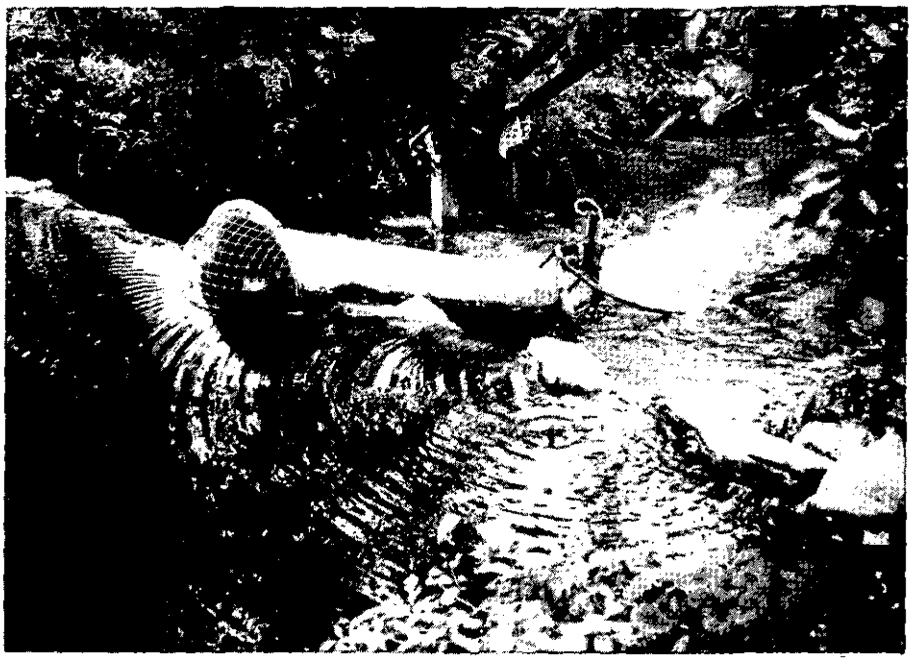
Mr. Hall owner of Kimhlesworth Farm, Chester-le-Street for whom the job was carried out, considers that the Enkamat has provided a permanent solution to the erosion problem which was threatening the ½-mile long road to the **300** year old Kimblesworth Grange.

For further information and more examples of Enkamat usage contact C. J. Gillett of MMG Erosion Control Systems, Waterloo House, **King's** Lynn, Norfolk, **PE30** IPA. Tel: 0553 4423.



*Shell's Cos Terminal of St. Fergus, Peterhead, showing grass growing on the bank that has been stabilized using Enkamat.*

# THE NATURAL ENERGY PLATAPUMP



The Platapump is a simple but very effective water turbine driven pump which derives its motive power from the natural energy of moving water; no other source of fuel or power is required. It has few moving parts and needs very few spares; it does not require skilled servicing and will operate for long periods with the minimum of attention.

The turbine shaft is directly coupled to a simple, variable-stroke crank which drives a two-cylinder positive displacement pump. The pump suction draws clear water from the upstream side of the turbine through a fine mesh filter. The turbine will operate with a fall of as little as 9 inches (230mm) and a flow of 1 cusec (28 litres/sec) but ideal conditions would be a fall of 27 inches (686mm) and a flow of 3 cusecs (85 litres/sec).

A simple adjustment to the pump stroke allows an infinite choice of flow and delivery head, within the limit of the energy derived from the water flow through the turbine at any particular time.

Amongst its many uses the Platapump is well suited for trickle irrigation, domestic or agricultural water supply, plantations and shelter belts, fish farms, washing down dairy sheds and reservoirs for fighting forest fires.

*More details from Natural Energy Water Turbine Pumping Equipment, Hilliards House, Amlets Lane, Cranleigh, Surrey, GU6 7DH. Tel: 04866 3150.*

---

# SUBSOILER IMPROVES MARGINAL LAND BY LEAPS AND BOUNDS

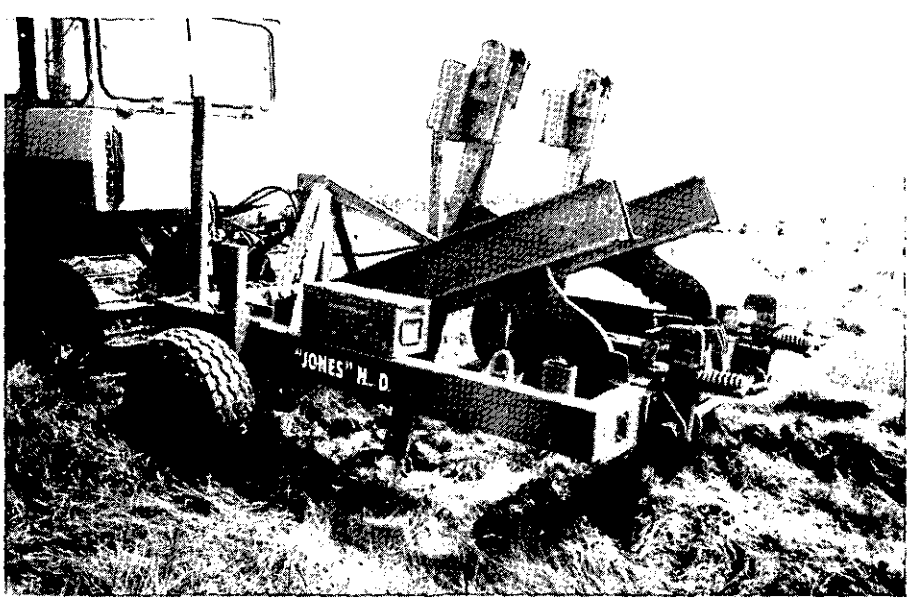
F. A. & J. Jones and Son noted problems particularly in Scotland and Wales where subsoilers are damaged by underlying obstructions. To overcome this problem, most conventional subsoilers are fitted with shear bolts, however the constant replacement of these bolts when working rock 'infested' land, is time consuming and often completely uneconomic. Hence they set about designing a machine to overcome this problem and aid land in desperate need of subsoiling. Their answer, introduced to the press in June, was the Heavy Duty 'Rockopper'. This tool relies on a double pivot system, built into the robust subsoiler legs and their hinging carrying frames.

