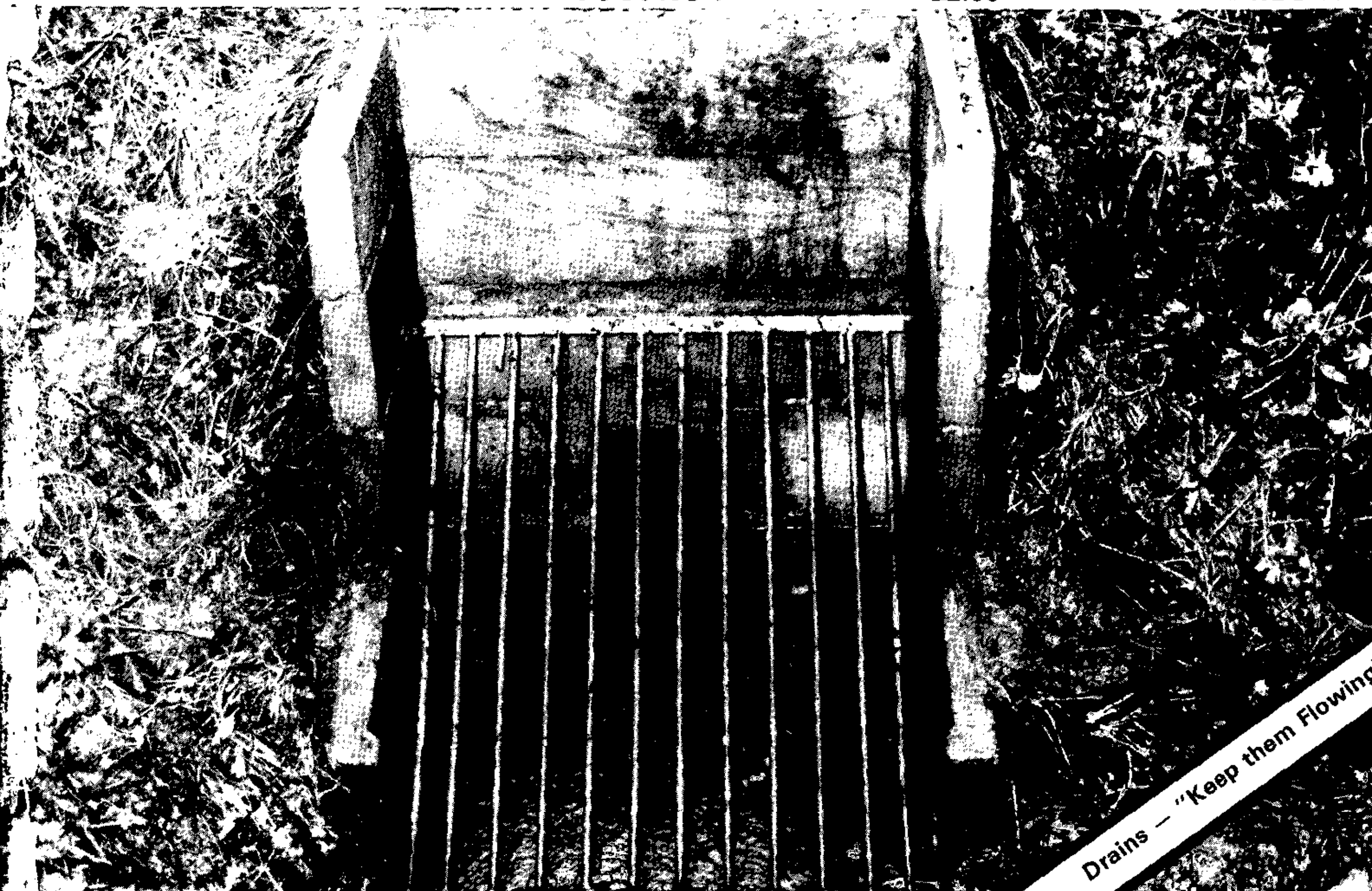
ISSN 0309-023X

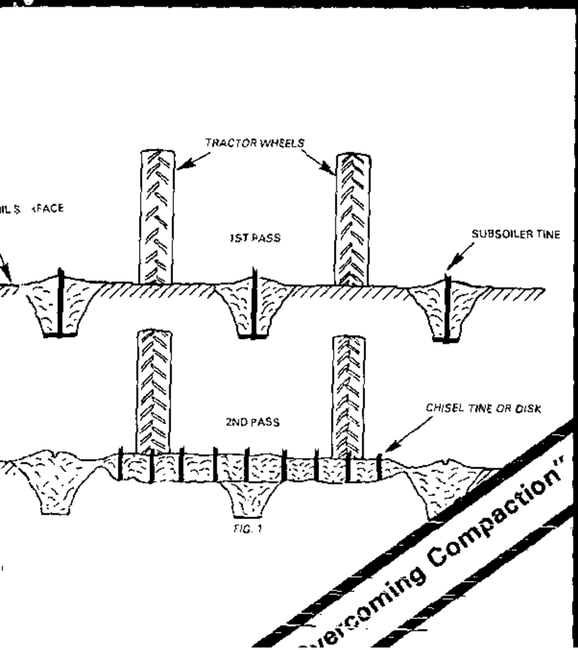
soil and water

JOURNAL OF THE SOIL
AND WATER MANAGEMENT
ASSOCIATION LIMITED

NATIONAL AGRICULTURAL CENTRE • STONELEIGH • WARWICKSHIRE CV8 2LZ

1981 VOL 9 NO 1 £2.00 £1.00 RASE MEMBERS





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VOLUME 9 NO 1 ISSN 0309-023X

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soil and water

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Soil and Water is the ½ yearly 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. Membership is open to all parties, details are available from the Technical secretary, SAWMA Ltd., NAC, Stoneleigh, Warwickshire CV8 2LZ. Tel: Coventry (0203) 56151.

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

Copy date for the September edition July 31st, 1981.

Printed by Avon Litho Limited, Stratford-upon-Avon. Warwickshire.

Further copies available upon request.

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'WHAT OF THE FUTURE'

Despite the gloom that haunts the Nation with its economic problems, it is not all bad news. Things are happening, enthusiasm rubs off and the results of this emerge in the gathering momentum of the SAWMA programme, as new and constructive ideas continue to come before us. This year would appear to be very stimulating.

SAWMA is poised to commence a new era. Since the last issue we have a new Technical Secretary installed full time, his name is Mike Saull, who is well qualified technicallv and full of enthusiasm.

Fortunately Peter Watkins has not vanished, but is very much at hand to pass on his advice and experience to our new team. To Peter we convey our best wishes and thanks for his work. We are sure that in his work for the RASE he will continue to make a great success of his full time post of Assistant Agricultural Director.

More is afoot, Council has approved the 1981 programme, and before long we shall have devised the 1982 programme, upon which work has already commenced. The programme of activities and events are listed in this issue and you can see that we have a varied and packed programme.

THE JOURNAL

The Journal will slowly take on a new appearance, which we hope will attract a broader readership. This clear unbiased statement of news and views is most important for SAWMA as it is through the Journal that we maintain a service to the majority of members. Soil and Water is our communications link.

The editorial committee has been reformed and every effort is being made to create a quality half yearly Journal. Your contributions to our editorial will be most welcome. If your professional Association or Company have Press Releases or editorial in your house journals of interest to SAWMA membership, would you please let us have the opportunity of reprinting them. Good photographs of special field events would be much appreciated.

The announcement of increased membership fees we know will cause some comment, but as with everything else, having kept them down for some years, it is inevitable. SAWMA needs your continued support at this critical stage of development. It has the ingredients necessary to give you very good value for your investment.

It is to be noted that during the last few months several requests have been made to SAWMA to initiate new activities. This accentuates the fact that there is a need for a more detailed programme. This is in hand, and your suggestions have not been forgotten.

We look forward to seeing you at this year's events and make sure that you bring along a new member because we are sure they will not regret it!

M. S. Darbishire
Chairman
SAWMA Technical Committee

Feedback

LETTERS – ON THE USE OF TENSIOMETERS

In the last edition of Soil and **Water** (Vol. *8,* No. *1*), Dr. Frank Cope **of** Fisons published an article entitled 'Calculating when *to* apply water'. **Thi**is has prompted a letter from *two* lecturers at the UEA. David Dent and Peter Scammell who were not entirely **hapI:**y with the authors' comments on the use **of** Tensiometers. Their **letter** and Dr. Copes reply are reprinted below.

Dear Sir,
We think that in his discussion of alternative methods of calculating when to apply water (Vol. 8, No. 1), Dr. Frank Cope makes some misleading statements about the use of tensiometers.

1. Any instrument that measures soil water directly can only measure it at a point. In our article on irrigation scheduling (Vol. 6, No. 2) we suggested that a pair of tensiometers be located in the droughtiest soil that occupies a significant area under the crop to be irrigated, and irrigation applied when this soil reaches critical water tension. This does not mean, as Dr. Cope states, that the more retentive soils will then be over-watered, because the crops on the better soil will use at least as much water as the crop on the droughty soil. Irrigation when the crop on the droughty soil needs water will merely top up the water reserve in more retentive soils.

   If the farmer schedules irrigation using tensiometers he has the choice of irrigation for maximum yield, as we have outlined, or delaying irrigation until critical tension is reached even on the most retentive soils and accepting a loss of yield on droughty patches within a field.
2. Modern tensiometers are made of clear plastic, which does not expand or contract appreciably in the normal temperature range so temperature does not affect the decision when to irrigate.
3. The instrument is filled with blue liquid so that air bubbles are easily seen and can be instantly purged. **In our experience tensiometers are reliable and convenient i**n **commer**cial use.

David Dent and Peter Scammell
School of Environmental Sciences
University of East Anglia

Dear Sir,
'Tensiometers scarcely need a defence against me, for I have made and used them for nearly 30 years. In the hands of skilled and enthusiastic users, such as I perceive my critics to be, tensiometers are effective particularly in research projects. However they are not quite such an ideal choice for the busy farmer as might be supposed at first sight.

The important features of any practical system for scheduling irrigation are those of reliability and convenience. Reliability tends to depend on the **user taking pains, whilst conve**nience is to an extent a matter of **opinion.** Several hundred irrigators in England now schedule by computer **budgetting methods. Should ten**siometers be used by a similar number then tensiometers too would have been judged to be convenient by those whose opinion matters most.

My short review in your Journal **could not argue every point, but I do** not **knowingly mislead. Here is my** reply to the points raised.

(Point *1*) **It happens that instru**ments are available which measure soil water **directly** and which avoid some of the problems of measuring at a single small 'point', examples are the neutron meter, flux plate, and collimated gamma beam methods although for various reasons these are also unsuitable for irrigation scheduling. Tensiometers do not measure soil water content directly but rather the energy of that water hence the need for calibration.

I am aware that crops on retentive soils are likely to transpire rather more water than those on droughty soils and have never suggested otherwise. The point is not of first importance since measures can be taken to overcome difficulties but I prefer not to use readings made on a droughty soil for scheduling other retentive soils because:

i) An **unadjusted** seasonal schedule determined by the need of a droughty soil will then over-specify by at least the difference in available water in the respective root zones. The difference may be quite large and can result in one or more extra irrigations being given. For most irrigators this represents an appreciable extra cost and use of resource, that might have been used effectively on another crop.

ii) **The water characteristics and drainage below the main rooting** zone are likely to be different between droughty and retentive soil **types so that often more water** drains quickly from **droughty** soil after irrigation. This loss might be **prevented by very exact application of water, generally it is not and the problem of applying the** correct amount of water is one which warrants more attention. Though less important in the **UK than in Holland the subsoil below the main root zone in droughty** soils may also contribute less water **to crop needs via occasional roots or, (more rarely) by upward movement.**

(Points 2 and 3) The effect of temperature is quite small, at least in the UK, but can result in confusing slight variations in the readings of tensiometers which have broken down due to an entry of air, etc. Blue colour or no, it is not always very clear to a person in the field just when a tensiometer has ceased to operate correctly and if a faulty instrument continues to show variation in readings it is more difficult to spot a fault. However technical problems of this kind can usually be overcome, **by** using more measuring devices, and providing training for users.

Dr. Frank Cope
Fisons Ltd.

AMENDMENT

Contrary to any rumours that may have arisen, concerning Mr. L. *J. Walton's* article *(Vol 8* no I), he is not a former partner of Greens *of Soham* Ltd, but a farmer partner. We apologise for any confusion that may have occurred.

Mike Saull SAWMA's Technical Secretory.

A CASE FOR BETTER AND MORE PERMANENT DRAINAGE SYSTEMS

By Robert Walpole, TEng(CEI) MIAgr.E

The Author

Introduction

IF THE FULL AGRICULTURAL POTENTIAL IS TO BE REALISED OF SOILS WHICH SUFFER FROM LIMITATIONS DUE TO POOR DRAINAGE CONDITIONS, IT IS FUNDAMENTALLY ESSENTIAL TO INSTALL FIELD DRAINAGE. NO FARMER OR MANAGER WHO HAS EXPERIENCED THE DIFFICULTIES OF FARMING WET LAND WILL DISPUTE THIS.

WHY THEN IS THE DESIGN AND INSTALLATION OF A DRAINAGE SYSTEM NOT TREATED WITH MORE ATTENTION AND CONCERN AND WHY AFTER INSTALLATION IS NOT THE MAINTENANCE OF THE DRAINAGE SYSTEM GIVEN THE ATTENTION IT DESERVES?

It is an extraordinary thing that a large proportion of fields in this country have been drained more than once in the last twenty years, some three or even four times! Surely this cannot be the right approach, there must be something wrong.

Evidence suggests that the systems initially installed were not adequate to provide the degree of control required, thus failed prematurely and indeed successive attempts proved no better. The conclusion can only be that the original problem had not been diagnosed correctly, or if it had, the cure prescribed was not the best.

The causes can be numerous and the need for economy not the least. Of course it could have been that the installation was at fault, that it was not properly supervised, or that the timing of the installation was not the best for the characteristics of that particular site.

It also follows that early failure can occur if maintenance is neglected, a situation all too common, and proper care and attention inevitably extends the life of the systems.

Drainage today is very expensive, the Government Grant is less than it has been for about 30 years. This does not indicate a reduced need for drainage, but it does increase the need for better quality drainage systems.

System Design

The design of a system should not therefore be approached in a casual or routine manner, hoping that the results will prove adequate. Nor should it be necessary to have two or three bites at the cherry!

The approach to drainage design and problem diagnosis requires a great deal of skill, training and experirnce, combined with uptodate knowledge of the results of experimentation. If a system is not producing the results required, the reasons for this must be fully understand, otherwise the same mistakes will be repeated.

Proper site examination must be carried out in the first instance and sufficient time allowed for this in order that a design can be evolved that will meet the circumstances at the outset.

Often the cure to the problem is assumed to be simple; often insufficient attention is paid to the farmers own valuable experience and that of his man to the tractor. It has often been assumed that modern sophisticated machinery can provide the best job because of its capabilities. How wrong this can be; tior has . shown that the cheapest system has sometimes been the best.

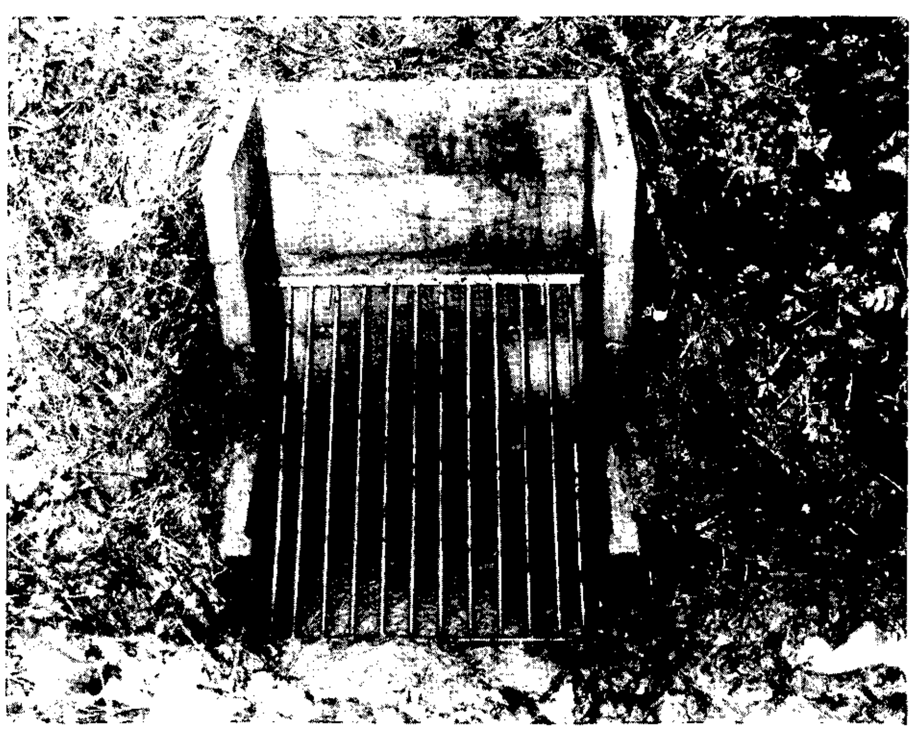
The 'broad brush' approach to drainage design can be a dangerous and expensive gamble. It is all very well to apply generalised designs based upon local successes and related to tradition in districts, but all so often each field is an individual problem. Many soils if not most have complexities caused by previous agricultural practices over the centuries, the results of which in themselves have formed obstructions to water movement through the soil at various levels and these need to be taken into consideration.

Site Mapping

When drainage layouts are designed by those who are also soil experts, investigations involve the recognition of the soil types and the variations that occur within each area or field under consideration. This is necessary to clearly delineate the areas where different drainage treatments need to be applied. In so doing, the boundaries of the soil types are plotted and mapped, thus placing them on permanent record.

Such an operation demands a detailed soil survey involving many auger borings or trial pits and the recording of the horizons or levels of different soil characteristics, that are likely to affect crop suitability, root development and water movement.