When the Rockopper encounters an obstruction the leg/legs move upwards and backwards faster than the forward travel of the tractor. The device is re-set by lifting the 3 point linkage obviating the need for the driver to leave his cab.

The Rockopper kick out mechanism can be set to allow either the individual leg or all legs to lift on impact. This is important when using a wheeled tractor at high speed. For example, on a 2 legged subsoiler with legs on a wide setting, the retraction of one leg would throw immense side thrust onto the 3 point linkage of the tractor, possibly causing the tractor to overturn if working across a hillside.

Although the Rockopper has been developed to work in very severe conditions, it can of course be used for all the normal subsoiling on a farm. This must be a welcome new addition to the Jones range of subsoiling and cultivation equipment.

Indeed Alan Jones claims "That the Rockopper will overcome all difficulties due to subsurface obstacles and will help make previously unworkable land suitable for profitable cropping".




***More details from F. A. & J. Jones & Son (Engineering) Co. Ltd. North Scarle, Lincoln. Tel. Spalford (052 277) 224.***

V10-2

Cranfield


To help you answer these and other questions NCAE is organising short courses for Farmers, Contractors and Consultants in association with ADAS, SAWMA and UKIA.

- **IRRIGATION: Principles and Practices**
  14th–16th December 1982
  For farmers, growers, equipment manufacturers and distributors
  **FIELD DRAINAGE: Principles and Practices**
  4th–7th January **1983**
  For contractors, consultants and manufacturers.
  Special rates apply for members of SAWMA.

Other Short Courses include:

- *Soil Management*
- *Surveying*
- *Glasshouse Irrigation*

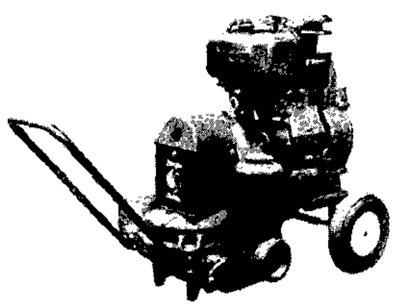
For full details of our Short Course Programme and the above courses please contact **Mrs Pam Cook, Short Course Secretary, Room 108**

**NCAE** **Silsoe, Bedford MK45 4DT**
**Tel. Silsoe (0525) 60428**

# A RANGE OF PUMPS FROM SYKES

At the recent ADA Demonstration Sykes Pumps Ltd exhibited a wide and varied range of pumping units, including the well known Univac series of heavy duty solids handling pumps featuring fully, automatic vacuum assisted priming, which enables priming and re-priming to take place rapidly at suction lifts down to 9.14m. Representing this series Sykes displayed two versions of their UV150; a standard 150mm unit but fitted with an electric motor and designed for high outputs with a solids handling capability of up to 75mm, and a noise suppressed version, seen under operating conditions, equipped with a Hatz Silent Pack diesel engine. Also representing the Univac range was the UVC3, a 75mm model mounted on a two-wheel trailer chassis and equipped with a retractable drawbar.

For lighter, general purpose pumping, the Company displayed several lightweight portable self-priming recirculating pumps. Known as the "M" series these are available fitted with 40mm, 50mm and 75mm suction and delivery openings and may be supplied with either Briggs and Stratton or Villiers air cooled petrol engines. Completing this display was the latest addition, the 3DYN, a diesel engine driven solids handling diaphragm pump.



*Lightweight diesel driven pump from Sykes.*

From an extensive and varied selection of electro-submersibles were several Pumpex drainage pumps which are marketed within the U.K. by Sykes Pumps Limited under an agreement with the manufacturers. These included a number from the P range, available in seven basic models with eighteen different versions for different head applications, and several from the PF range which, equipped with a vortex impeller, are designed to handle sludges and slurries.

*More information from Sykes Pumps Limited, 445 Woolwich Road, Charlton, London, SE7 7AP. Tel: 858 8121.*

# FLO-TILLA

Pettit's NEW "FLO-TILLA" cultivator concept recog[illegible] the [illegible] for sub surface cultivation [illegible] pr[illegible] optimum soil structure for easier sowing, better drainage, plant growth and yields.

Depending on soil types conditions and cropping, Pettits' realise that equipment must be able to work at various depths and yet ensure that all the soil is moved over the entire profile without inversion.

Over the last two years they have invested heavily in the design and testing of the "FLO-TILLA" Vee-shaped, cultivator, and final assessment and design improvements have been carried out jointly with the Cultivation Department of the N.I.A.E., Silsoe.

By working at exactly the correct depth, power is conserved, and costs reduced.

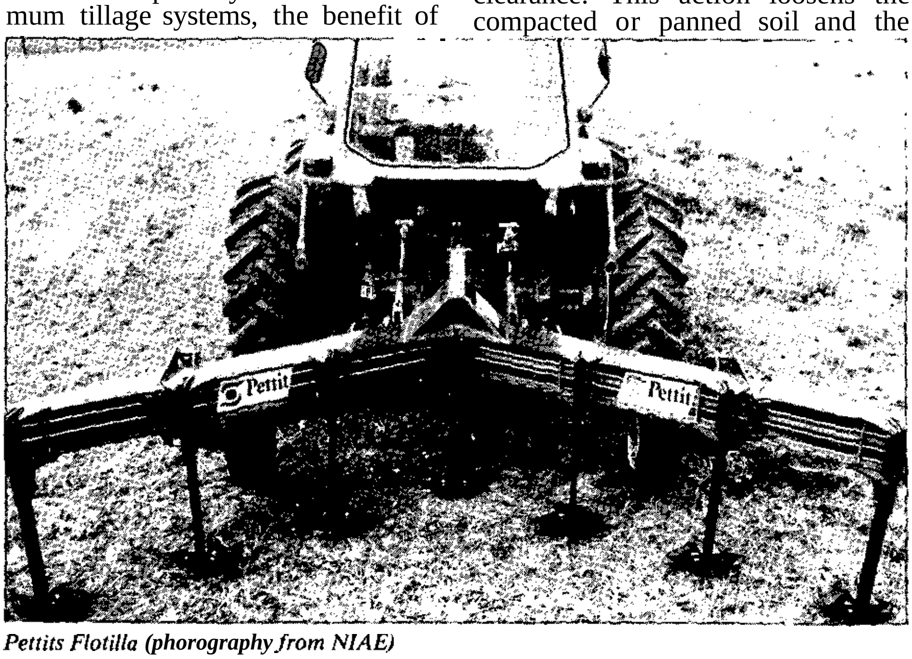
Whilst its primary use is with minimum tillage systems, the benefit of the "FLO-TILLA" can also be seen where other practices predominate.

The simple construction and operating method makes for easy setting up, tractor p.t.o.'s and external hydraulics are not required. The Vee frame has from three to seven narrow shanks carrying Vee shaped shares. Shanks are easily adjusted for optimum depth and spacing, and the latter ensures full utilization of tractor horsepower, giving a wider working width. Depth of working between 20cm (8") — 40cm (16") is precisely controlled by two adjustable pneumatic tyred wheels. The staggered configuration is the result of extensive trials at the N.I.A.E. to obtain maximum interaction between shares giving a flat subsoil profile with no dead areas using minimum Dower requirement.

Manufacturers claim that the configuration gives little surface disturbance and allows for good trash clearance. This action loosens the compacted or panned soil and the surface is left suitable for rapid seedbed preparation by disc harrows, tined implements or other power cultivators and, in certain conditions, may also permit direct drilling.

Prices range from £3,300 for the five-leg model up to £4,500 for the seven-leg model.

*More details from F. W. Pettit Divirion, Geest Industrial Group Ltd., Moulton, Spalding, Lincs.*



*Pettits Flotilla (phorography from NIAE)*

# STUBBLE DIGESTER

Cytozyme, a new range of biological, enzyme-related aids to crop production, already being used in many countries, is now available in the United Kingdom.

**Cstozsme Stubble Digester** it is claimed, has the capacity to speed decomposition of straw residues. Produced by a two-stage fermentation process, it is a balanced preparation of enzymes and biological components which, by initiating cleavage of internal bonds in the cellulose fibre in straw, speeds up the digestion and decomposition of straw residues, and releases nutrients for use by the succeeding crop.

**Cytozyme Soil Plus,** applied directly to the soil, influences the growth of micro-organisms, stimulates the development of nitrogen-fixing bacteria.

Extensive field trials have been conducted this year in the Midlands and East Anglia on wheat, barley, potatoes and sugar beet. Replicated plot work with Stubble Digester is currently in hand at the Cotswold Cereal Centre, and in Oxfordshire, Hertfordshire and the East Midlands. Watch this space for results!

*More information is available from Bactozyme Limited of Netherthorpe, Worksop, Nottinghamshire.*

V10-2

# "TWO INTO ONE DOES GO" A VARIABLE COUNTERBALANCE EXCAVATOR FROM PREISTMAN

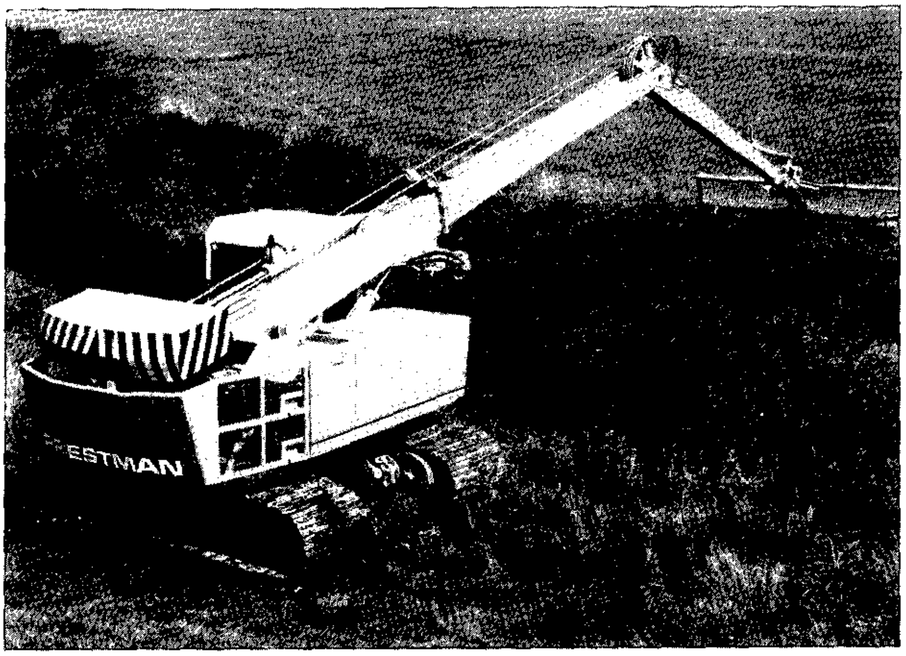
The name of Priestman has long been synonymous with land drainage, therefore the announcement of their new range of equipment, designed principally to meet the needs of contractors in arterial land drainage, will be welcomed.

Of the range of four models to be available, the VC 15 was selected to demonstrate the outstanding features of this highly versatile, economic, simple and very cost effective design. The range VC 8, VC 12, VC 15 and VC 25 models combine all the advantages of the excavator and conventional dragline machines, whilst dispensing with the disadvantages of both.