Soil mapping in detail is generally a once and for all operation. The benefits are not limited to drainage design, the associated classification of the soil can identify its potential capability and its limitations, and thus provide a greater understanding



A practical example of a piped ditch headworks, showing a good grating, silt trap and headwall.

which forms the basis of good management, and simplifies decision making on cultivations, cropping systems, drainage and irrigation need, and even fertiliser application.

The site circumstances of climate, slope, geological strata, soil, cultivation systems, cropping and the condition of existing drainage systems all need to have expert and critical examination. This attention leads to the design and proper installation of a successful system.

Starting Points
The following, but by no means comprehensive illustration of some of the queries that can arise, shows the need for, and the value of, expert advice.

What is the present drainage status of the field and how should this be assessed?

What are the causes and problems of poor drainage conditions?

What is the agricultural potential of the soil after drainage?

What design rate should the system cater for, and how often is this design rate likely to be exceeded?

Would the drains give better control if spaced wider and deeper?

Would it pay to spend more for better control?

Why has the existing system not worked well enough?

Is permeable backfill over the drains an advantage? It is expensive and would it be better to have more drains closer together but at the same cost?

Are plastics pipes better than clayware and what are the advantages, and disadvantages?

What are the ideal bedding conditions, and how does this affect the life of the system?

Should the field be moled or subsoiled and what are the best conditions for carrying out these operations?

How long will the moling last and can subsoiling be done over moling?

What can be done to protect the system against deterioration by precautionary measures and refinements in design?

Answers to these queries vary with location and site circumstances, and to deal with them all, even in brief, will take many pages, but it may help to illustrate their significance if one subject of maintenance is looked at a little more thoroughly:

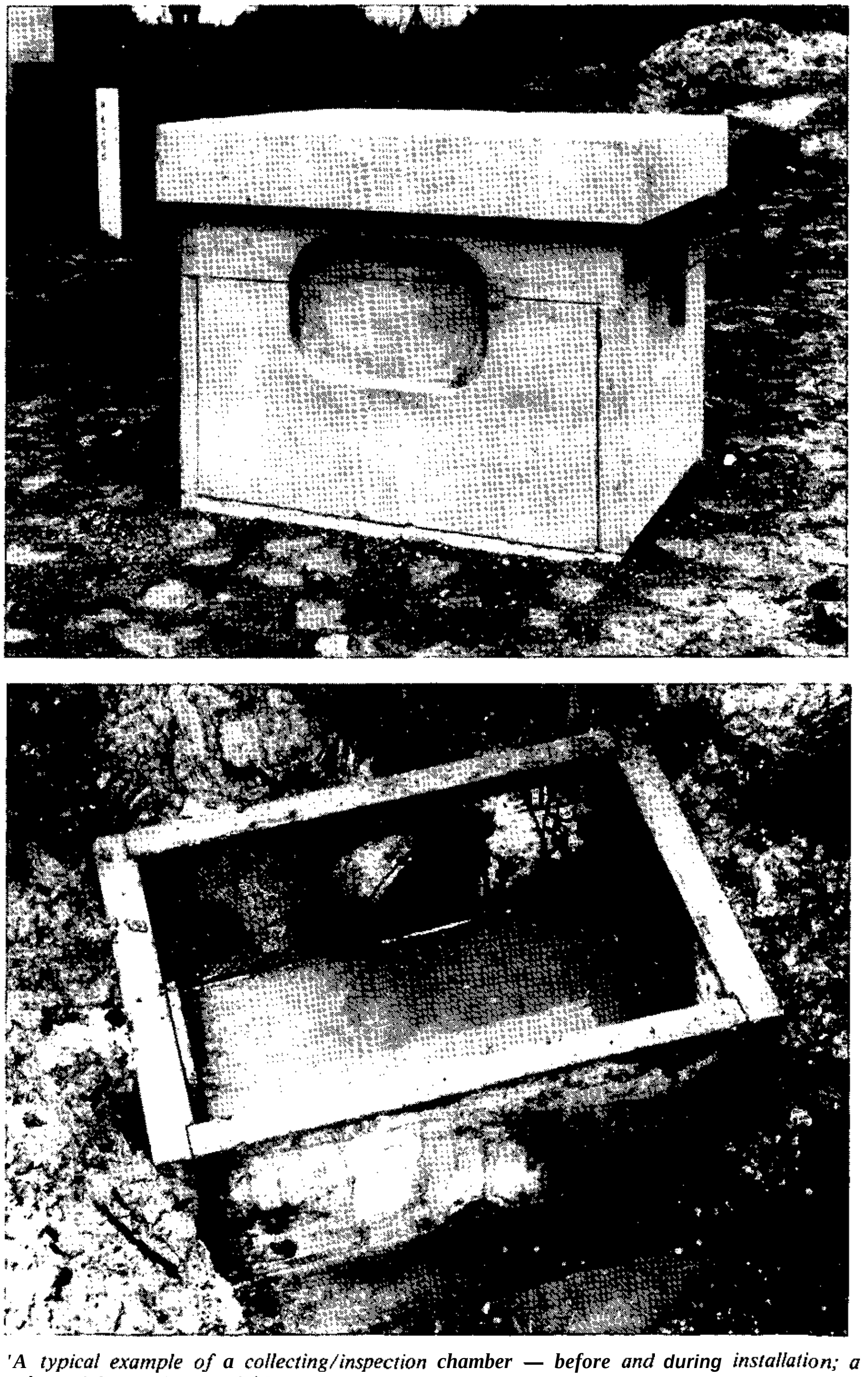
Piped Ditches
One of the most serious aspects of modern farming is that of ditch elimination, not from the conservation aspects, although this is of prime importance, but the affect that the removal of ditches can have on storm runoff and drainage control. It can never be disputed that ditches are the most efficient drains of all, if properly maintained to their correct dimensions. They have the added advantage over pipes of providing storage to contain and balance the runoff from exceptional storms.

It is probable that the piping of ditches, or piping which allows their elimination, is likely to be an unwelcome legacy in many areas, not highly regarded by future generations.

Granted that ditch maintenance is an unwelcome problem on most farms, but at least the need for maintenance can be seen and easily remedied. What happens if they are eliminated and pipes substituted?

If gradients are good, if the pipes are closely butted, or if joints between pipes are sealed; if adequate inspection chambers are provided at all major junctions and the head works are protected by properly designed silt traps and gratings, then there is every chance that they may provide a useful service for a long time, if properly maintained.

'Out of sight out of mind' should never be the policy. Headworks need to be cleared of debris, and they together with inspection chambers, cleared of silt at regular intervals.



'A typical example of a collecting/inspection chamber — before and during installation; a substantial cover is essential.'.

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Where gradients of the pipes are poor and where the velocities within are not high enough to be self cleansing, they should be rodded and cleared to prevent the successive accumulation of silt.

The capacity of a pipe is finite, limited to its cross sectional area and gradient. It is probably designed for a maximum storm event of about once in ten years. Whereas a ditch has an ever increasing capacity until it is full. The gradual siltation of pipes in a piped ditch may not be noticed for many years, the damage probably starting from below when the pipe cannot take the required flow. It will probably become surcharged and the surrounding soil will be waterlogged at pipe level first and then progressively move up the soil profile.

I find that the refinements necessary to observe the efficiency and carry out maintenance of piped ditches are not included in present systems, it is of fundamental importance to do so now.

Conclusions

1. Sections of pipe should always be of suitable length for rodding. Some interlocking high tensile steel rods will clean up to 200 feet quite successfully.
2. Silt traps and rodding chambers should be provided to allow access and easy inspection. This is not easy if the chambers are below ground level. Thus, they should be above ground and sited in positions of minimum inconvenience to cultivation operations.
3. Headworks with silt traps should have gratings set at a maximum angle of 40" to the horizontal, allowing trash to rise and water to continue flowing at least until an inspection can be made. It is a good idea to do this after all severe storms, particularly in late autumn and early winter when leaf fall is severe.

It is worth drawing attention to the necessity of recording the position of disused ditches, or at least the position of their inspection chambers. Once the main landmarks have gone, their position may be known by the present generation and they may be shown on old ordnance survey maps, but what of the future, will they be easy to relocate?

We have already experienced the problem of locating old Government Drains laid down in the mid-1800s, even now they occasionally appear by accident. Record plans with positional measurements are an essential feature of farm records and should be preserved carefully for posterity.

Grant Aid

It seems that under the new Grant Schemes which came into force on October 1st 1980 it is now not possible to obtain prior approval on drainage and irrigation work, but a claim can be submitted after the work has been completed, though there is certainly a risk involved.

The design of the scheme must be right, relative to soil type, layout, pipe sizes etc. The applicant is responsible for this and for obtaining clearance on all the many aspects of statutory requirements and consents. Failure to comply might jeopardise the payment of a grant.

It is now more important than ever that the work should be properly designed and installed.

Surely it will pay to have the problem fully investigated and then to have the installation properly supervised? Needless to say the system should incorporate every possible refinement, to facilitate easy maintenance if necessary, and thus promote long life.

DRAINAGE SYSTEM DESIGN — THERE'S NOTHING NEW.

Dick Dottridge — White Horse Contractors, Abingdon, sees the past catching up with **todays** drainage system trends.

Land drainage dates from the beginning of tillage farming and history contains a wealth of knowledge about it.

It was practised by the Egyptians and other nations in the early days. The Roman Classicists make frequent reference to the subject. Virgil Cato and others refer to the use of open ditches for the removal of drainage water. Columella describes both open and covered drains, the latter being filled with stones or twigs to provide channels for the flow of underground water.

The practise of modern drainage may have commenced in the seventeenth century.

In the early part, a French agriculturalist named Oliver de Serres and an Englishman named Captain Walter Blith got together and decided that the materials available — i.e. stones, chalk, twigs, straw etc. — were not satisfactory, the systems only lasting for a few years.

Consequently from this period onwards, work was largely confined to surface drainage and no important progress was made for about a century. However in 1736 Elkington came on the scene and the Government of the day thought so much of his work that they appointed John Johnson of Edinburgh to study his methods and write them up.

An important development in the middle of the nineteenth century surrounded fierce controversy between Wilem Smith and Josiah Parkes. This feud was particularly important then, and is worth repeating now, because I consider that we may be in danger of making a similar mistake today. Smith advocated drains at 10' or 24' apart at a depth of 30" whereas Parkes favoured a minimum depth of 4' and 20' to 50' apart, using pipes of 1" bore. Smith used pipes and stones for infilling.

There were both on the right path because Smith was on heavy impervious soils and Parkes on light land with a high water table.

However, the real benefit from these two gentlemen was the public attention caused by the feud and as a consequence Parliament passed an Act — (Land Drainage Act 1846) — setting aside £3,000. (A very large sum then) to assist landowners to improve their land by drainage.

Bailey Denton was the next to come forward with a middle course between tenets of Smith and Parkes and a lot of this work where the outfalls have been maintained is functioning today.

Progress through the centuries was very slow and most of the changes have come about in the last forty years or so. Therefore there may be a case for taking stock of present day practices NOW to find out if we are not making mistakes as did our forebears.

We should ask ourselves for instance if present costs, diminishing mineral resources and the environmental problems of today necessitate afresh look at drainage as a whole. Perhaps this is too extreme, and I would not recommend such action in the present climate of economic constraints, but there must be room for debate on some present practices.

For example, with the potential output from today's big drainage machines it might be less expensive to install pipes at say, one metre apart with no permeable filling; subsoiling would still be carried out immediately and more frequent intervals subsequently.

Should we not, after 20 years or more of plastic piping, be able to be assured with complete confidence that it fulfils its manufacturer's claims instead of hearing constant doubts voiced about its efficacy and durability? Outstanding work is being carried out to measure the benefits of drainage to crops, and this should encourage action to research into the relative engineering and economics of drainage.

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WHY DO MOST DRAINAGE SCHEMES RELY ON CLAY PIPES?

LOOK BENEATH THE SURFACE AT THE FACTS

It's not stick-in-the-mud traditionalism that makes farmers prefer clay land drainage systems.

Let's look below the surface arguments and deal with the facts. Let's compare the Oakland 3" clay tile with the average 60mm plastic tube.

PERFORMANCE

The ability to carry water is dependent on the cross-sectional area of the internal bore. *The Oakland tile has twice the water-carrying capacity* (44 18 sq mm against plastic's 2207 sq mm).

LONG LIFE

It follows that twice the water carrying capacity leads to *twice the life* under siltation conditions. Longer life, too, from the Oakland clay tile's total resistance to attack from both crop chemicals and vermin.

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NATURAL BENEFITS

The absorption properties of clay mean minimum loss of nutrients through leaching. They also mean enhanced growth in drought conditions. And because clay is natural – not an oil-based artificial product – it means the raw material is not subject to economic or political attack.

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New, additional factories manufacturing only clay tiles mean that demand is never likely to exceed supply.

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Silt Trap Inlet - Dimensions (internal): 30" x 30" x 33" high. Extension rings: 9" deep. Sizes available: To suit 6" dia., 9" dia., 15" dia. and 18" dia. pipes. This unit is designed to protect piped ditch inlets preventing the entry of vermin and trash and providing a silt capacity 12" deep below the invert of the pipe. The 2½" thick base slab has a removable centre to make it lighter to handle and to assist in placing it in position on site.
For further information about JKH Drainage Products please send for the 1981 catalogue.
JKH DRAINAGE UNITS LIMITED
Hampstead Avenue, Mildenhall, Suffolk, England.
Telephone: (code 0638) 713795

OVERCOMING COMPACTION

G. Spoor and R. Godwin presented a step by step approach to loosening soil and overcoming compaction at the recent SAWMA Conference. This is an account of their paper.

Principles of Loosening

The principles of the loosening operation to allow soil loosening over as wide a range of moisture conditions as possible are given below:—

1. Always loosen from the top down rather than the bottom up.
2. Ensure implement is working above its critical depth, if not, consider one or more of the following modifications:
   a) loosen surface layers first
   b) increase share width
   c) add wings
   If the implement is still below its critical depth, stop operating and wait until soil conditions are more favourable or have dried out.
3. Surface layer loosening ahead of tines fitted with wings is essential for effective deep loosening at higher moisture contents. Prior loosening of the surface layers to break the surface crust is essential for effective deep loosening at very low moisture contents on the heavier soils.
4. The evenness of the surface after loosening is dependent upon tine spacing. If even surfaces are required but not being achieved. reduce the spacing between the tines.
5. Minimum clods on the soil surface for direct drilling situations can be achieved with vertical leg subsoilers using disc or knife coulters ahead of legs fitted with narrow shares and wings. Clod disturbance problems can be expected to arise with equipment used under dry cracked soil conditions. Ensure, when attempting to minimise surface disturbance, not to increase the working depth to below the critical depth of the tine.

Field Operation of Loosening Implements

Considerations:

1. Diagnose the problem, is it:
   a) general compaction
   b) local compaction
   c) a pan?
2. Decide on the appropriate working depth just below the problem area, always working as shallow as possible.
3. Decide on the spacing required to give an acceptable surface finish and overcome the problem at depth.
4. Plan field operations to give a minimum amount of *trafficking*. Well loosened soil is extremely weak and therefore very vulnerable to recompaction by subsequent traffic, with disastrous results if the soil is wet. The danger of loosening under wetter soil conditions is not in achieving loosening, which can be done by surface loosening and wings, but from damage resulting from subsequent traffic under the wet conditions. Field operations must be planned so that the minimum amount of traffic crosses the field between loosening and crop establishment to prevent recompaction. The implications of this are:
   a) aim to work towards the final seedbed condition either before or during the loosening operation itself or both.
   b) consider carrying out other operations at the same time as loosening e.g. clod breaking, levelling, seedbed consolidation.
5. *Plan* any operation *to* make maximum use of the undisturbed soil for traction. From a tractor efficiency point of view there is improved traction, lower rolling resistance and less compaction if the tractor is working on a consolidated undisturbed soil rather than on loose soil.

Possible Working Methods for Effective Traction and Minimum Recompaction

1. Single tine or widely spaced tine operations under good loosening conditions.
   This type of operation is appropriate where tractor draught power is limiting, where complete loosening is unnecessary or where the aim is to achieve the desired result over a number of years rather than in one season.
   In this situation keep to regular spacings between passes (1½ – 2m) during deep loosening, leaving undisturbed strips between. Use these undisturbed strips as traffic ways for secondary tining or discing operations. See Figure 1.
2. Where the tractor cannot pull two tines at the required working depth and the soil at depth is at a moisture content slightly above optimum.
   Under these conditions check that you really need to be working — to that depth; every cm shallower produces a big reduction in draught (Figure 2). Shallower working may then make pulling two tines possible.
   If this is not possible, do not reduce the operation to one involving a single tine, but continue with two tines conducting the operation in two stages, as shown in Figure 3.
   Stage 1: Loosen the surface layers using chisel tines but leaving traffic lanes of undisturbed soil.
   Stage 2: Carry out the deep loosening with two tines positioned behind the tractor wheel, the wheels running in the traffic lanes.