The combination of exceptional outreach and payload, which is stated to be 50% greater than the conventional hydraulic excavator, coupled with a decrease of 15% in weight for lower ground pressure will be welcomed by contractors throughout the world. To achieve the dramatic improvements, the concept of perpetual motion was applied. It has been effected by the use of a variable counterweight system interlinked with the hydraulic winch and dragline cable attached to the bucket.

Outstanding features all of which indicate the VC ranges potential as well as the 50% greater outreach and payload, and the lower weight include:—

- ***Low front end equipment weight for maximum payload.***
- ***Direct pull to bucket for maximum digging effort with low front end weight.***




*The Preistman VC15*

- ***Safe and easy to operate with minimum driver skill.***
- ***Arm assists penetration for marimum digging power.***
- ***Controlled movement of bucket at all times.***
- ***'Luxi-cab' and pilot controls for driver comfort and efficiency.***
- ***Conserves energy with less horsepower and fuel demand.***

The overall weight of the VC 15 is 18 tons, provides for a 15m outreach when using a 600 litre excavating bucket or 4.0m cutting bucket. It has the versatility of adaption where required, and the standard excavator boom can be fitted. The tracks and rollers are Caterpillar D 4, with wide tracks as optional on demand. The hydraulic 'pilot' consists of two four-way controllers situated either side of the driver seat. Twin gear pumps and conventional spool equipment are used for the 3,000 psi hydraulic system.

The Priestman VC 15, a new concept of excavator design, is without doubt the fore-runner of a new range in excavators with a wide potential of applications. Less dead weight with more pay load must in these days of economic pressures be the right formula.

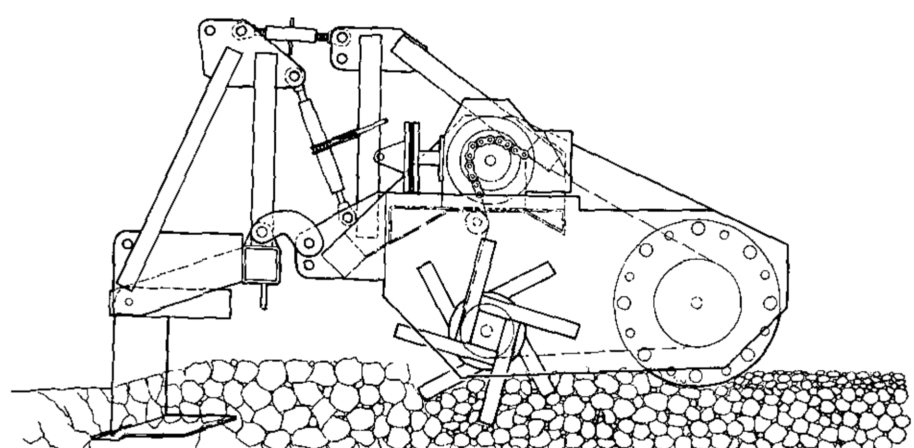
# TILLAERATOR FROM McCONNEL'S

The Tillaerator, launched earlier this Autumn, has been developed over the past three years by McConnel engineers working in conjunction with a Scottish farmer who designed and built the initial version and forerunner of the new implement. It has a progressive soil-treating action which can be divided into three parts. At the front of the machine, loosening tines are fitted to shear the soil and prevent smear. In the middle, a bladed rotor churns and agitates the topsoil while breaking down clods, and at the rear, a powered crumbler roll performs a final cultivation treatment and clod breakdown, giving a fluffing action to aid the passage of water and air. See diagram opposite.

Correctly set, the manufacturers claim that the soil-engaging components of the implement should work progressively shallower from front to rear, to give an even, well-prepared seed bed in one pass without smearing or clod formation. Field tests have shown that on its own or in conjunction with the Commando Shakaerator, the McConnel Tillaerator will be a useful one pass tool for the arable and grass land farmer.

A 2.5m Tillaerator costs £2,500 while the 3m version is priced at £3,000. Both prices include the removable front soil-loosening tines, standard on the initial batch on sale this autumn.

*For further information, please contact Richard Fish, Ludlow (0584) 3131.*



*Cutaway cross-section showing drive-line of the McConnel Tillaerator.*

Soil and Water, Volume 10, No. 2, Autumn '82

'The Author:

# AGRICULTURAL LAND CLASSIFICATION — WHAT PRICE GRADE THREE?

Tom Worthington a former MAFF **employee** but now a Director of Reading **Agricultural Consultants, summarizes his view concerning the use of and recent modifications to the Agricultural Land Classification of the Ministry of** Agriculture, Fisheries and **Food.**

The Agricultural Land Classification of the Ministry of Agriculture, Fisheries & Food is a widely-quoted feature of the agricultural scene today. It is often included in advertisements for land sales and is frequently prominent in discussions concerning development proposals. Yet despite its familiarity, it is still often misunderstood.

For example, its use in land sales is fraught with problems. The published plans are all marked "Provisional", and the explanatory booklet stresses that "it has (often) not been feasible to delineate patches of different quality of less than about 80 hectares". Bearing in mind the small scale of the plans and the limited resources that went into the original surveying, this is an entirely acceptable caveat. Therefore, prospective purchasers should beware of the accuracy of the plan shown to them in the vendor's surveyor's office!

## ALC Objectives

It is useful to remember that the original purpose of the classification, introduced in 1966, was stated to be "for advising on the release of agricultural land for urban development". It was agreed, too, that the system would have to be "as objective and uncomplicated as practicable". However, the definitions of the grades, made in the same publication, proved to be more or less totally subjective. For examples, Grade 1 land (the best) was defined as "Land with very minor or no physical limitations to agricultural use", while Grade 3 was defined as "Land of average quality, with limitations due to the soil, relief or climate, or some combination of these factors which restrict the choice of crops, timing of cultivations, or level of yield".

Similar vague definitions, with full scope for subjectivity, are applied to the other grades. Admittedly a few definite constraints were identified in the accompanying explanatory notes. For example, limiting gradients were defined for grades 3, 4 and 5. However, advice on the influence of other factors was typically of a general descriptive nature.

Notwithstanding the problems of definition, the land of England and Wales was mapped to the system, and by 1974 it was possible to publish a summary of the results. These indicated that the quality of the agricultural land of England and Wales comprised:

| | % |
|---|---|
| Grade 1 | 2.8 |
| 2 | 14.6 |
| 3 | 48.9 |
| 4 | 19.7 |
| 5 | 14.0 |

Land graded for agriculture comprised about 81.5% of the total land area of England and Wales.

Since the purpose of the whole campaign had been to assist in the planning process, the definition of almost 50% of the land as Grade 3, with only 17.4% as Grades 1 and 2, proved a distinct problem. If it had been intended that the colours on the plan should quickly and visually define the best land as "no-go" areas, then only 17.4% could be picked out on that basis. Since much Grade 4 and possibly most Grade 5 land is unavailable for building due to a combination of engineering, amenity and conservation constraints, the almost 50% of Grade 3 was effectively all lumped together as of equal (and average) quality. This was despite the fact that it obviously varied from land which was almost Grade 2, and thus very good, to almost Grade 4, of distinctly poorer quality.

## Grade 3 Land Sub-classification

There was thus a clear need for a further subdivision of Grade 3 land, to identify the better and poorer quality within the grade; consequently, in 1976 a new sub-classification scheme was introduced, dividing Grade 3 in sub-grades 3a, 3b and 3c. In planning terms, Grade 3a tends to be grouped with Grades 1 and 2 as land to be protected for development. With the benefit of hindsight, this makes the published plans considerably less helpful than might have been the case to those interested in planning. The published plans do not show sub-divided Grade 3, and it is therefore impossible to pick out these areas of better land from the generality of the Grade 3. When it is realised that some plans have virtually no Grades 1 and 2 depicted on them, this means that they are of very restricted use.

While the original classification was based on subjective definitions, the new sub-divisions are seemingly rather more objective. Unfortunately, they are defined in terms of the level of yield to be expected from the land being surveyed, when compared with the national average yield to be expected from all land under a similar farming system. Since no such figures are published or likely to be published, the definitions remain very subjective. In an effort to improve their objectivity, various Criteria of Eligibility are listed. These deal with both physical factors of the soil (depth, stoniness, drainage, etc.) and its prevailing climate (altitude, rainfall, exposure, etc.). These seem to provide a totally objective system for evaluating the soil within Grade 3.

V10-2

However, as I have shown in detail elsewhere, they have been erroneously based on a consideration of rainfall, rather than soil moisture deficit. This fault makes it possible for 40cm of coarse sandy loam soil at Berwick on Tweed and on the North Kent coast to be classified as Grade 3a. This soil at Berwick would experience a mean cumulative soil moisture deficit of 80mm in July, while the comparable soil in North Kent would experience a deficit of 168mm in August. The severity of the drought affecting these two soils, and cost and logistics of irrigation to remove the two deficits, are obviously very different. Yet they can theoretically both be graded as 3a, if the local mean annual rainfall is over 635mm. Similarly, East Devon has a mean deficit of 101mm, very comparable with northern sites with their rainfalls of 635mm, yet its rainfall is 910mm.

Applying the soil droughtiness maps used by the Soil Survey of England and Wales (SSEW), 40cm of coarse sandy loam on the North Kent coast would be Class 4, yet the same soil can be graded 3a by the ALC system with its "objective" criteria.

**National Implications**

The implications of this failure of the system are considerable. For the planner (and for the nation), it is possible for development to be steered onto average quality (Grade 3b) land, when Grade 4 land is actually available, but has been wrongly classified as Grade 3a. The farmer may buy land under advice that it is Grade 3a, when it is in fact Grade 4. Further, he may be thwarted in his attempt to sell poor quality (Grade 4) land for development, under the pretext that it is of Grade 3a quality.

Although this is crucially important to a few farmers, this is probably of somewhat academic interest to most. What they are really interested in, is whether the earning value of land reflects its quality grading. From economic survey data, I have calculated that over a five-year period, net farm income (NFI) has a direct relationship to land quality. In the example used, the mainly Grade 1/2 land of the Fens produced an NFI almost double the mainly Grade 3 land of South Essex. Land of intermediate quality produced intermediate values consistent with its quality level. This finding suggests that the ALC is soundly based, and is some justification for relying on its grade when purchasing or renting land, provided that you can rely on the grading being accurate.

It is of particular interest that the other "official" land quality grading system, namely the Land Use Capability Classification of the SSEW, has broad definitions of its classes 1 – 4 which are almost identical to MAFF's Grades 1 – 4 of the ALC. Yet the objective criteria of the two systems, applied to the same soil, can produce results which are far apart. In my view it is essential that the two systems should move closer together rather than warily maintain their individuality. It is well known that discussions have been held over a long period with this aim, but these have consistently failed to achieve the objective of unity.

**Conclusions**

Overall, what is needed is much more clearly-defined objective standards for the whole classification. These need to be soundly based and adequately explained. The MAFF's use of annual rainfall as a standard must be dropped, in favour of the SSEW's calculations of soil moisture deficits. The measurement of "soil depth" needs defining: deciding the effective depth of a soil can be extremely problematical, especially on clay soils.

However, even when these small wrinkles in the system are removed, certain fundamental problems will remain. For example, some of the best grassland in the country is found on. Grades 3 and 4 land. The existing grading system does not obviously cope with this situation, and in the long term it may be that a completely separate system will need to be developed for grassland.

Finally, making use of land grading results in the planning process is often difficult. For example, it could happen that development could be sited either on unfarmed, semi-derelict Grade 1 land, or alternatively on impeccably-farmed Grade 3c land Which is the preferable location?