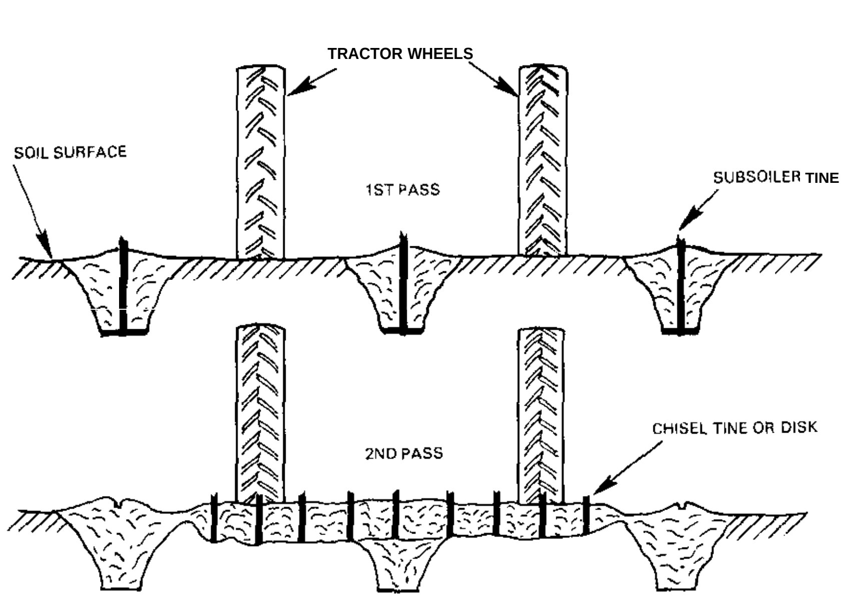


FIG 1

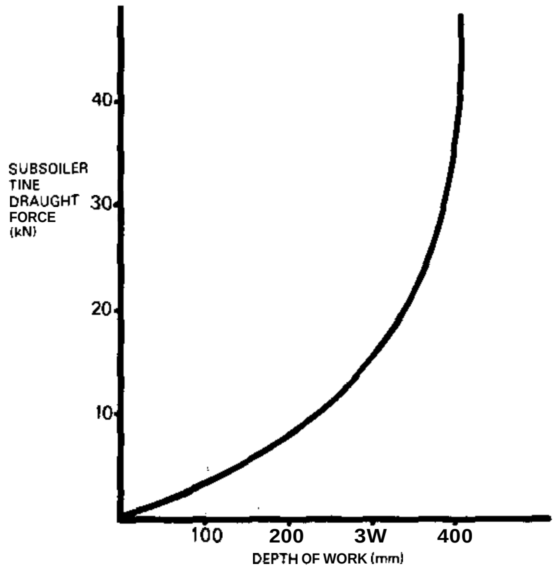


FIG 2

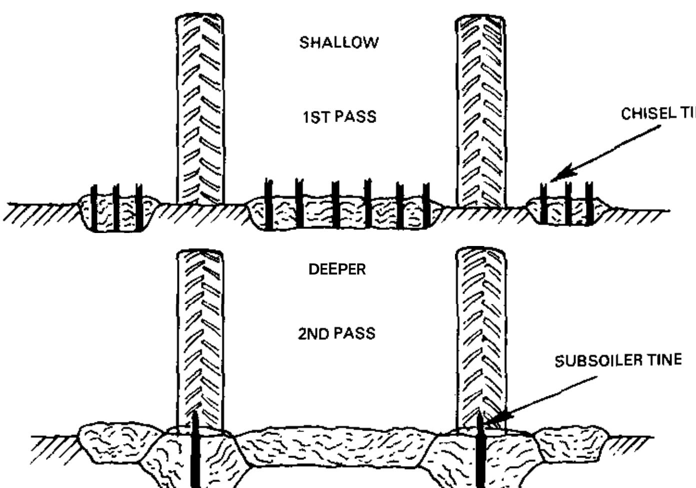


FIG. 3

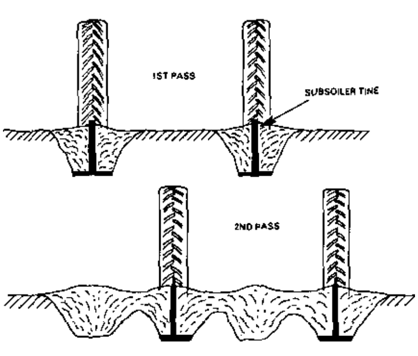


FIG. 4a

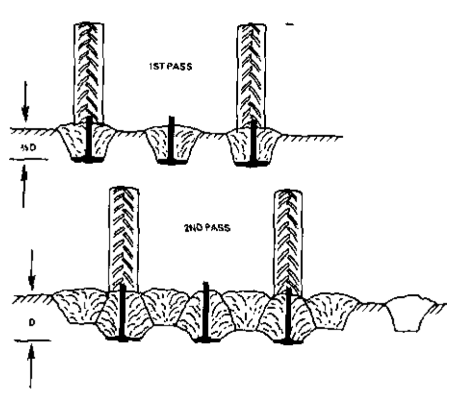


FIG. 4b

3. Where adequate power is available to break out the complete tractor width.
   Use a multi-stage implement with two or three rows of tines working from the surface downwards, followed by a final clod crushing stage.
4. Where the tractor can pull two tines at the required depth. With the usual method of working with two tines, not all the soil is completely loosened at depth, shown in Figure 4a.
   An improved method using three tines is illustrated in Figure 4b. This method allows satisfactory loosening over the widest possible range of working moisture conditions. This method has the advantages that:
   a) more soil is loosened at depth
   b) spare traction capacity allows further clod breaking or levelling tools to be attached during the second pass.
   c) higher operating speeds can be achieved if no further implements are attached.
5. On direct drilled land, where level surfaces with minimal surface disturbance is required.
   Under these conditions shallow leading tines are inappropriate and plane, winged or "Paraplough" tines must be close enough together to give complete loosening covering the complete tractor width. Aim to avoid this operation under very dry soil conditions with heavier (clay) soils.
6. When a ploughed finish is required.
   Loosen at the same time as mouldboard. ploughing with the tines operating in the furrow bottoms. An operation ideal for pan bursting.
   Tines should be set to work immediately behind the tractor wheel in the open furrow and behind each mouldboard at a depth of 8–10 cm. Because of the extra draught required it may be necessary to remove one body from the plough or reduce speed.
7. Shallower loosening operations where more than one pass is required.

   The usual practice is shown in Figure 5. The normal spacings used for tines or discs will be too wide to loosen all the soil during the first pass and a second pass at an angle to the first pass is required to complete breakout. During the second pass the tractor wheels work on loosened soil resulting in poor traction, recompaction, and a significant time delay should it rain before the completion of the second pass. Therefore it would be

V9-1

preferable if either all the soil could he loosened during the first pass or if the tractor could drive on undisturbed soil during the second pass. To loosen all the soil would require a reduction in the tine or disc spacing or the attachment of sweeps to the tines. This will increase the draught and it will be necessary to reduce the working width if traction or power are limiting.

If reducing the working width means it is no longer possible to loosen the complete width behind *the* tractor, arrange the tines as shown in Figure 6 to leave traffic lanes for the subsequent pass.

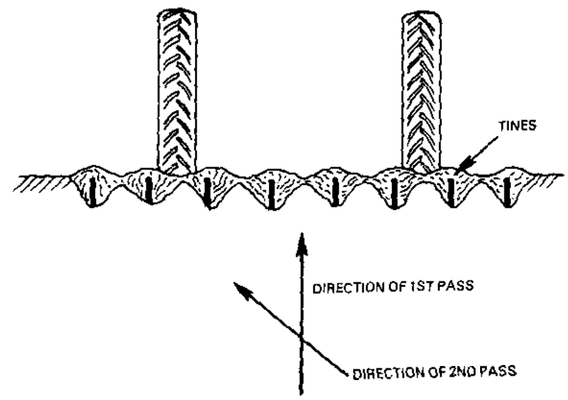


FIG. 5

Conclusions

There are, therefore, ways of overcoming compaction using commercially available equipment without causing unnecessary levels of recompaction as a result of subsequent field operations.

Whilst it is better to avoid compaction in the first place, this is frequently impractical.

Ensure during loosening that a useful loosening job is being done and be prepared to check and adjust tools to ensure this is so.

Plan both loosening operations and seedbed preparation operations together, to reduce work input, increase operating efficiency and to minimise trafficking and hence recompaction of the loosened area.

Relatively small changes to existing field procedures will allow effective loosening and less recompaction with equipment that is already available on the market.

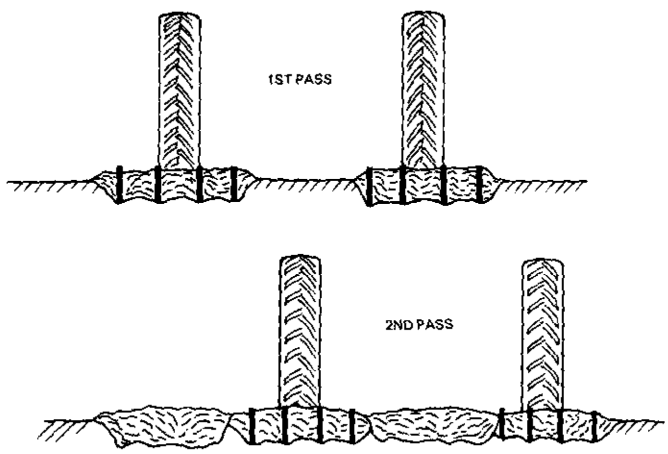
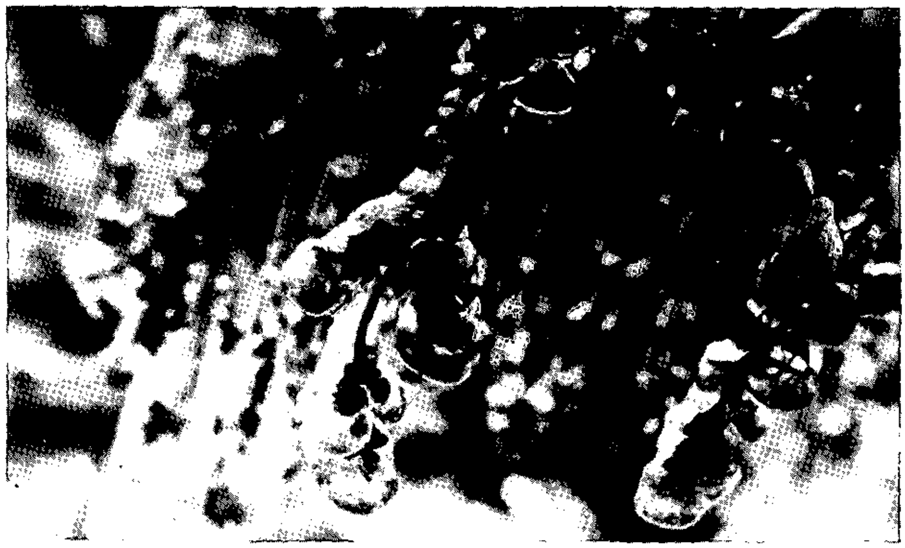


FIG. 6

FROST PROTECTION IRRIGATION

Lawrence A. Thornton

Mr. L. A. Thornton is Managing Director of Perrot Irrigation Ltd. and for many years has been involved in irrigation scheme design. In this article he looks at Frost Protection.



Fully Frost protected fruit after a night of temperatures down in early May to − 8°C.

Spring 1981 — twenty years later! — the following report will undoubtedly be of interest to readers:

1961. SOFT FRUIT AND SPRING VEGETABLES. 'The unusual run of weather in the Spring of **1961 (February/March)** with its 4 to 5 weeks early growth commencement brought later a series of night frosts which led to complete commercial loss and total frost damage in unprotected areas, (depending on area and surroundings) and gave the experts ample opportunity for testing frost defence irrigation sprinkling in all phases.'

The Spring of 1961 removed all doubts regarding the use of FROST DEFENCE SPRINKLING for blackcurrants. Not only was no frost damage evident but also the currant stalks withstood severe icing, without damage.

It was uniquely beautiful, if a little disturbing to the layman, to see the stalks lying under the weight of ice in a regular spreadeagled mass on the ground. On the morning of 22nd March 1961 the frost had lasted for 10 hours, and all the signs would have convinced one that the season's blackcurrants lay destroyed, trampled and smashed. Great was the astonishment when, with the thawing of the ice, the shoots stood out as erect as ever and the fruit was unharmed.

The report concerned a 2½ acre blackcurrant plantation of high yield.

The parameters for the planning of the particular installation were:

1. Protection from frost damage.
2. Irrigation for optimum growth.
3. Distribution of fertiliser.
4. Distribution of plant protectives through hydraulic syphon.
5. Prophylactic weed control and surface vermin control.

Quick coupling galvanised steel pipes 70mm and 50mm o.d. were used. Sprinkler mountings, risers and sprinklers were taken from stock or current production. The design is unchanged 20 years later!

If the reader does not know about frost defence of fruit and vegetables by sprinkler irrigation there are some curious facts to appreciate.

If equipment is provided to create a steady fine drizzle of rain throughout the period of frost and over the entire area at risk the crop will be protected from air frost.

Ice forms round the plant, fruit or blossom and the temperature inside the globule of ice does not fall below freezing point as long as the ice continues to form on the surface. In addition to this the formation of the ice releases an astonishing amount of latent heat. This creates a comparatively warm micro-climate which resists the effect of falling freezing air. The heat released by freezing is equivalent to that released by a reduction in temperature in the same mass of water by 80 degrees Celsius viz. from 80°C to 0°C. 80 calories per gram!

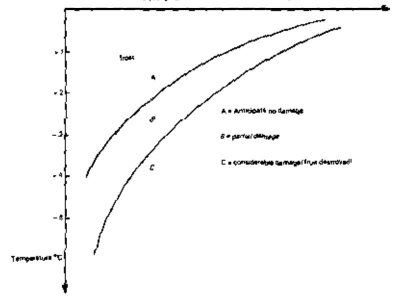


Fig. 1. Degree of damage to crops in relation to temperature.

The application rate must be appropriate to the crop and the droplet size must be calculated correctly to obtain protection.

Emergent stem and young fruit buds have inherent strength in cell structure to resist frost for a limited period down to −5°C. Later physiological advances in cell structure and character of sap may cause a formation of ice within the plant at −1.7°C and total destruction at −2.5°C, but it takes longer for this to happen.

Damage occurs when ice forms within the plant tissues, water being drawn from the sap. Hence the cells are destroyed by desiccation. In top fruit a layer of ice forms beneath the skin of the embryo fruit in flower and lifts it from the cortex. The damage may heal and show itself later by excessive russeting.

Top Fruit after a night of frost.

Design parameters require primarily a source of water which will provide between 20 to 40 cubic metres of water hour per hectare according to crop, (1,800 to 3,550 gallons per acre hour) and secondly, equipment of the highest quality which will continue to operate at ambient temperatures of minus 10°Celsius or even lower.

Considerations of micro relief, avoidance of sources of cold air and the creation of windbreaks all contribute to the protection of fruit and spring vegetables from frost.

It is a fact that a properly designed system of frost protection irrigation giving the appropriate rates of sprinkling will completely protect plants from damage by desiccation, whereas a system which is only slightly inadequate may lead to additional heat loss by evaporation and actually contribute to fruit and plant destruction.

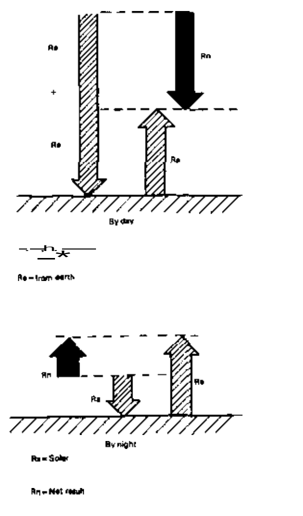


Fig. 2. Night and day radiation balances.

Full copies of technical reports are available from Perrot Regnerbau GmbH & Co., D.7260, Calw, Western Germany, or their British subsidiary Perrot Irrigation Limited, 38 High Street, Rowhedge, Colchester CO5 7ET. Please enclose a S.A.E. A4 size with postal order for £1.W or International Order for DM4.50 as appropriate.

Reports are:

- No. 3. **Practical experiences in SCAB control, employing anti-frost sprinkling systems.**
- No. 4. **Frost Defence for early potatoes and spring vegetables.**
- No. 5. **Report on the employment of a sprinkler installation for blackcurrants in 1961**
- No. 12. **Frost Protection and Permanent Sprinkler Irrigation.**

IRRIGATION AND PROTECTION AGAINST SPRING FROSTS... Micrometerological Considerations.

Michael Hunt, a regular Anglia Television Weather forecast presenter, outlines the mechanics of irrigation for frost protection.

In two previous articles (Vol. 8, No. 1 Soil *and Water)* irrigation has been considered as a means of making good rainfall deficiencies which would otherwise prevent a crop achieving its full potential yield. If an irrigation system is available then it can *also* be used to help prevent frost damage in late spring when foliage **and/or** blossom are at a critical stage of development.

The formation of frost on clear windless nights is due to the fact that the ground loses its heat by radiation and is thus cooled. The air in contact with the cold ground is in turn cooled and if the process goes on long enough the ground temperature falls to below freezing, with a shallow surface layer of air also being gradually chilled to freezing point or below. If skies are cloudy then quite a lot of heat radiated outwards by the ground is radiated back by the cloud sheet which effectively acts as a form of blanket. If skies are clear, but with a moderate wind, then the heat loss from the ground is distributed by turbulence over a deeper layer of the atmosphere, and the resultant fall in temperature near the ground is less than that with calm or very light winds. (Thus it is that in some parts of the world wind machines are used to prevent frost damage to crops.)

A light, loose, dry soil will become colder at its surface on a potentially frosty night than a soil which is heavy, compacted and wet. ***Thus a crop which has been very recently irrigated in the normal way* will havea decreased frost damage risk even if*** no ***sprinkling is actually carried out on the night when a frost occurs.*** It must be emphasised that this partial protection is limited to low-growing crops such as potatoes and strawberries, and is only effective in marginal frost situations when the frost over unirrigated areas is limited to a few degrees below freezing, for a couple of hours around dawn.

**I.e. for 'growing' purposes.*

Comprehensive Protection

For protection against sharper frosts and for fruit trees and bushes it is necessary to operate the sprinklers throughout the period of night when temperatures, in general, are below freezing. The protection given by this method is due to the fact that when water changes into ice a considerable quantity of heat is released. The heat is known as the latent heat of fusion and about 1 million British thermal units are liberated when 750 gallons of water freeze. The East Malling Research Station has calculated that this quantity of heat is very approximately the same as that lost in an hour by an acre of orchard on a radiation frost night. Theoretically therefore spraying at a rate of 750 gallons per hour per acre should give protection from frost but in practice the sprinkling rate must be considerably greater than this.

The water must be applied continuously and fast enough to ensure that there is always some liquid water undergoing freezing. As long as this is going on then blossom, buds, and young tender leaves remain undamaged even although encased in a sheath of ice. After some hours of sprinkling the build up of ice on branches is considerable but actual breakage of branches doesn't usually occur although they are often bent almost to the ground by the weight of ice.