**References**


1. *MAFF (Agricultural Land Service), Agricultural Land Classification, Technical Report No. 11, 1966.*
2. *MAFF (ADAS) Agricultural Land Classification of England ond Wales — the definition and identification of sub grades within Grade 3, Technical Report 11/1 1976.*
3. *J. S. Bibby and D. Mackney, Land Use Capability Classification, Technical Monograph No. I, The Soil Survey, 1969.*


**Tom Worthington is also Author of Agricultural Land: Grade 3 — Third class. Copies of this are available from Reading Agricultural Consultants Ltd., 14a Honey Lane, Cholsey, Wallingford, Oxon. Price f2.50 inc. p&p.**

# ROOTS AT WORK

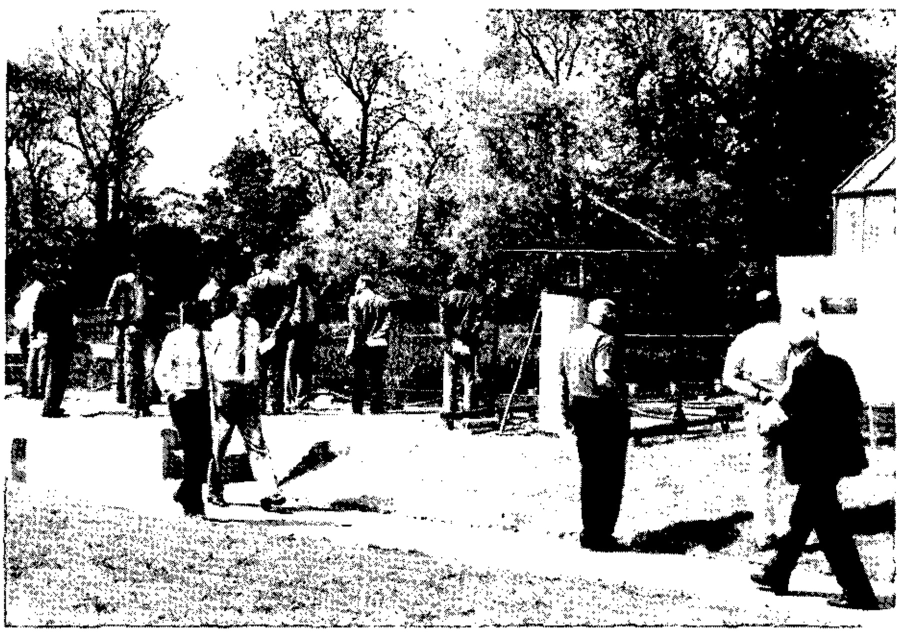
**ARC Letcombe Laboratory, near Wantage, displayed its field and laboratory investigations on various aspects of soil-plant relationships at Subject Days in May. The 1800 people who visited 'Letcombe' over the three days included farmers and representatives of the agricultural industry, members of ADAS and other Government Departments, university staff and students, and research workers from other institutes at home and abroad. Although the research programme has greatly changed since the Laboratory was founded in 1957, and continues to change as new requirements are identified, an essential ingredient has been the close collaboration of scientists of different disciplines in both laboratory and field investigations, a feature which was apparent in the various exhibits. From Letcombe Dr. Bruce reports on the open days.**

## Open Days

Work on tillage was demonstrated at one of the Laboratory's experimental sites leased for a number of years on commercial farms, an arrangement which has allowed investigations to be made on various carefully selected soil types important for cereal growing in Britain. In an experiment comparing the long-term effects of ploughing, shallow tine cultivation and direct drilling on soil properties and crop growth, the even stand of winter wheat over the entire area of replicated plots clearly supported the findings in previous years when yield differences between tillage treatments were small, with yields of winter wheat around 10 tonnes per hectare.

Soil conditions, however, differ considerably with tillage system Earthworms thrive in undisturbed soil creating continuous channels linking topsoil and subsoil, and in many clays cracks extend to greater depths in land that has not been cultivated. These continuous pores improve


*Two treatments n the Letcombe Laboratory straw experiment: Chopped straw on the soil surface led to patchy establishment of direct-drilled winter wheat (right). Incorporating the straw by rotavation to a depth of 7 cm alleviated the effects (left). However, crop growth was best on plots where rhe straw hod been burned.*



*The lysimeter installation used for studying effects of waterlogging on crops and the fate of fertilizer nitrogen attracted much interest during Letcombe Laboratory's Subject Days.*

aeration and percolation of water as well as facilitating root extension. A new technique for observing root distribution in the field using a miniature television camera inserted into transparent tubes in the soil attracted much attention.

The consequences of direct drilling winter wheat into straw residues from the previous crop were clearly evident in an experiment comparing various straw treatments as possible alternatives to burning. Although shallow incorporation of the straw several weeks before drilling alleviated the adverse effects on establishment and growth (see photograph), results from previous years show that yields could still be decreased by up to 15 per cent compared with burned plots, depending on the amount of straw and wetness of the season. The penalty for direct drilling into chopped straw left on the surface could be as much as one-third lower yield.

The adverse effects of straw on crop growth observed in the field bad been the subject of detailed microbiological studies in the Laboratory. These showed that micro-organisms decomposing straw or weed residues in wet soil can produce substances, such as acetic acid, that are toxic to seedlings and inhibit their growth; attack by pathogens can also be enhanced in the presence of plant residues. Looking to the future, new work on the controlled breakdown of straw with selected micro-organisms shows promise of enabling the farmer to convert a waste product into a useful nitrogen-rich compost.

### Anaerobism

High water-tables or waterlogging cause anaerobic conditions in the soil and can affect plant growth and diminish yields. This was shown by results from experiments in the field with different drainage intensities and in lysimeters where water-tables and rainfall could be controlled more closely. A single waterlogging can decrease grain yields by 15 per cent but waterlogging on more than one occasion has a cumulative effect and there were losses of up to one-third after three such events. Laboratory studies showed how waterlogging affected nutrient uptake and-caused premature senescence in the crop, and how some plants could adapt to anaerobic soil by forming air spaces (aerenchyma) in the roots that allow oxygen to enter from the shoots.