In practice sprinkling should commence when temperatures in the orchard are still a degree or so above freezing. The first result of the sprinkling will be a relatively sharp fall in temperature (to near the wet bulb temperature of the air) but recovery of temperature takes place as the sprinkling continues. The actual sprinkling rates will vary according to the expected severity of the frost but a rate of 2mm per hour (just under 1/10 inch per hour) will normally give protection against a very sharp late spring frost of **−6°C** or **21°F.**

The water sprinkling method warms neither the plant parts nor the surrounding air (other than some possible initial rise in temperature due to the water being taken from a relatively warm source.) All it does is to maintain the temperature of the ice covered plants at about freezing point, but this is sufficient since damage to frost susceptible vegetation does not normally occur until the temperature has fallen a few degrees below freezing. Sprinkling once started must be carried on as long as the general air temperatures are below freezing and on a clear radiation night in spring this will be until shortly after sunrise.

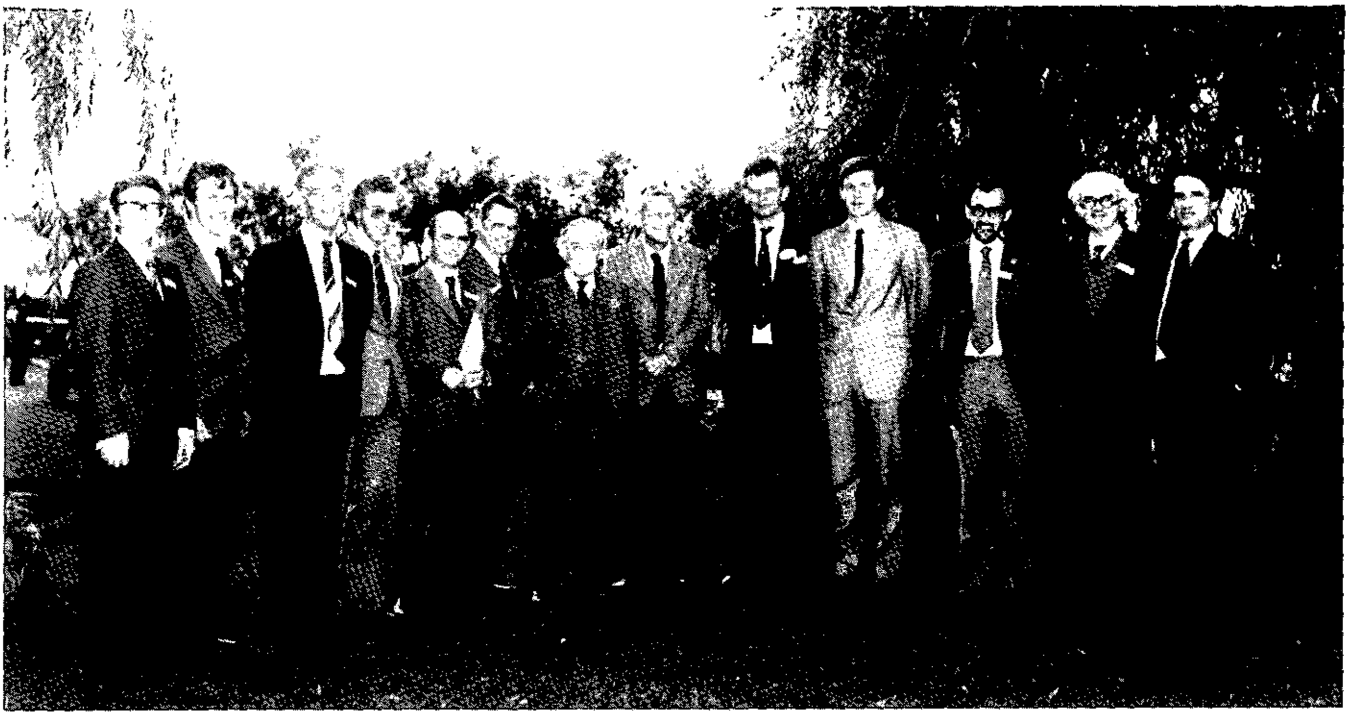
Cloches are, of course, a standard way or protecting some plants against frost damage and are effective even if temperatures fall to about −4°C or 25°F, but the protection can be considerably increased by using a sprinkler irrigation system on the cloches. A further **2°C,** or **4°F,** of frost protection can be obtained in this way.

Site Factors

If sprinkling is necessary on successive nights then fields can, of course, become very muddy and waterlogged and if protection was to be given on a number of nights in a growing season then considerable leaching of soil nitrogen can occur.

Under marginal frost situations the actual location of a field can be critical and even very shallow frost hollows should be avoided in the case of frost susceptible crops. A gentle slope reduces risk of frost damage as the cold air drains down the slope but, if there is a hollow at the bottom of the slope, then the risk is greater in that part of the crop planted there. The ideal location for, say, early potatoes is a field with a 'heavy' water-holding soil and a definite slope to the east or southeast as such slopes catch the early morning sun with a consequent reduction of frost risk around dawn. An open windy location also helps since even a light breeze will perhaps prevent a late spring frost when a crop in neighbouring location sheltered by trees or hedges and/or in a hollow might be considerably damaged.

Irrigation



Members of the Executive Council of the U.K. Irrigation Association and participants in the Inaugural Conference held at N.C.A.E. in October. From left to right:
Dr. Alan Ivemy (Hon. Treasurer); Dr. Michael Carr (Hon. Secretary); Professor Gerald Stanhill (Israel); Eddie Bailey (France); Mike Martin (Chairman); Dr. Marvyn Jensen (U.S.A.); Sir Nigel Strutt; Professor Jack Keller (A . ; Philip Bolan (Barclays Bank); Simon Murch (Vice-Chairman); Philip Cooper and Jack Ingram (both committee members); and John North.

THE U.K. IRRIGATION ASSOCIATION LTD.

The U.K. Irrigation Association was officially launched on October 15th, 1980 with an inaugural conference, sponsored by Barclays Bank Ltd., and held at the National College of Agricultural Engineering entitled 'Irrigation: the way ahead'. Speakers included Professor Jack Keller from Utah State University; Dr. Marvyn Jensen (National Programme Leader, Washington D. C.); Professor Gerald Stanhill (The Volcani Centre, Israel); Eddie Bailey Dimatco, Paris) and Sir Nigel Strutt. The object of the conference was to look at developments in irrigation techniques in other parts of the world to see how they could influence irrigation development in the United Kingdom. 270 delegates representing all sectors of the irrigation industry supported this event.

The Association was formed with the following principal objectives:

1. To promote interest in, and a better understanding of, all aspects of irrigation in the U.K.
2. To collect and exchange information.
3. To raise standards of knowledge and competence in irrigation design, installation and management.

Its formation after 2 years of discussion follows the publication of the report by the Advisory Council for Agriculture and Horticulture in England and Wales entitled "Water for Agriculture: future needs". This anticipates a substantial increase in the irrigated area and demand for water by agriculture.

To ensure that standards of design, installation and operation of existing and future irrigation schemes are high it is important for the industry to have a strong independent voice representing all sectors of the industry from manufacturer to user.

Membership is therefore open to everyone with an interest in irrigation, particularly farmers and growers. hut including manufacturers and suppliers of irrigation equipment, advisers, consultants and contractors, water authorities and education and research establishments.

Planned Activities include:

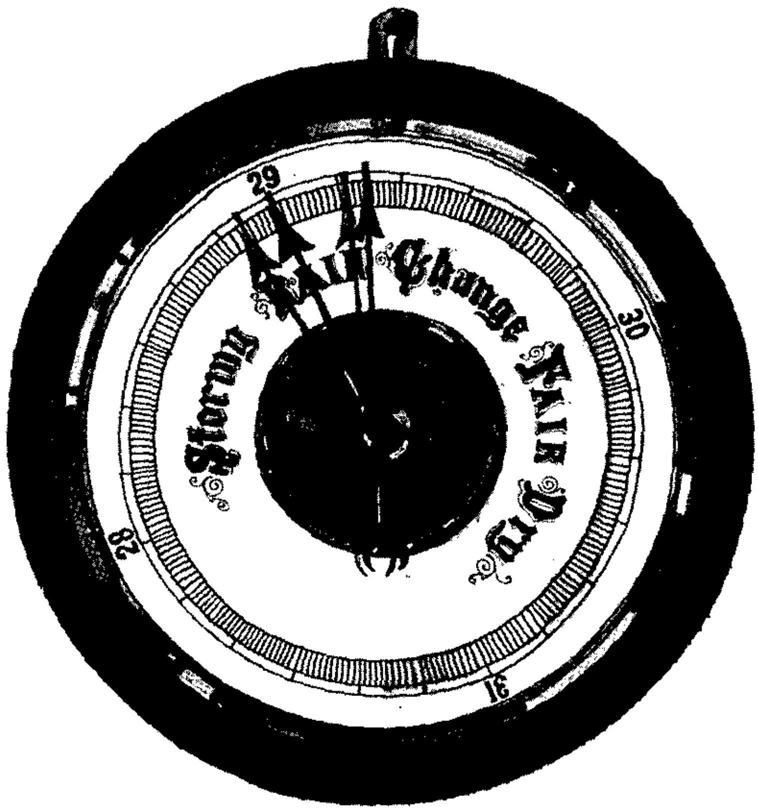
1. Short courses.
2. On-farms open day (arranged in co-operation with A.D.A.S. on farms in the Cambridge area, June 25th, 1981).
3. Overseas visits.
4. Local seminars.
5. Conferences.

In addition it is intended to produce a regular newsletter to keep members informed of events as well as developments in irrigation techniques and equipment in the U.K. and overseas.

The U.K. Irrigation Association is already represented on the British Standards Institute's newly formed Irrigation and Drainage Equipment Committee and in turn wirh the International Standards Organisation.

The formation of the Irrigation Association has had the support and encouragement of S.A.W.M.A. and the objectives and activities of the Irrigation Association have been planned to complement and support those of S.A.W.M.A. Reciprocal representation on committees as well as reciprocal benefits for members of both Associations have been agreed. The Irrigation Association is grateful to S.A.W.M.A. for their support and for the opportunity to have the space in this Journal to publicise its activities.

Anyone wishing to join the Irrigation Association and to become involved in its activities on a local or national scale is invited to write to M. K. V. Carr, Hon. Secretary, U.K. Irrigation Association, c/o National College of Agricultural Engineering, Silsoe, Bedford, MK45 4DT, from whom further information is available, or from any member of the Executive Council. The Proceedings of the Inaugural Conference will also soon he available from the Librarian, N.C.A.E. ar the same address.



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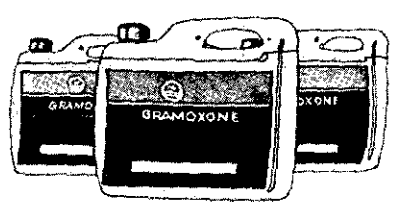

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SOIL PHYSICAL CONDITIONS AND THE PEA CROP

Tudor C. K. Dawkins, Paul D. Hehblethwaite, Michael **McGowan** and J. King.*
University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, Leics. LE12 5RD.

Peas are an important arable crop in the United Kingdom. In **1979**, **50,710**ha of vining **peas** were **grown**[1] with a value of over **£33.25** millions.

Peas are known to be very sensitive to poor soil physical conditions. The Processors and Growers Research Organisation (P.G.R.O.) recognises **soil conditions as** one of the **most** important factors limiting pea **yields**[2]. The problem in vining peas is exacerbated by a number of factors:—

a) Peas tend to be used as a break crop in cereal rotations when soil organic matter is often low.

b) Peas are grown on contract and sowing dates are determined by the contractors. Since the aim of the processors is a uniform flow of peas through theprocessingplants, some *sowings* are made very early in the spring when soil conditions are sub-optimal.

c) Ideally, peas should not be grown more than an hour's journey from a processing plant in order to maintain the peas in peak condition. For this reason peas may be grown on land which is not entirely suited to pea production. Indeed, many soils around processing plants are susceptible to *compaction* and slumping.

Several workers have quoted marked yield reductions arising from soil compaction by tractor wheelings, especially on headlands, but these have not indicated clearly to what extent these reductions were due to adverse effects on plant population and plant distribution, or to the impaired growth of individual plants that have **emerged**.[3,4,5,6,7,8,9].

In **1979** a joint survey was conducted with the P.G.R.O. to establish the importance of soil compaction to the pea industry. Several cases of severe **compaction** were examined and the **physiological** development of the crop recorded.

On average, plant populations in wheelings were reduced **by 50%;** the **plants that grew were stunted and t[illegible] yield of peas reduced by about 6[illegible]** Table 1 shows how **compaction** affected some of the yield components. It is interesting to note that even when a crawler was used for a post sowing operation on a silt soil, soil compaction was sufficient to severely affect growth.

An economic appraisal was made of the effects of compaction at one 15 ha site **by** comparison with an adjoining site where nu compaction was observed. **Wheelings** affected **25%** of the area and the yield reduction associated with these wheelings was ***about*** 9 ***tonnnes,*** indicating an economic loss of ahout **£1,000.**

Table 1. Table of *plant* components on three dates under wheeled and non-wheeled *areas* from P commercial field site.

Non-wheeled site				Wheeled site			
Component	**28.5.79**	13.6.79	7.7.79	**Component**	28.5.79	13.6.79	7.7.79
Plants per m²	117	117	117	**Plants** per m²	52	52	52
Leaf dry wt/m² kg	0.062	0.203	0.192	Leaf dry wt/m² kg	0.005	0.031	0.058
Stem dry wt/m² kg	0.039	0.190	0.379	Stem dry wt/m² kg	0.003	0.028	0.096
Root dry wt/m² kg	0.019	0.035	—	Root drv wt/m² kg	0.002	0.015	—
Root length cm	10.7	—	—	Root length cm	6.3	—	—
Nodule number/m²	2.644	—	—	Nodule number/m²	1.258	—	—
Plants HTS cm	28.9	66.1	84.0	Plants HTS cm	9.9	31.7	50.9
Photosynthetic area index	1.8	5.9	7.9	Photosynthetic area index	0.15	0.92	1.91
Dry wt pods per m² kg	— —	0.005	0.226	**Dry** wt pods per m² kg	—	—	0.100
Peas/pod	—	—	8.27	Peas/pod	—	—	5.04
Yield peas/m² TR 105 kg	—	—	2.09	Yield peas/m² TR 105 kg	—	—	0.86

When the strength of the soil is too great, pea roots are unable to penetrate and ramify through the soil or the hypocotyl may fail to emerge except through occasional large cracks. Figure 3 shows the effect of increasing bulk density on pea growth in a laboratory trial. The number of fibrous lateral roots are notably reduced at a bulk density of **1.4** g cm^{-3}.

Figure 2 shows readings of soil mechanical resistance and shear strength measured at one site.

At another site pea seedlings were found 'perched' in the top 5 cm of soil and no roots penetrated below this depth. Despite a recent subsoiling operation the soil at depth was devoid of any visible pores or cracks. Heavy rain disappeared slowly from the surface and the crop suffered badly.

In addition to the field surveys a series of **experimental** trials were **con**ducted in **1979-80** at the University of Nottingham, Sutton Bonington (SB) and the P.G.R.O. The main treatments were:—

1. Compact — an *overall compaction* by passing a tractor systematically across the whole plot. Post sowing.
2. Control thinned — a non compacted plot thinned to the population and distribution of the compacted plot.
3. Control — plot cultivated following *normal* farm practices.
4. Hand double dug — top soil and subsoil loosened but not mixed. Depth of loosening 45 cm.
5. *Tramlined — a plot* with *one set* of wheelings up the plot (similar to cereal *tramlines).*
6. Compacted and recultivated — compacted as in 1. above but the top *10* cm recultivated prior to drilling.

Other trials examined:—

1. The possibility of alleviating the effects of compaction with nitrogen (**30** units and **80** units) or **by** irrigation.

Fig. 1. Compaclion caused by wheelings.

**P.G.R.O., The Research Station, Thornhaugh, Peterborough.*

2. The effect of different plant populations and distribution.
3. The effect of deep subsoil loosening, with and without subsoil placement of P and K, using the Wye Double Digging Machine[10,11,12].

Soil conditions were measured by penetrometer and shear vane equipment. Water usage by the crop was also monitored at S.B. by neutron probe and tensiometers. Rooting depth was also investigated by examination of soil profiles.

Summary **of** Trial Work

Table 2 summarises final yield results only for the treatments listed above.

1. The compaction treatment at Sutton Bonington as in the field sites reduced yield *of* peas by over 50%. At the P.G.R.O. compaction had no effect despite the use of similar tackle. The calcareous soil at P.G.R.O. did not compact as readily as the soil at Sutton Bonington.

Plant numbers at S.B. as at the field sites were substantially reduced but this was not solely responsible for the yield reduction. It was noticed that plants on compacted soils were fundamentally modified at an early growth stage and never 'caught up'. Examination showed that all plant components were reduced by at least 50%. Compaction increased the resistance to penetration. The zone of greatest strength was about 7 cm, the depth at which the drilled seed lay. Depth of water extraction was reduced and examination of profile pits showed roots were reduced in number and restricted to less than 40 cm.

2. Hand double digging increased yield in ***1979*** by ***14%.*** This increase, though not quite statistically significant, was due to an improvement in yield potential of individual plants. Rooting was deeper than in the control. Double digging encouraged development of roots beyond the depth of soil loosening.

In 1980, however, double digging by hand and by machine produced a significant reduction in yield. This appears to be related to the high rainfall. In 1979 and 1980, double digging resulted in deeper rooting but in 1980 also in more indeterminate growth of the plant. More haulm was produced and less peas, as shown in the harvest index. Harvest index for the control plot was 10, that of the double dug was 7. At the P.G.R.O. the double dug treatment also produced a yield decrease, though not significant, presumably for the same reasons.

Double digging in both years provided a free and unimpeded growth medium to a depth of 45 cm, an effect readily detectable by penetrometer.

3. *Tramlining affected 10% of* the plots. In 1979 a significant yield decrease was accorded to tramlining; this reduction in yield was not found in 1980. One must bear in mind that in farming practice tramlining would probably affect only *1%* of the field with wheelings.

Table L. Plot final yields and plants per m' from trials at Sutton Bonington and the P.G.R.O.

Treatment	Plants per m'				Yield g m^{-2}			
	A*	B*	C*	D'	A*	B*	C*	D*
Compact	40	42	25	111	271	211	120	420
Control	81	70	105	100	632	450	455	420
Double dug	—	73	101	109	—	512	338	390
Control thinned	42	40	29	—	496	325	330	—
Tramlined	—	59	80	100	—	353	495	360
Compact recultivated		56	73	62	—	354	615	330
L.S.D. $P < 0.05$	12.0	4.0	17.9	25.5	176	81.2	56.1	NS

A* Sutton Bonington 1977 Variety Sprite
B' Sutton Bonington 1979 Variety Scout
C* Sutton Bonington 1980 Variety Scout
D* P.G.R.O. 1980 Variety Scout

Soil Type: P.G.R.O. Fine sandy loam overlying Jurassic limestone.
S.B. Course gravelly loam overlying Keuper Marl.

4. Recultivation of compacted soil at Sutton Bonington prior to sowing largely restored yield and plant numbers in ***1979.*** In 1980, recultivation of the surface 10 cm of soil produced the highest yield. In both years plants were stunted which resulted in more determinate growth as reflected in the pod analysis and harvest index. At the P.G.R.O. a slight yield decrease was noted, possibly due to delayed maturity, a feature not found at Sutton Bonington.

5. The *effects* of distribution on yield at different populations in ***1979 – 80*** indicated that distribution had little effect on yield. This indicates therefore that yield reduction in compacted plots was not due to poor plant distribution but simply to reduction in plant numbers and modification of the growth habit.

6. The nitrogen and irrigation treatments did not alleviate the effects *of* soil compaction.

7. Deep incorporation of P and K did not increase yield above that of the normal double digging treatment. It was found that the P and K index of the subsoil was already adequate.

Conclusions

1. A considerable reduction in yield can result from poor soil management.
2. Tramlining could be a useful husbandry technique in pea production.
3. The potential of one pass systems for early spring cultivation/sowing/spraying needs to be investigated as a means of reducing soil compaction.
4. Double digging apparently may increase or decrease yields depending upon season but could still be a viable practice if it leads to increased yields of subsequent crops. The residual effects of double digging, with and without subsoil incorporation of P and K, are being investigated using winter wheat at Sutton Bonington. Current Work rates of the Wye Double Digger are slow but the machine is still in an experimental form.
5. More attention needs to be given to

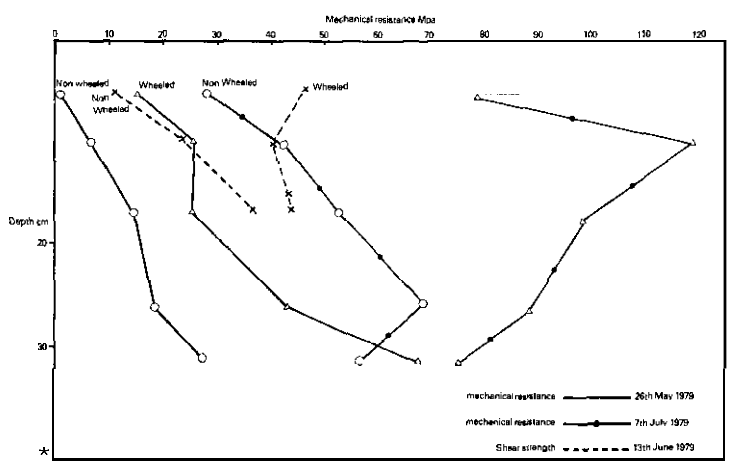

Fig. 2. *Changes in mechanical resistance and shear strength with depth under wheeled and non-wheeled sites.*

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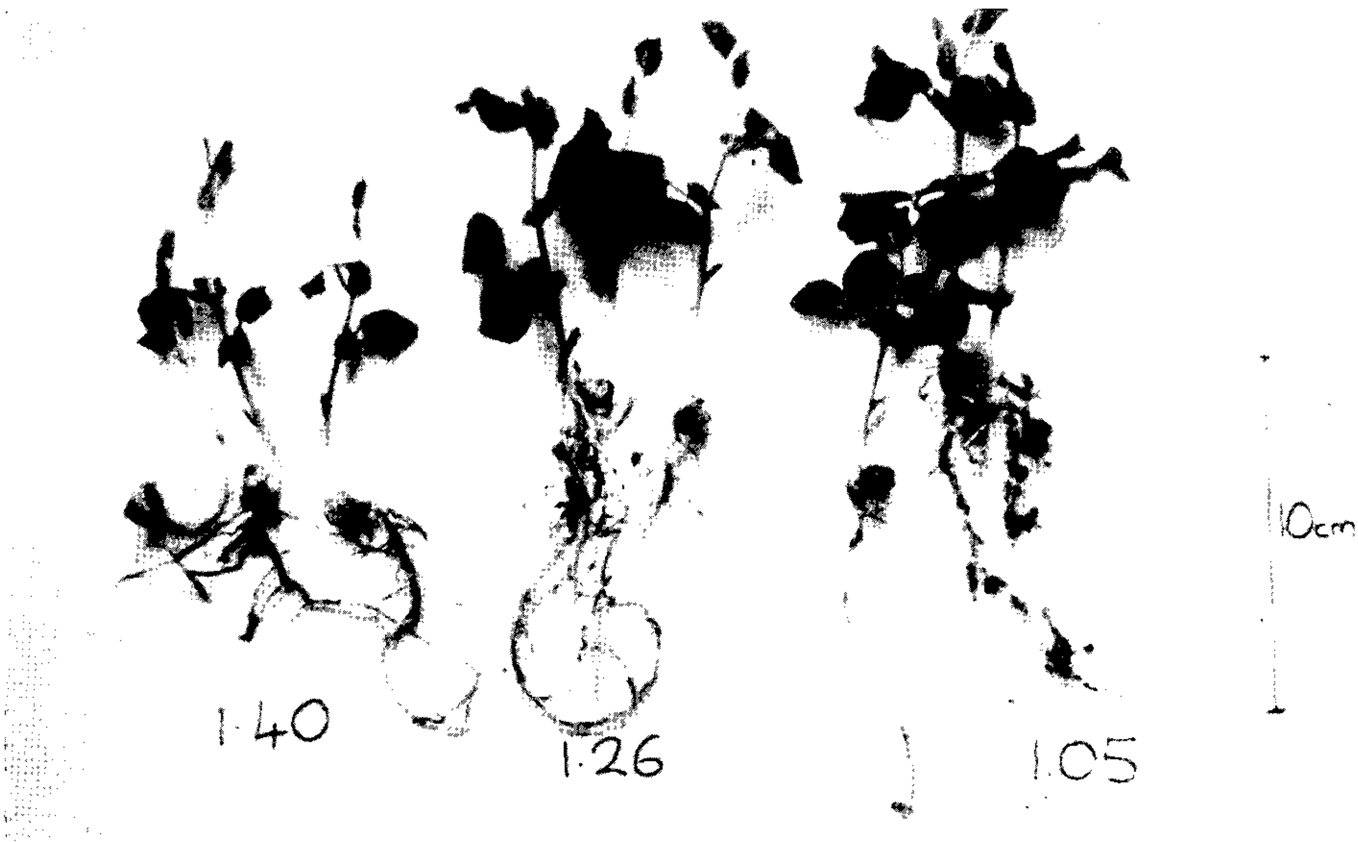

Fig. 3. The effect of *bulk density on pea growth.*

what is happening 'below ground'. Research is needed into the dynamics and development of roots and of the effects of soil compaction, soil loosening and deep fertilization.

6. More research is needed into the mechanisms by which soil compaction affects roots and shoots. The role of ethylene in modifying root and shoot development of peas is under investigation. A compound, 'D.I.H.B.', has been found to increase the length of pea roots'''' and barley roots[14] under mechanical stress. It is possible that D.I.H.B. could be used to alleviate the adverse effects of poor aeration[15] and inhibiting amounts of light and ethylene[16].

Acknowledgements

The authors gratefully acknowledge J. Travers, D. Hodson and B. Hull for their technical assistance, the P.C.R.O. for advice and co-operation and to Dr. P. T. Gooderham and I. B. Warboys for the loan of the Double Digger.

Thanks are also due to C. S. Taylor and J. C. Brereton for their help in collection of data.

Instruments used for the measurement of soil parameters were kindly loaned by the Department of Soil Science (M.A.F.F.), Shardlow.

This work was funded by the M.A.F.F. and P.C.R.O. and this is gratefully acknowledged.

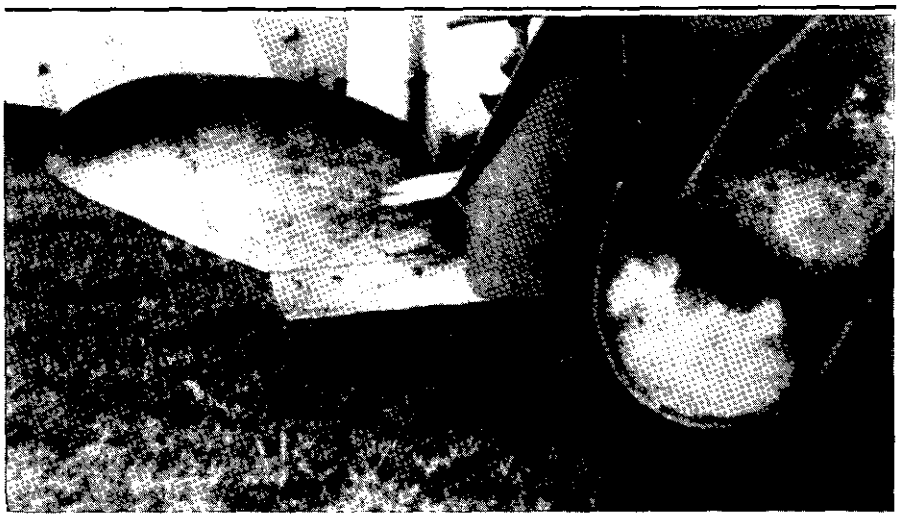

Fig. 4. The *Wye* Double Digger

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MEETING MARKET DEMANDS

Henry Oakland

1979 marked the 50th anniversary of the takeover of the brickyard at Escrick, Yorkshire by Henry Oakland & Sons Ltd. During World War II emphasis was put on clay drain tile manufacturing and under the guidance of the Oakland Brothers, growth of the company in the land drainage industry was steady until the mid-sixties when extensive modifications were made to the Escrick plant. A continuous kiln replaced the out-of-date batch kiln and automated handling reduced labour requirements.

In May 1970, Oakland was acquired by the Hepworth Group — a world leader in clay pipe manufacture (mainly for sewer pipe) and its technological knowledge of manufacturing was largely responsible for increasing output by nearly 50 per cent. Then, when a new plant at Donington near Blackfordby, Leicestershire was established to produce four and six inch tiles, Escrick production of three inch tiles leapt another 30 per cent.

During 1975 and 1976 sales were depressed but during 1977 and 1978 the downward trend was reversed. Present production capacity at Escrick is 400,000 feet per week and Donington produces four and six inch tiles at up to 150,000 3 inch equivalent per week, Glenboig factory in Lanarkshire is currently turning out around a further 400,000 feet weekly.

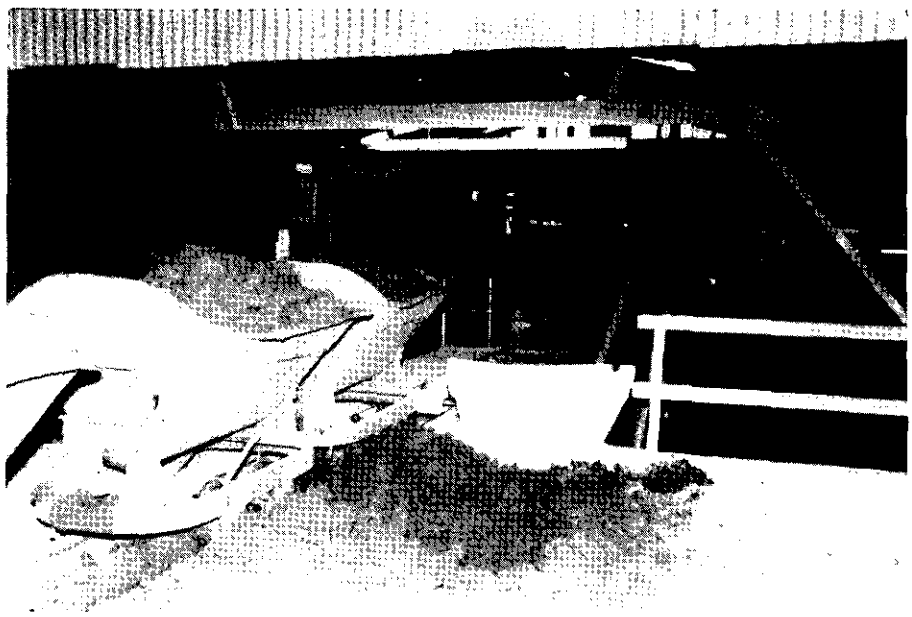
Hepworth Ceramics trades under the Henry Oakland banner in the land drainage business and its 1.6 million feet per week capacity makes it the largest producer of tunnel kiln fired clay drain tiles in Europe (and probably the western hemisphere). But the story does not stop there: seasonal shortages of tiles in the past prompted greater use of plastics materials for drainage and Oakland is taking large and firm steps to maintain its market share which reached a figure of around half the UK market during the past year.

A giant new tile plant at Penistone near Sheffield was planned as Oaklands answer to farmer demand for clay tiles in the future.

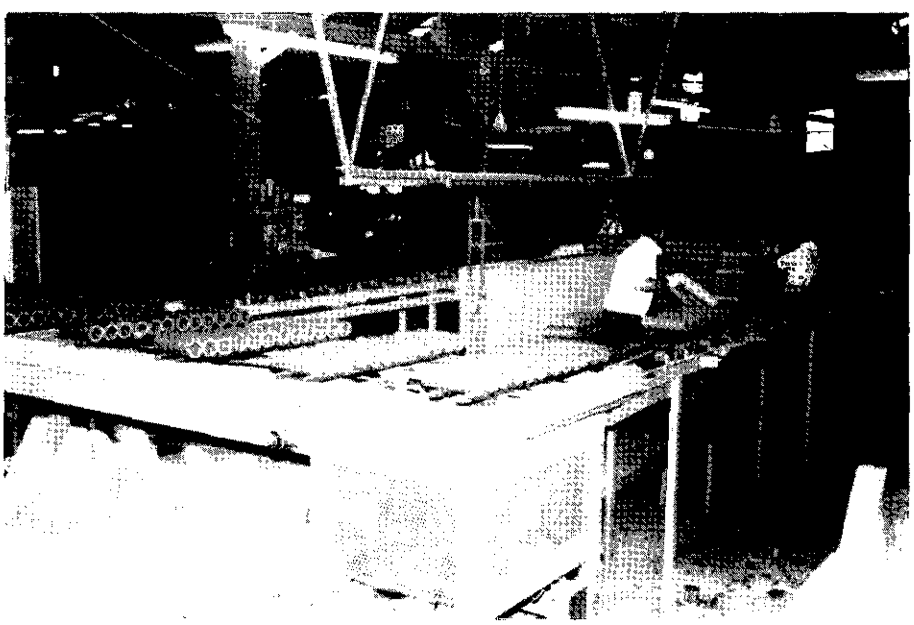
The new factory which reached full capacity during 1980 will be trading, like the rest of the company, directly with both drainage contractors and direct to farmers to provide an extremely competitive service and has a production capacity of 650,000 feet each week.

Specially equipped lorries owned by Oakland or its customers, and yard equipment are geared up to using the Hulo „G packaging system to reduce handling at the yard and in the

A ladder and bucket excavator, loads and digs from the top of the pit reducing wet weather problems at the Yorkshire yard.



Clay isfed directly to rolling mills; little grinding is required.



Man handling d rile is reduced but enough is maintained to provide viral quality control field to help maintain competitiveness for the manufacturer and the contractor.

'Quarry to Lorry **in** 48 Hours'

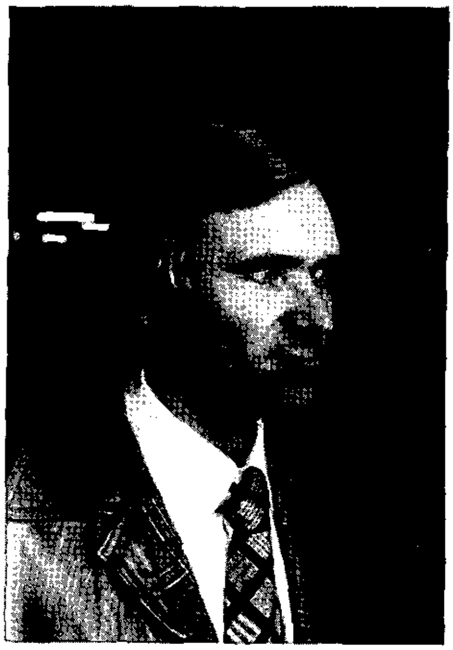
At the Escrick plant efficiency is the order of the day; the tunnel kiln provides excellent consistency in quality. The plant is not labour intensive and can use several fuel sources.

A good source of excellent raw materials is available too; *60* feet of clay deposits underlie the eight feet of sandy top-soil and both are used in the tiles. Excavation of the pit is by a ladder and bucket elevator which resembles a ladder-type trencher; it moves sideways across the cutting face to deposit the clay into small rail trucks.

This excavation method provides good mixing of the two materials and by varying the angle and depth of cut the proportions of sand/clay can be controlled. High quality, plastic clay material eliminates the necessity for grinding before extrusion.