Monolith lysimeters had also been used to obtain an overall balance sheet for fertilizer nitrogen applied to grass and cereal crops. The fertilizer is labelled with the stable isotope nitrogen-15 to distinguish it from nitrogen already present in the soil. In general, about half of the fertilizer nitrogen is used to produce harvestable crop (grass, or straw and grain); of the remainder. 8 – 25 per cent is immobilized in soil organic matter, up to one-fifth may be lost by denitrification, while 2 – 8 per cent is lost by leaching. Stresses, such as drought or waterlogging, can markedly diminish the efficiency of fertilizer utilization by the crop.

An understanding of how roots are made opens possibilities for controlling the development of root systems so that they exploit the soil more efficiently. In studies of root morphogenesis at Letcombe, particular attention is paid to the patterns of cell multiplication and models are being developed that will help formulate rules governing cell division. Although basic research of this kind offers no immediate practical application, many farmers who initially viewed the exhibit with scepticism left appreciating the potential advantages if, in the long-term, root systems could be designed to fulfil specific requirements.

Indeed, throughout the various exhibits, the close admixture of pure and applied science, and the contrasting occupations of the visitors, stimulated many interesting discussions. These, together with the fine weather, contributed to a pleasant occasion enjoyed by staff and visitors alike.

V10-2

*Soil and Water, Volume 10, No. 2. Autumn '82* **Open Days**

# CULTIVATIONS FOR WINTER CEREALS

A very successful Open Day on cultivations for winter cereals organised **jointly by** the Scottish Institute of Agricultural **Engineering and** the **Scottish** Agricultural Colleges, was held at the Edinburgh Centre for **Rural Economy, Bush** Estate on **June** 10th. Sandy Hamilton from the **SIAE** reports **on the** *event.*

Three talks, by an agronomist, an engineer and a farmer respectively, followed by an afternoon inspecting four sites with a wide range of static, growing and mobile exhibits, proved a successful formula for the large number of farmers, consultants, advisers and others who attended the Open Day.

Guthrie Paterson of the Agronomy Dept. of the West of Scotland Agricultural College presented the first talk outlining present and future developments in cultivation and sowing of winter cereals in Scotland. Timeliness of sowing he considered was an important factor, and reduced cultivations or direct drilling can alleviate the situation. It is proposed to produce a provisional classification of soil suitability, based initially on soil texture and drainage characteristics, to assist farmers in predicting the probability of success in such operations. Faster sowing might be accomplished by broadcasting but limited trials to date have indicated a slight loss in yield with this method. Straw residue can pose problems for drill operation and can have other adverse effects including increased probability of slug damage, carry over of certain diseases and reduction of residual herbicide activity. Any departure from ploughing can be expected to result in increased weed growth and weed control management becomes increasingly important. Pre-harvest application of glyphosate is achieving very good results.

## Soil condition and its influence

'Soil factors influencing the selection of operations and machines for winter cereal establishment' was the theme of the talk by Gordon Spoor of the National College of Agricultural Engineering. Five particularly important areas were identified; trash cover, smoothness of soil surface, surface tilth, drainage status and root zone condition. Where drainage status is poor, shallow tillage and direct drilling approaches are unsatisfactory. It is also essential to provide pore space for roots and water, and to achieve this, compacted soils will require loosening.

In the third talk, James Mackie of Bentland Farms, Laurencekirk, described 'A farmer's method of growing winter cereals'. Ploughing appeared to be best, especially where winter barley followed winter barley. It was aimed to establish 300–350 plants per square metre and constant vigilance was necessary throughout the growing season to check for disease and spray when required.

## Field Visits

The first *of* the 'field' sites consisted entirely of static exhibits covering a wide range of topics relevant to the subject. In addition to SIAE and the three Scottish Colleges, there were displays by the Macaulay Institute for Soil Research, the National Institute of Agricultural Engineering, the National College of Agricultural Engineering and the Agricultural Development and Advisory Service.

***Site 2 was divided into three sections.***

***(1) The first contained an investigation into the long-term responses of winter barley and soil properties to a number of contrasting methods for cultivating and sowing on a 'poorly' drained soil. These included direct drilling, conventional ploughing, shallow ploughing, rotary cultivating and broadcasting.***

***(2) A trial to examine the effects of different levels of tractor wheel traffic prior to drilling on long-term crop and soil responses following chisel ploughing and direct drilling.***

***(3) Working demonstrations of equipment including the Tasker/NIAE Tillage Train, the NIAE Rotary Digger, the Pettit/NIAE Subsoiler and the SIAE Shallow Plough. Subsoilers were put through their paces on an adjacent plot with different machines, including the Howard Paraplow (maximum and minimum shatter), the Cousins Subsoiler (with and without winged tines) and the McConnel Shakaerator (with and without vibration), and a trench was dug across the entire area to show the effects or in some cases non-effects of these implements. The SIAE 'A' Blade Drill was also on display.***

The growing crop demonstration showed varieties, effect of sowing date and crop protection methods. Fifteen varieties of winter wheat and six varieties of winter barley were grown. The effect of sowing dates from Oct – Feb was demonstrated with winter wheat (Mardler) and from mid-September to mid-November for winter barley (Igri).

The final site consisted of a commercial scale direct drill site of winter barley and an experimental area to test the responses of winter barley and soil properties to a number of contrasting methods of cultivating on a freely drained soil.

Everyone who attended appeared to find the day interesting and informative and very favourable comments were passed on the standard of the exhibits and the forward-looking machinery developments.

*The SIAE Shallow Plough in Action. To try and ensure a more even depth of ploughing, the plough beam is hinged between bodies 4 & 5. An air spring (clearly visible in the photograph) increases the downward load on the rearmost furrows to help penetration.*

*Visitors at the SIAE/SAC Open Day inspect a trench showing the effects of different subsoilers under the guidance of Allan Langley of the East of Scotland Agricultural College.*

# "THE HISTORY OF AGRICULTURAL DRAINAGE"

The roots of agricultural drainage go back at least 2000 years and it is no coincidence that the major periods of activity have coincided with demands for increased food production.