In the plant, three-inch tiles are extruded at a rate of 10,000 per hour in sets of three, side-by-side to reduce handling and to prevent rolling. It is only after firing that the tiles are broken into singles. One eight hour shift can stack enough kiln-cars to maintain full kiln flow production for **24** hours. One man oversees production flow at night and also carries out routine equipment maintenance. The total system uses an average of 30 tons of butane per week and one ton of clay for every **425** three inch pipes. The resulting production lives up to Oakland's motto 'Quarry to Lorry in **48** hours.'

'Oakland is not just a manufacturer, it is a supplier of pipes too,' says Richard Sturdy, the company's sales and marketing director who puts a great deal of emphasis on the company's involvement with the industry at the farmer and contractor level: 'Oakland has been one of the most promotion conscious and progressive marketers in the business — we know the benefits and advantages of our product and we're not afraid to tell our present or potential customers,' says Sturdy. 'We listen to what our market has to say and act accordingly — we are in business by courtesy of British Agriculture, so we must listen and supply its needs.'



Sales and Marketing Director Richard Sturdy sees bright future for clay tiles and Oaklands in Britain.

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Farmers Column

NORTH NORFOLK CEREAL CROPPING

Mike Darhishire, SAWMA's Technical Committee Chairman, starts the ball rolling for a new 'Soil and Water' feature, as we tour his farm, and examine his soils.

As the years go by, one is faced with increased problems, *when* logically one would *expect* that *greater* experience *would* cause them to diminish. The cereals seem to be beset with an ever increasing number of pests and diseases, and one is almost scared to put a vehicle on thefield for fear of compaction and irreparable soil *structural* damage. New materials and new equipment devised to combat our problems only add to the confusion.

The damage caused by deep wheel ruts on *muddy* fields of *sugar* beet were a passing inconvenience, — soon covered by a quick harrowing. The import of the longer term effects on future crop yield were not seriously appreciated.

Last autumn, after the winter cereals had been sown, my nice dry seed beds seemed in good order. So pleased, I took a flight over *the* farm to boost my ego still further and was appalled by what I saw.

Background History

To put the reader in perspective, I farm some 200 acres in North Norfolk, classed as a Grade 3, sandy, light loam. From 1950 to 1978, I had a 90 cow dairy herd, with a crop svstem of 3 – 5 vear leys, sugar beet. barley and kale. Some 200 acres of straw were purchased annually, and the phosphate and potash contents were low.

For the past 2 years I have changed to an all cereal rotation. This was a new 'ball-game', all the eggs were in one basket and it had to work. What had 1 to consider?

Considerations

1. To maintain a good soil structure and a high organic matter content bearing in mind that now there were no livestock or break crops envisaged.
2. To reduce input costs to a minimum compatable with good husbandry and achieve the maximum margins possible.
3. To combat the potential problems faced by continuous grain cropping.

The tasks set provided an interesting challenge and maybe the policy adopted provides food for thought. At this date no proven dcductions or results can be given to support the action taken.

The Aurhor.

Cultivation and Cropping Policy

In 1979, before stubble cultivations began, a pit was excavated, about 15' × 3' × 5', in the centre of a field, at random. The profile exposed proved most interesting. The light loam top soil of about 14" overlaid the sandy sub-soil, but at 14" there was a compacted pan of some 3" thickness. From the top soil through the pan down to about 4' 6" were vertical worm holes through which the wheat roots passed like wires in a conduit. Either side of the roots the soil was of good colour and structure.

I decided to sub-soil at 2m intervals to a depth of 24" using a 70 hp tractor. The equipment used was a heavy old tool bar frame upon which we mounted the sub-soil blade plus 5 'jumbo' tines. Three of these cut to a depth of 8", and two either side of the main blade to 14" depth. The programme was to subsoil 25% of the farm annually. in actuai fact we managed some 90% in two years. The land was subsequently ploughed conventionally.

The reason for my alarm when airborne was the picture of my 'perfect' seed beds in the autumn of 1979, which gave the impression of a plan for a new 'Spaghetti' Junction. There were so many wheelings visible. So I adopted a new approach this year. Previously the policy was to cultivate the stubble after a 'burn', plough, roll to firm, harrow to take out the wheelings, and then drill. Pre-emergence spraying using tramlines was my final operation. Good standard practice one might say.

Now I plough at 6" – 8" with 10" sub-soilers attached to the front furrow body, and pull a double press. The plough is a three furrow reversible with a shallow body. Drilling takes place on the pressed work, preferably across the direction of ploughing. Finally pre-emergence spraying down the tramlines.

This has effectively reduced the number of passes by three operations, and has enabled us to complete all our sowing in October, as opposed to an area of some 75% in 1979.

In spite of the extreme wet weather, we have a firm, uncompacted seedbed without trace of wheelings. The one adverse factor experienced was the tendency to place the seed too deep, however this can be readily corrected. The rapid dissipation of excess rainfall is already apparent.

I now intend to sub-soil at 24", at intervals of 3 – 4 years. An inevitable question will be, why not direct drill? At this transitional stage I elected not to do so. First we have a lot of cleaning up to do after 28 years of dairy farming. The second is that I want to break up the pans as soon as possible. The third point is that I am not convinced that it is the best solution for this land, though I shall retain an open mind on this.

To meet the other tasks set, I use a semi-organic fertiliser and a slow release nitrogen. The first to maintain and improve the organic matter content, and the second to reduce leaching and at the same time make the nitrogen available when the plant needs it. This latter factor was proven this last year. The former appears logical and will take time to prove.

I apply fertilizers on the burnt stubble *before* any cultivations. P & K is applied to the whole farm using the previous crop tramlines as a guide. Fast and shallow ploughing then places it readily available to the young growing plant. This reduces wheelings on cultivated seed beds.

For the record, the nitrogen is a split dressing, the first of some 1 – 1½ cwt per acre is in January, if possible carried out on frozen ground, minimising compaction. the second application is in late March at some 2 – 3 cwt per acre dependent on soil conditions and variety, i.e. wheat or barley.

To combat some of the potential problems of disease in continuous grain cropping, I have adopted a policy involving the technique of 'Blends', developed at Cambridge, which reduces the incidence of fungal diseases. The varieties are high yielding, low grade types. This practice curtails the pathological build up and last year, for example, no spraying for mildew was required.

In spite of the seven week drought of April and May this year, Sonja yielded 115 tonnes on 42 acres, to give an average of 2.73 tonnes per acre ex farm, at 15.5% M/C (6.85 tonnes per hectare).

Summary

I attempt to apply such techniques that I feel will suit my average soil type, to effect constant improvement to both husbandry and margins. My approach may not be highly scientific, but it does show how some of us apply the results of science in practice. Those better qualified may well criticise, if they do I should be pleased to listen, in that way I may learn.

FARMERS

This feature is designed to be your column. Why not contribute to Soil and Water and air your views at the same time, using this or our letters page.

BRITISH DRAINAGE MACHINES UP FRONT

After a long wet winter and further economic gloom it is refreshing to hear of a company where full productivity and expansion is the order of the day.

The more so when this is a British drainage machine manufacturer, whose products have achieved National and International repute within the short period of four and a half years. Since the first 25/20 Mastenbroek machine commenced work in September 1976, the John Mastenbroek Company has not only maintained a full production order book, but has done much to re-instate the lost British supremacy in land drainage technology internationally.

Having gained experience in the field, and as a distributor, John Mastenbroek and his team decided that there existed limitations with respect to the available equipment, and a new approach should be taken to meet the needs, innovations, and improvements demanded by the contractor today.

"One of the major aims", says Mr. Mastenbroek, "was to overcome a basic problem with land drainage machines of dipping and tipping, which is to maintain a consistent and accurate grade under all soil conditions."

The Mastenbroek range now includes 9 models from the 120 – 525 hp unit — (8½ – 60 ton) — offering both trenching and trenchless types, with digging depth to 3.0m and widths from 12–70cm. All models are in service with contractors in UK and overseas. Machines have also been sold in Holland, France, Germany, Canada, USA and the Middle East.

The simplicity of operator control, requiring minimal operator training, and maintenance schedules streamlined to keep downtime to a minimum, reduces the contractor running costs. Most machines are supplied with a combination of laserplane depth control and AID auto grade systems for slope control. The design lends itself to tailoring the machine to individual contractor requirements and soil type conditions.

"Good contractor/manufacturer relationship is vital to the future long term quality of land drainage technique and equipment", states John Mastenbroek. One of the dangers, not readily appreciated, is that with the greater power and potential speed of the latest machines is that if misused, accuracy of grade and tile placement can diminish.

In the past investment was in labour, today, it is in machinery. Few realise the heavy capital investment needed by the efficient contractor, £150,000 – £200,000 for a one machine outfit plus the necessary back up equipment. How does one compensate for this at current rates for land drainage work?

A few years ago some 100 chains per week was adequate, but today we must look to some 2 – 300 chains per week average, and this requires machines with an additional capacity.

Another important factor is that progressive farmers are now becoming more aware of soil structure deterioration and its problems. This indicates a trend to seasonal drainage work under good conditions and contractors and manufacturers need to maintain an even work load and meet this new challenge.

There is a growing need to communicate and to improve the dialogue between manufacturers, research workers, contractors and farmers to improve standards of land drainage and obtain a consistent return from our present investments in drainage technology.

THE TASKERS TILLAGE TRAIN

The thinking behind the Taskers Tillage Train.

Experts agree that the optimum time for drilling winter wheat crops is between the end of September and the end of October. However, the length of time taken by primary and repeated secondary cultivations, drilling and spray and/or fertiliser application has previously either limited the winter wheat acreage that could be drilled with a conventional system or produced a high machinery and personnel requirement.

Accepting the fact that excessive machinery and personnel levels for short working periods is uneconomical and that numerous heavy machinery passes cause soil damage and compaction the farming industry has had to look for alternative methods of cereal drilling.

Tine Cultivator or Disc Harrow

Numerous repeated passes with a tine or disc type cultivator have been popular but require a high energy consumption and machinery requirement. They do not till the top layer of soil across the full width of the machine although repeated passes do help. Depth control is a problem producing an uneven depth of tilled soil which affects drilling depths which in turn affects plant emergence end maturity.

Direct Drilling

Direct drilling has been the answer for many farms, providing one-pass drilling after a good straw burn or light cultivation. However, the system has its problems including the high machinery cost, moisture retention in heavy soils, smeared slots and the effect of acids from rotting straw upon seed germination.

Tillage Train

The alternative which the NIAE and Taskers have developed is the Tillage Train, which combines the tine cultivator and disc harrow into a single machine.

The Tillage Train has been designed and developed to fully cultivate to a carefully controlled depth the top 2in of soil across the full 3 metre machine width in a single high-speed pass.

The resultant tilled soil is ideal for drilling into with a convention?.! combine or grain only drill. A second pass prior to drilling and crossing that of the first can be carried out a few days later to kill off weeds that have germinated as a result of the first pass or they can be simply sprayed off.

Rather than simply attaching tines and discs to a common frame the Tillage Train provides precise overall depth control, individual tine and disc depth adjustment, facility for the disc to absorb impact and follow the ground contours and for the whole machine to withstand the stress of high speed working.

The Tillage Train has a 3 metre working width and is capable of working at a rate of 3 hectares per hour providing a daily potential output of 25 to 30 hectares per day. It requires a four-wheel drive tractor with a power output of 100 hp for working on lighter soils and 140 hp on heavier soils.

The main frame of the Tillage Train is of all-welded, square-section, hollow steel tubing. Its steel fabricated drawbar is pivot mounted onto the main frame but held in position by a triangulated link which is adjustable and also incorporates a rubber damper to provide some 'give'.

Wheels on each side can be raised or lowered hydraulically so that the tines and discs can be lifted out of work for transport or at headlands.

Sub-frames

The Tillage Train has two staggered banks of heavy-duty spring tines and a set of scalloped disc harrows carried on a single sub-frame and mounted ahead of the wheels. A second subframe behind the wheels carry the rear set of discs.

Both sub-frames are rigidly fixed at their front end and rubber mounted at their rear end, the rubber mounting providing 'give' for the discs to absorb impact loads and to help them follow ground contours. The subframe mounting system includes adjustable turnbuckles to provide individual sub-frame depth control.

The individual depth setting for each sub-frame is essential so that the Tillage Train can be set-up to cope with different soil types and soil conditions and to meet different 'finish' requirements. Recommended retail price of the Taskers Tillage Train is expected to be approximately £3,500 plus VAT.

For further information please contact:

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Craven Tasker (Andover) Ltd.
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A ROYAL CUTTER — "THE KINGS DYKE"

Years of experience in practical ditch cleaning and the production of buckets for the job has directed continuous efforts to improve on the conventional cutter bar.

The "Kings Dyke" a new concept of the reciprocating cutting knife for heavy duty work in ditch mainten- r ce ma kes a substantial contribution) more efficient ditch c _ This very smooth operating and practical weed cutting bar can be attached to many makes of bucket of various sizes. The professionally engineered heavy duty bar allows for prolonged life and offers simplicity of in-field maintenance.

The whole reciprocating knife assembly works encased in a greased lubricated chamber and the knife is retained by a full length pressure plate. The knife bar is hydraulically driven, with a built-in relief valve and the direction can be reversed.

A major feature is the paired heavy duty blades. These 100mm 'pairs' offer double the cutting area compared to the conventional 75mm blades. Further, the reciprocating travel is reduced by 25mm with the benefit of reduction in wear.

By the removal of two large cap screws on any of the 300mm heavy duty base plates, the paired knife blades can be replaced without the removal of the complete knife bar.

Without any protruding bolt heads, the "clean" top surface of the cutting bar and the very efficient cutting bar assembly minimises the downtime due to the usual clogged knife.

This latest Mec-Mac Ltd., "Kings Dyke" cutting bucket (3.0m length) is priced at £2,200 ex-works, and conversions for other makes can easily be arranged complete with hydraulic motor, starting from £1,400.

For further information contact:
John Thory,
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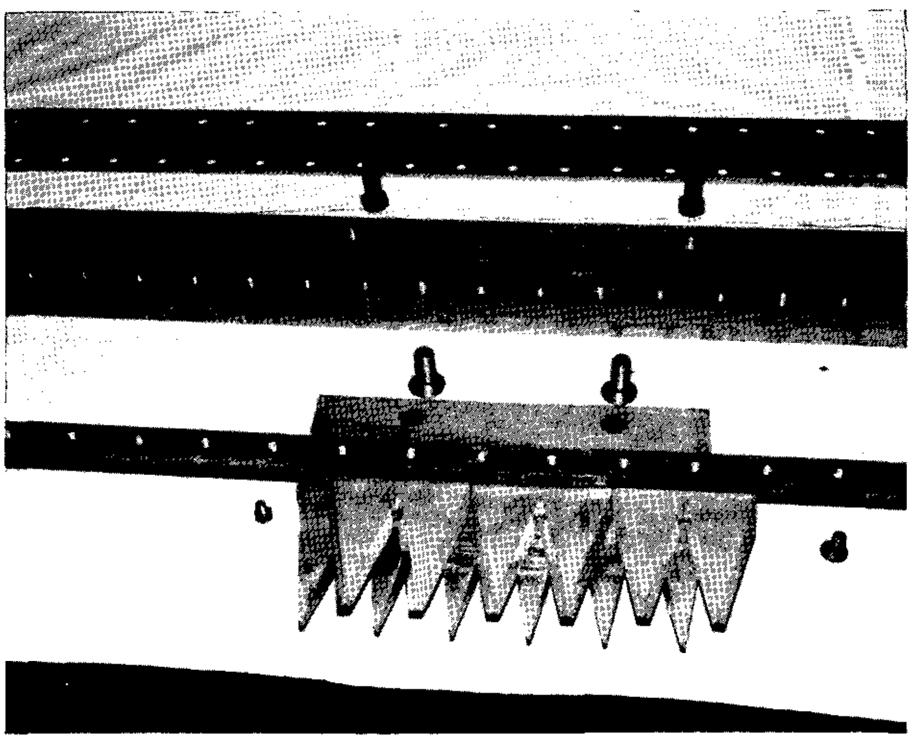

Mec Macs 300mm baseplate and paired blades

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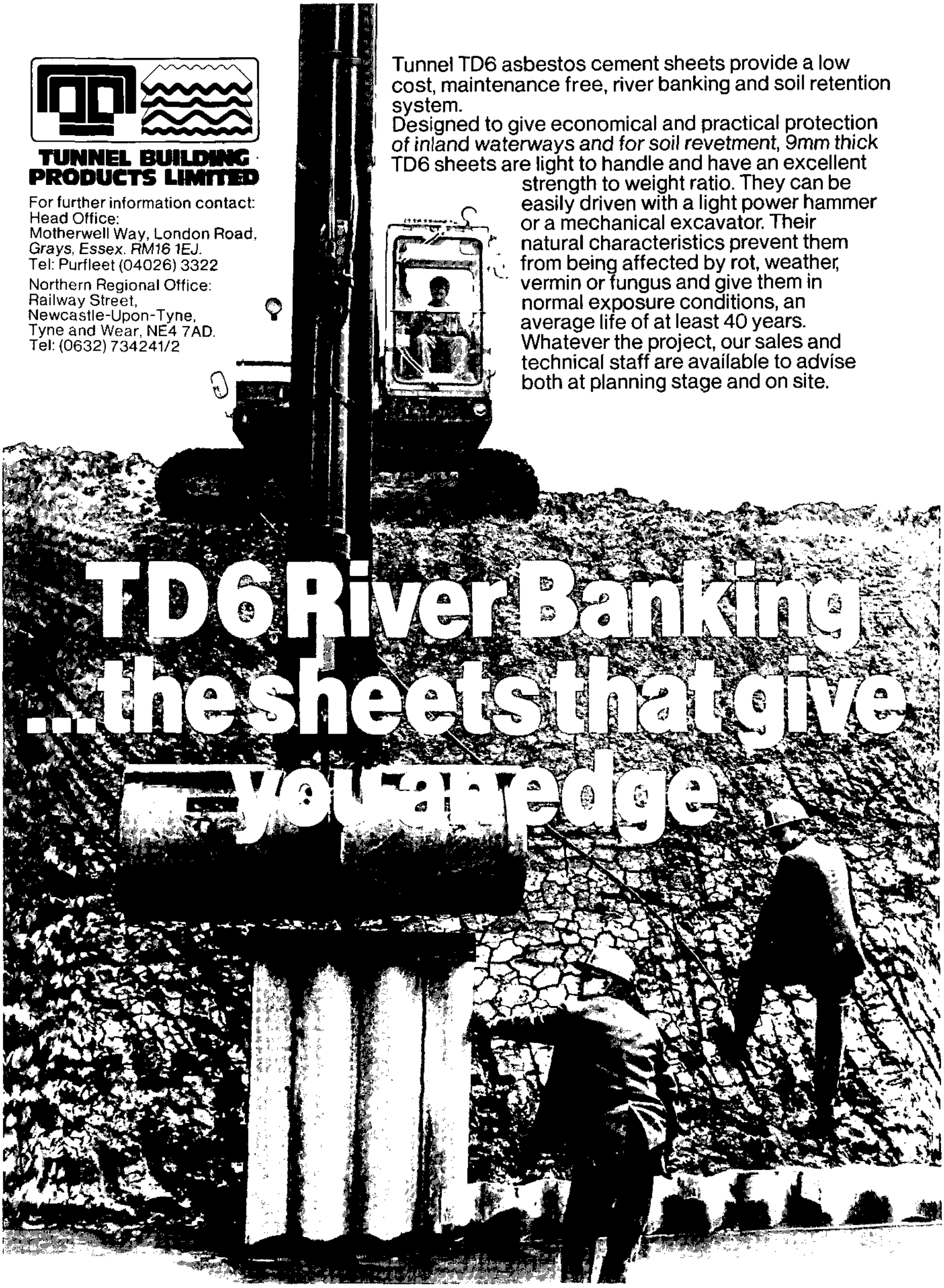


NEW MATERIAL CAN HELP DRAINAGE SYSTEMS MAINTENANCE—

D. Clark, H. H. Robertson (UK) Limited.

The Author examines the installation of a glass reinforced cement headwall on one of the Trumpington Farms in Cambridgeshire.