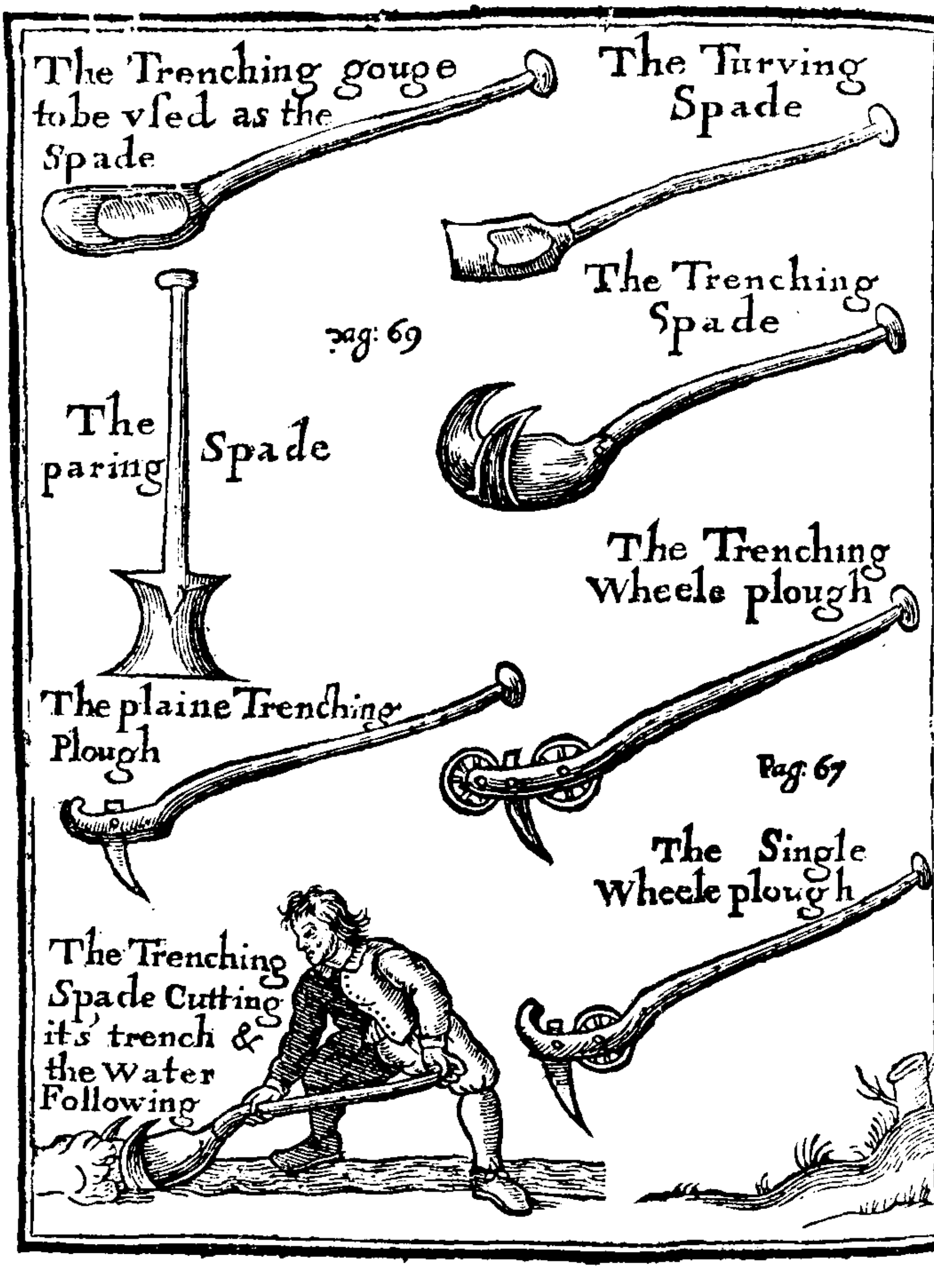
The first of these periods, and indeed the real beginning of agricultural drainage in England and Wales, was during the Roman occupation when they introduced skills and techniques and were responsible for the drainage of low-lying land such as the Fens. Activity waned until the Normans established their rule in the 11th Century. Piecemeal works are recorded from then up to the 18th Century. One of the major achievements of this period was the draining of the Bedford Levels in 1636 by a Dutch engineer Cornelius Vermuyden.

During the 18th and 19th Centuries changing agricultural systems together with the Industrial Revolution brought the 'Golden Age of Agriculture', and evidence suggests that over 4 million hectares were drained between 1850 and 1880.

During the Depression little work was carried out, but with incentive provided by World War II, drainage has now once again established itself as an important part of agriculture with up to 100,000 hectares now being drained annually.

An ADAS exhibition traces the history of agricultural drainage from the Roman beginnings through to the present day. Since 1976, when it was featured at the Royal Show, the exhibit has been on tour and has attracted much interest at venues throughout the country.

A programme of venues is in preparation for 1983 in the Eastern Region, but in 1982 you can see the exhibit at: University of Keele on 2nd – 28th October, Hereford College of Agriculture on 2nd – 24th November.




*The English Improver Improved Walter Blith (1652) — drainage tools of the period.*

V10-2


# If you're obstructed by stubble weeds this is your symbol of freedom.

Using 'Gramoxone' 100 in clearing stubble weeds is all together a faster more cost effective way of dealing with the problem.

Saving valuable time and money 'Gramoxone' 100 is rainfast within ten minutes.

So even if it rains, it's not a washout. It tackles most common weeds, even Watergrass, Sterile Brome and Yorkshire Fog.

What's more 'Gramoxone' 100 plays the essential role in Direct Drilling, the most timely method of establishing winter cereals.

For unbeatable value for money, fill up with 'Gramoxone' 100 you'll get miles more to the gallon.

GRAMOXONE 100

ICI Plant Protection