The Trumpington Farm Company — which is responsible for about 6,000 acres on five separate units in Cambridgeshire — is currently carrying out a continuous programme of remedial land drainage work which is proving the advantages of products manufactured from glass reinforced cement — a material first introduced to the farming world some four years ago.

In varied soil conditions ranging from gravel to clay and peat, the company produces high yields of wheat, sugar beet, potatoes, a variety of vegetables, and even turf. They are well aware of the need for the effective control of soil water as a basic essential for profitable crops.

Since first seeing H. H. Robertson (UK) Limited glass reinforced cement headwalls exhibited at the Farmers Weekly International Drainage event early in 1980, the company have now installed over two hundred and fiftv units as part of its drainage maintenance programme — an ongoing programme involving the installation of new pipework and the replacement of damaged drains and headwalls.

The advanced technology which developed glass reinforced cement as a lightweight, yet strong and rigid material, has been used by the building and constructional industries for some years. It is only in the last four years, however, that it has been used to manufacture products which help the farmer with some of the problems involved in not only installing, but also maintaining an efficient land drainage system.

Most people know that failure to maintain drainage systems can only lead to further problems and yet many farmers still expect ditches, underdrainage systems, outfalls, junctions, inspection chambers and the like to function perfectly without any attention. Ditches choked with weeds and rubbish will prevent underdrainage systems from discharging freely. Blocked outfalls will prevent the drains discharging to that point from operating and will lead to silting up of the pipes, rapid failure of mole drains and high water table levels in the field. Complete failure of the system will follow rapidly, but even before this happens the land will remain wet for longer than normal and crop yields will fall. A waste of cultivation, seeds, fertilisers and effort.

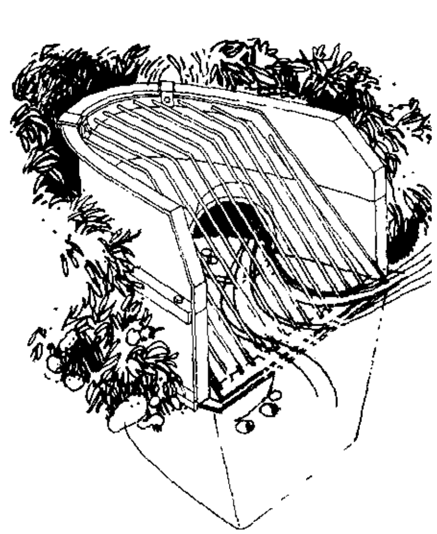
Well designed and easily installed land drainage products can, however, make the task of maintenance easier to undertake.

Traditionally such items as inspection chambers, junction boxes, and headwall units to ensure well secured outfall pipes, were constructed by hand using either brick or local stone. In recent years, however, high labour and material costs have seen both farmers and drainage contractors turn initially to heavy two-piece precast concrete units and, more recently, to low cost lightweight glass reinforced cement units.

The acceptance of glass reinforced cement land drainage products by not only the farmer and the contractor, but also by the Ministry of Agriculture for Grant Aid schemes, gives some indication of the benefits of the new material.

With expenditure in grants toward land drainage schemes by the Ministry currently averaging a total of £24 million per annum, and with major land drainage contracts costing up to £100,000, the non-inclusion of an easily installed headwall unit costing as little as £9.00 on which the efficiency of a total pipe system could depend, is surely a prime case of 'spoiling the ship for a hap'orth of tar'.

The Robertson glass reinforced cement headwall units used in the Trumpington estate maintenance programme are a neatly designed one-piece unit which includes a built-in splash plate. They are available in two sizes to take up to either a 6 inch diameter or 15 inch diameter pipe and they will [illegible] from [illegible] height, at any angle, with neat holes easily punched through with a bricklayers hammer. A facility which obviously overcomes the need to stock a variation of different headwalls to suit various pipe dimensions.



The Robertson sectional pipe drain inlet with its sloping face galvanised grating.

Easily installed and designed to fit any ditch angle, the units are light to carry — the smaller version weighs only 20lb (9 kilos) and the larger only 53lb (24 kilos). The patented design also ensures that the outfall pipe is recessed for protection and this enables unhindered ditch maintenance or grass cutting operations to be carried out. Under test the units have been proved against the possibility of soil erosion and in addition the benefits of lightweight construction ensure that they will not slip under their own weight.

Commenting on their use in Cambridgeshire, Mr. S. Poyser of The Trumpington Farms Company said "Although we had previously used two-piece precast concrete headwalls, we were experiencing some problems during flail mowing, when pitch fibre pipe ends were being damaged. After seeing the Robertson units at the Drainage Event, we purchased an initial hundred and found them easy to install. They were a good permanent fixture and they could easily be relocated even when the banks were overgrown. It also surprised our drainage contractor when I managed to deliver eighteen to him on site in the back of my Ford Fiesta."

In addition to headwalls, Robertsons also manufacture glass reinforced cement variable height inspection chambers; simple yet strong junction boxes; and a unique lightweight sectional pipe drain inlet. This has a vandal-resistant galvanised grating with a sloping face to prevent blockages in the water flow — a problem often found in conventional vertical grids.

Research Notes

ROTHAMSTED SUBJECT DAY 1980

A Review by T. Woodhead and J. A. Catt, Rothamsted Experimental Station

Soil: Basic Research and its Applications. That was the theme of Rothamsted's 1980 Subject Day, attended by some 450 invited visitors — farmers, advisers, researchers and teachers, including several SAWMA members. Forty-six researchers from Rothamsted presented thirty-nine displays of current research. These displays, grouped thematically, dealt with six subject areas: soil structure, soil mineralogy, soil organic matter, nutrients, transport processes in soil, and soil distribution and variability. There were, additionally, introductory lectures to set the scene for the displays, and a Subject Day Booklet* that reviewed the present state of knowledge and the history of Rothamsted's contribution in each of the six subject areas. Visitors also had the opportunity to see new instruments and techniques, and to tour Rothamsted's classical and other experiments.

The structure *of* soil, that is the relative positions of the solid soil particles and the consequent shapes of the voids or pores, has until recently been described only in qualitative terms. It has thus been difficult to investigate effects on crop growth of changes of structure such as are caused by cultivations or machinery wheelings. The Subject Day displays gave descriptions of new techniques that are being developed to give numerical values for structure — as of the shapes and complexities and relative abundances of pores of different sizes, and of the strengths of bonds between particles. These techniques are being used to investigate why soils which appear broadly similar can be very different as regards ease of management, and to measure the rate at which soils regain a favourable structure after compaction. For organic matter, results from Rothamsted experiments indicate that soils which had been direct drilled for 5 to 11 years showed no net increase in organic matter (contrary to claims made elsewhere), but did show that organic matter became concentrated in a shallow surface layer. In soil mineralogy, it is known that some clay minerals shrink and swell on drying and wetting. For these clays, the particles are extremely small and very reactive, and can affect soil structure and its stability. Displays were included that described techniques that have been and are being developed for the study of such clay particles.

Transport through the soil of water, nutrients, gases and heat must proceed effectively if good crops are to be obtained. For some time it has been possible to describe mathematically the transport of these entities through a soil assumed to be uniform and regular, and to thus make meaningful contributions to help deal with practical problems in land drainage, irrigation and leaching. But real soils are not regular, and they may also shrink and swell, and research was described that aims to extend the theories of water movement to allow for these real-world complications — extensions that can be particularly helpful for drainage design. Mathematical methods featured again in reports of studies of nitrafe leaching and pesticide movement in soil. Visitors were also able to see a field experiment study to determine coefficients for the transport through soil of water, gases and heat, and the effect on these coefficients of different cultivations. Ultimately such research should help us recommend management techniques to give optimum physical conditions for plant growth in particular soil and weather situations.

Soil Survey maps and the knowledge they express concerning soil variability enables results from research investigations on a particular site to be applied to other areas with similar soils. Presentations of the Survey's work dealt with soil classification — particularly in relation to units shown on published maps, with soil mapping techniques — including air photo interpretation and computer analysis of lateral variability, and with agricultural applications of soil maps, such as land capability assessment.

Members attending the recent SAWMA soil compaction conference, were in fact able to see this display for a second time.

From the various displays our visitors were able to appreciate a dual purpose in all Rothamsted's research, namely to produce results of immediate practical value to agriculture, and to provide scientific information that will bring long term improvements and the ability to adapt quickly to future needs. To these same ends, we confirm that SAWMA members, as individuals or groups, will at any time be welcome at Rothamsted to discuss with members of staff current topics of research that pertain to soil and water management.

**Booklet copies available, cost £1.00, from Rothamsted Experimental Station, Harpenden, Herts, AL5 2JQ.*

MACAULAY INSTITUTE JUBILEE

Miss E. M. Watson, Information Officer, Macaulay Institute for Soil Research, Aberdeen.

What is soil? Where does it come from? How can we make the best use of our land? These were some of the topics included in the exhibition for the Macaulay Institute Jubilee Open Days in June 1980.

The Macaulay Institute for Soil Research was established at Craigiebuckler in 1930 and in 1980 celebrated its Golden Jubilee. It was initially funded through the generosity of Mr. T. B. Macaulay, a Canadian of Scottish descent, but now it is run by the Department of Agriculture and Fisheries for Scotland with the scientific advice of the Agricultural Research Council.

The Institute celebrated its Golden Jubilee by opening its doors to members of the public, farmers and other scientists on two Open Days to allow people to see for themselves the wide range of topics studied at the Macaulay. The theme running through the exhibitions and displays was 'Soil — our most important natural resource'. — Soil forms the raw material on which our agriculture is based, without it there would be no food for man or animals.

Almost 4,000 people visited the marquee exhibition and laboratories and saw why it is so important to understand the nature and development of the soil and how we can best use and conserve it to increase crop and animal production. By providing this knowledge, the Macaulay Institute aims to ensure that the land is kept in good heart and that, wherever possible, its fertility is improved.

Soils are exceedingly complex materials formed in the first instance by the weathering of rock and subsequently the biological modification, by decaying plant and animal remains. Part of the institute's work is to study these processes and identify the chemical nature of the substances formed, how they affect soil structure and plant growth and how micro-organisms help to bring about these chemical changes.

Some soils are inherently more fertile than others. Healthy plant and animal growth depends on the presence of adequate amounts of biologically essential elements and analyses of these are carried out by the Institute for the North of Scotland College of Agriculture which in turn advises the farmers. Some nutrients are required in only minute quantities but the balance is important and in many areas of Scotland the soils are either deficient in or contain excesses of these 'trace

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elements'. The Institute is well equipped to measure both major and minor elements.

In order to keep the most fertile land in farming and horticulture and sacrifice only the poorer land to building and other purposes, it is necessary to know where our best soils are. The Soil Survey of Scotland map the soils and so far have covered 90% of the arable land. Deep peat, a highly organic soil, while of little use for arable agriculture can be drained or improved for grazing or forestry or can be extracted, dried and processed for horticultural use.

As well as covering the topics outlined above, the Open Days gave an opportunity to see some of the Institute's sophisticated equipment — tunable dye laser, scanning electron microscope, stereoplotter and digitiser amongst others — in use. A soil acidity testing desk proved very popular and there was also a historical exhibition showing developments in soil science and agriculture over the past 50 years and the growth of the Macaulay Institute.

The Jubilee celebrations in June were formally opened by Lord Mansfield, Minister of State at the Scottish Office with responsibility for Agriculture, who unveiled an enamel and copper panel depicting the Four Seasons, commissioned from a local artist Joe Currie. Lord Mansfield emphasised the need to interpret scientific results in a way which got the message across to farmers simply and effectively. 'The quicker farmers realise the benefits of your findings, the sooner the rewards of your research will be harvested by all', he said.

Hopefully the Macaulay's next half century will lead to a further steady advance in understanding the secrets of our greatest natural resource — the soil.

Lord Mansfield (right), Minister of Stole at the Scottish Office, toured the exhibition accompanied by Dr. T. S. West, Director, Macaulay Institute (left) and Professor T. C. Phemister, Chairman of the Institute Council of Management.

Part of the historical exhibition at the Macaulay Institute Jubilee Open Days.

Advisors Diary

HE COMES TO ADVISE — Doug Castle, from the Field Drainage Experimental Unit, Training Section, NCAE, Silsoe, outlines the work and training of a D.W.S.O.

A telephone call to the local Ministry of Agriculture office requesting advice on field drainage or the submission of an application for grant aid, often leads to a visit by the district Drainage & Water Supply Officer. You might have watched him look round the field; peering under hedges; going down and poking into ditches and culverts; muttering enthusiastically about a broken, silted up old horseshoe or pencil drain; pondering (if thats the word) over areas of crop loss, wet areas, patches of water loving weeds; pacing this way and that assessing the many slopes of the field; augering, finger texturing and probably digging a profile pit to decide the likelihood of moling and/or sub-soiling.

Development of a Training Programme

In the late 1950s when the Ministry gradually withdrew from contracting, many people experienced in the practical side of drainage installation took on a role of advising on drainage design coupled with the processing of grant aid applications for technical soundness, and at a later stage, checking that the scheme was installed in accordance with the minimum acceptable standards of workmanship and materials. With the changing emphasis of the Ministry's involvement in drainage, came a need to train people with varying backgrounds in the design methods. The Ministry's Regional Engineer for East Midlands Region, Mr. R. H. (Bob) Miers, based at Lincoln set about solving the problem by organising ad hoc courses, lasting a few weeks at a time, to provide in-service officers with relevant training. During the early 1960s these courses became more specialised in aspects of field drainage, irrigation and water supplies to farms.

Inevitably, older members of staff began to retire, and it became neccessary for staff to be recruited. The problem being that whilst many young people had been to agricultural colleges or been associated with farming practice, they had no knowledge of drainage design and the several associated subjects. Academic training which fitted the Ministry's requirements was not available in the UK and so there was no alternative but to set up a training centre and teach new entrants the theorv and practice of the job.

In 1965 the first 6 month new entrant training course started at Lincoln with 3 experienced staff acting as full time tutors, and receiving help from others drafted in for specialist roles. The course syllabus covered virtually everything related to arterial and field drainage, irrigation and water supplies for livestock and domestic purposes. Hydraulics and hydrology, geology and soils, surveying, mathematics and mechanics, electricity, materials, law and other subjects fitted in to a programme of lectures, laboratory and desk exercises and at least 1 day per week out on the farm putting theory into practice with field exercises.

The training centre at Lincoln evolved with the continued need to train new entrants, whilst providing regular short courses to up-date in-service staff, advisers from the Scottish Colleges and staff from the Department of Agriculture for Scotland.

The training programme for DWSO's extended beyond the Lincoln training course to a further 18 months' in a Division working under the supervision of experienced colleagues, gradually gaining practical experience until after 2 years' training the new DWSO was able to demonstrate an ability to assume the responsibilities of his own district.

A frequent 'criticism' of the training was that the new DWSO did not receive a formal qualification at the end of the 2 year period. However, in 1974 the City & Guilds of London Institute gave acceptance to, examinations held in conjunction with Rycotewood College, Thame, and so enabling officers with relevant underlying qualifications and practical experience to be accepted as members of the Institution of Agricultural Engineers (MIAgrE) and to register with the Engineers Registration Board as Technician Engineers (TEng(CEI)).

In 1978 the Lincoln training centre moved to the National College of Agricultural Engineering at Silsoe, Bedfordshire and linked with the College for a postgraduate diploma in agricultural engineering, compiled to meet the needs of MAFF and any student wishing to relate his studies to UK conditions.

Examination of soil characteristics is important for drainage design

(Photograph — J. E. Gregory).

Present Day Training

The new-entrant DWSO is required to have a minimum HND (Agriculture) or similar qualification and is selected through open competition by the Civil Service Commission. Training commences in September with the diploma studies lasting 9 months, before trainees join a Division to complete their 2 year training period.

The postgraduate diploma combines lectures with laboratory work, assignments and practical field work so that the DWSO is able to design field drainage, irrigation and farm water supply schemes from first principles. With relevant practical training and experience an application for MIAgrE and TEng(CEI) follows. Research and Development is an important aspect of the DWSO's work, many local officers being involved with sites established as part of the national R & D programme co-ordinated by the Field Drainage Experimental Unit at Trumpington, Cambridge. The DWSO's training provides a sound technical background for R & D work.

The young DWSO calling on you is very much a specialist — those odd looking capers in the field, mask a well trained officer collecting information on which to base decisions which will help you to gain the maximum benefit from your investment.

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WORLD'S LARGEST CONTRACTOR IS MORE THAN 130 YEARS OLD!

Most North American drainage cont'act ıg businesses use one o vo drainage machines and employ between fc a d ten ›l‹ and most oiten tl w ıe · oı a rı ǝr will be operating › f tl pieces of equipment. At th ıı eı ‹ this scale, in France, Fournier Drainage SA s a line-up of 31 drainage machines and employs 221 people! Tl oı ›:ati which i based ir Île de France, ǝ r area surrounding Paris, is probab) the largest drainage contractor in the world a l ıc of the business, Christian Fournier i: still very n :t i t with the world of drainage from l ǝad office. The company was f ıded in 1849 by › ı Chandora aı since th has been headed up by Constant Lemaur, Jacques Fournier, Robert Fournier aı d Roger Fournier. With a list of awards r l credits as lc ʒ as your arm the c y presents a very professional image.

A 76 page corporate brochure written in French and English tells the story of the company and also lists the locations of the six branch offices which serve the drainage market in France. They are at Alsace-Lorraine (North-east France), Nord-Picardie (between Calais and Paris) Bourgogne (South-east of Paris), Auvergne-Centre (Central), Aquitaine (South-west France) and Midi-Pyrenées (around Toulouse in South-western France). This geographical set-up allows the company to deal with local problems by local experience and also to provide fast after-sales service.

Fournier Drainage's fundamental concern in its work is quality, because this, the company says, is what really determines the efficiency and life of a sub-surface drainage system. To achieve this qualiiy the company is dependent on trustworthy employees, first rate equipment and materials of top grade.

The line of machines includes 18 chain trenchers and 13 ploughs and the back-up equipment that services it comprises trucks, low-loaders, vans, tractors, hydraulic excavators and automobiles. Each machine is painted with striking orange and green colours to distinguish the company.

Variable angle (shallow angle) chain trenchers are used for high production of open trenches in good digging but steep chain machines are used in rocks. A wheel machine is used to lay large diameter concrete main drains where large quantities are required but on shorter mains of large diameter an hydraulic excavator is used.

Ploughs, mostly of the self-propelled type, are used but their use is restricted in rocky soils and in other

The sign on the wall shows the clean-cut, professional image set by Fournier Drainage.

soils until soil analysis shows that a good job can be done by the trenchless method. Ploughs are not generally used if an old drainage system has to continue being used.

Communications between the different jobs and offices is eased by the use of radios, telephones and telex. Most jobs are within a 170 km (105 mile) radius of one of the branch offices. A complete engineering division provides support services to the crews in the field including maintenance and repair of machinery. It also investigates and diagnoses drainage problems and designs drainage schemes. Each job is mapped out and quoted carefully to provide accurate records of work for the customer and the government.

In total, the company expects to install drainge in 12,000 hectares (approx. 30,000 acres) of agricultural land each year, average price per hectare is 5,500 French Francs/ha (approx. £580/ha). That amounts to approximately 15% of the total French drainage market. Fournier Drainage also expects its annual area drained each year to increase by 15%.

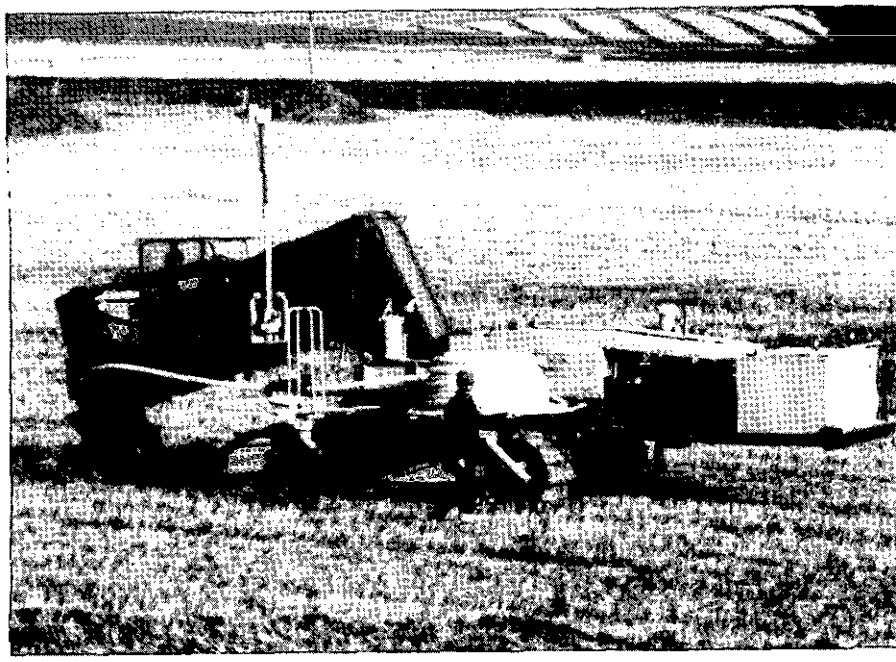
One area of expected growth will be in th Export Department, a n created divisioı headed up t a young engineer, Dan Andries. Its services will be available all over the world for specialized tooling accessories and drainage materials, the sale of earth-moving and drainage equipment and especially for setting up staff requirements on large drainage or agricultural earthworks contracts. Such people as foremen,

Many of Fournier's machines are Barth chain diggers, this early model still puts in a good day's work.

charee-hands, operators and labourers can be hired and trained as and where necessary on a contract basis. The division can, if required, act as the general contractor, supervising the methods of work during the contract.

Within France, an area of increasing importance in drainage is Britanny, a market in North-west France that Fournier is working in more and more. Other types of drainage are also undertaken, notably drainage from glass houses, roads, highways, sports grounds, air fields, race courses and recreational lands.

Fournier Drainage is no stranger to plastic tubing or large jobs: over a period of eight months in 1971 and 1972 the company installed tubing (laterals and mains) in 675 acres belonging to one farmer, Monsieur Quervet at the Domaine de Saint-Gervais, near Sagonne. And, way back in the early 1930s farmer Henri Thirouin of Boiteaux, near Ablis had Fournier drain over 700 acres. ~ h a t job was laid in manually dug trenches and, of course, clay tiles were used!



More up-to-date is the self-propelled plough built by Drainomat.

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CONTINUOUS CORN IN THE COTSWOLD

A **Report** on the SAWMA visit to Manor **Farm,** Eastleach, Gloucestershire **by** Dr. H. P. **Allen**

Thirty members of SAWMA spent a most instructive and enjoyable day on this Cotswold farm which has been run for many years as a farming partnership, by Mr. Rex Jenkinson and his brother-in-law Mr. John Honour.

Introduction

The farm extends to about 1900 acres, half on Cotswold brash with a fair clay content, and half on heavier Evesham-series boulder clay. In some fields there are 'rock-plates' a few Inches below the surface which gives rise to very poor crop growth. Little can be done about these. When Manor Farm was purchased by the late Mr. F. J. Honour in 1920, in Rex Jenkinson's words it fed little else but rabbits. After Mr. Honour's death in the 1950s there was virtually no liquid cash available, all the money being tied up in the farm itself, and the farming partners had to think hard about the best way to farm the land with the twin objectives of improving productivity and producing a satisfactory cash flow. Cereals, especially winter cereals, seemed the obvious crop enterprise and they eventually settled for a system involving the bulk of the land (1,400 acres) in winter corn with about 450 acres left in permanent grass with the idea that this pasture would be used to maintain a flock of sheep and to feed and fatten bought-in steers.

During the early '60s they realised that the problem was to drill this acreage of winter corn and to harvest it satisfactorily. Harvesting 1,400 acres of cereals, planning, cultivating and preparing the land for drilling this large acreage of corn proved a formidable task. It was at this time (1965) that I.C.I. Plant Protection Division contacted Rex Jenkinson and asked him if they might carry out a direct drilling trial with winter wheat upon Manor Farm. Convinced that it would be a total failure, Rex nevertheless agreed to the trial and his convictions were proved correct; the result of the trial was a large patch of couch-grass and no corn! A repeat trial the following year also proved unsuccessful; in retrospect this was not surprising because at this stage in the development of direct drilling there were considerable areas of ig-no ance concerning th: requirements and use of the technique, particularly the need to drill early in the
and to ensure a surface mini-tilth of good physical condition. Knowledge of direct drilling on heavy land was in particular very rudimentary at that time.

In spite of this unpromising start, Rex Jenkinson realised the potential attractiveness of direct drilling as a means of enabling him to get in his 'target' acreage of winter barley and wheat. By the end of the '60s a combination of factors, including the advent of improved drills, especially the International Harvester 6 – 2 drill, enabled Rex to settle on a system of continuous winter cereals involving winter barley on the lighter land (Cotswold brash) and winter wheat on the heavier (Evesham-series clay) land, using direct drilling. The introduction of direct drilling was gradual; some fields have been direct drilled every year since 1969/70 and all fields have been direct drilled for at least five to six years.

Rex grew 880 acres of winter barley in 1979/80. He favours winter barley because it is easy to manage and yields well, it is ready to harvest early and therefore spreads the workload, giving more time for drilling. Furthermore winter barley grows, on the poorer soils and is less sensitive to drought than either winter wheat or spring barley, and winter barley is a good aggressive 'smother-crop'. In 1979/80 465 acres of winter wheat were direct drilled.

The Method, Step **by** Step

Mr. Jenkinson's recipe may be summed up as follows:

1. *Know all about each field,* especially about possible constraints, e.g. plough pans, drainage shortcomings.
2. ***Clean the headlands.***
3. *Carryout a detailed chemical and physical soil analysis.*
4. *Aim to have the land ready for drilling by the end of the second week in September.* Drill the winter barley in the last two weeks of September and the winter wheat in the first half of October and finish all cereal drilling by the middle of that month. Mr. Jenkinson estimates that for every week's delay in drilling after the end of October he pays a penalty of 1 cwt per acre. He has also found out that with early drilling, 1¼ cwt of seed per acre is sufficient, whereas for really late growing he has had to sow nearly 3 cwt per acre!!
5. ***Bale what straw is required,*** leaving a swathe of straw in a circle right round the headland, (allowing for adequate firebreak), and leave a few swathes ***across*** the fi[illegible] to facilitate burning. Two acti[illegible] men set fire to the surplus straw and a [illegible] Rover [illegible] water-bowser [illegible] on ha[illegible] emergencies. [illegible] can burn 300 acres o[illegible] a day [illegible] hasises the value of a good [illegible] burn for killing [illegible]d[illegible].
6. ***After a [illegible]od b[illegible]n, [illegible] sh[illegible] scratch-tilth (1 inch).*** [illegible] uses a 24 ft Scandinavian C tine machine. This encourages germin[illegible] of weed seed and brings them into the 'Gramoxone net' (Rex's expression). He then sprays with Gramaxone at 1½ pints per acre to kill the emerged weeds.
7. ***Direct drilling — with his International and Bettinson drills.*** He plants the seed 1 inch deep, no more. His experience with deeper planting is that frost heave can result in the below-ground stem breaking and the seedling having to rely on a few surface roots for its future welfare.
8. *Crop Protection Inputs.* Mr. Jenkinson aims to remove as many weeds as possible in the autumn, using appropriate selective broad-leaved and grass weedkillers, because in a thick crop it is often difficult for weedkillers to reach their targets in the spring. He takes appropriate and timely measures to combat diseases, such as eyespot, Rhynchosporium, mildew, Septoria, and rust if it occurs. All his cereals receive a straw shortener in early/mid April.
9. ***Fertilizers.*** Mr. Jenkinson believes in adequate nitrogen. He incorporates some N within the seedbed for winter wheats and splits his top dressing, by applying 50% in late March and 50% in late April. His winter barleys do not receive seedbed N; they have a small quantity of N in November and the spring top-dressings are split on the basis of 70% in March and 30% in April. With aid of straw shorteners the wheat will stand 130–150 units of N per acre and the barley 120 plus units per acre. For his very small acreage of spring corn heap-plies 70% of the N in the seedbed and the rest as a top dressing in May. Rex believes that a good burn with the ash scratched into the surface soil provides him with most of his potash requirement.

The System in Action

As examples of his farming, Mr. Jenkinson took us to two contrasting fields, 'Edgepits', on Cotswold brash (with 35% clay fraction) and 'Rough Ground' (Evesham-series boulder clay).

'EDGEPITS' has grown winter barley by direct drilling for 10 years. There is at most 4–5 inches of soil

Direct *drilled* winter *wheat.*

Manor Farm, Eastleach

above limestone rock, but he is growing around 7.25 tonnes of barley per hectare here each year.

Weed control has been excellent, though sterile brome has been, something of a problem this year.

'ROUGH GROUND', on Evesham series clay was considered by the War Agricultural Executive Committee during World War II to be so poor, that it was not subjected to a ploughing order! Mr. Jenkinson last ploughed it in 1969 but it has been direct drilled with winter wheat ever since then. A soil profile pit showed a very well structured profile for more than two feet. Mr. Jenkinson said he had seen wheat roots down to 6 ft. Yields for the years 1977–79 were 3 tons plus per acre for 1977 (Huntsman), 3 tons per acre 1978 (Huntsman) and 3.5 tons per acre in 1979 (Aquila). Clearly this field has benefited enormously under a regime of minimal soil disturbance — old root channels, worm channels, earthworm action and the absence of any disturbance with ploughs and cultivators, have permitted a build-up of an excellent system of vertical communication from topsoil right into the heavy clay subsoil, and apart from a very restricted drainage scheme in the centre of the field which totalled £200 before grant, the field is neither tile-drained nor mole-drained, nor has it been sub-soiled.

The year by year performance of 'Rough Ground' has convinced Rex Jenkinson that continuous winter wheat direct drilled with his method (including a scratch tilth) is right for the heavier land on his farm. He now ploughs only when he has manure to bury. If 'couch' rears its head, he will deal with this by using 'Round-up' on a 'patch-spraying' basis but as long as yields of winter cereals remain at their very respectable levels he believes that, for his continuous winter corn, direct drilling is the right approach.

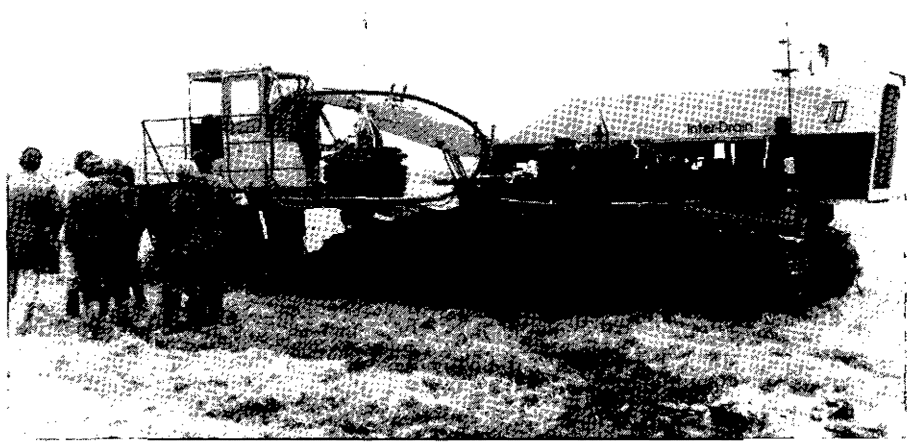
Of course, one cannot apply one man's farming system unaltered to another man's land, but there is no doubt that our SAWMA visitors took away with them much food for thought. We are most grateful to Rex for the opportunity to visit Manor Farm and for the time he devoted to us.

NORTH YORKSHIRE DRAINAGE DEMONSTRATION

P. M. Clough, Consultant with Estate and Farm Surveys Ltd., Fossgate, York.

The first drainage demonstration for some years in the North Yorks area was held at New Farm Estate a few miles outside York on the 28th January, 1981. It was organised by Estate and Farm Surveys (York) Ltd., who as consultants both designed and supervised the scheme which was installed by P. A. Jackson of Whitby.

The primary aim of the event was to introduce farmers to the latest techniques in drainage design and installation as this is an area where considerable technological advances have been made over the past decade resulting in a comparative fall in the cost of land drainage. The attendance figure for the day of over 120 showed that a lot of interest in drainage still exists at the farming level and the event did generate some fairly enthusiastic discussions; the majority of which centred around those by now familiar bones of contention of plastic pipe versus land tiles, the optimum drain spacing and the need for permeable backfill.



Trenchless drainage machine in working position.

The scheme itself was designed for plastic pipe to be installed with gravel backfill over most of the area using trenchless methods of installation, and it showed how the detailed soil survey carried out prior to planning the scheme had resulted in a considerable reduction in the cost of the scheme. A superficial survey of the 125 acre site would have lead to a recommendation for a 16M spacing of laterals with gravel backfill. However, the 'detailed soil survey showed that the soils varied considerably from well structured loams to massive impermeable clays so although the 16M spacing was necessary over most of the area in places it could be widened to 20M and in others the gravel omitted. This gave a reduction in price of approximately £3,000 on the final cost of the scheme which was £32,000 before grant.

The underdrainage was installed by a 320 horsepower 'Inter-Drain' trenchless drainage machine using an automatic laser levelling system capable of adjusting the pipe gradient up to six times a second. The efficiency and power of this machine greatly impressed everyone present and despite the wet conditions its wide caterpillar tracks created little ground disturbance — something which could not be said of the large four wheel drive gravel carts. Disturbance of this nature is unfortunately one of the inevitable consequences of winter drainage and many farmers indicated they were now considering spring and summer drainage through a standing crop if necessary. This is probably a reflection of the impact the recent publicity given to soil compaction problems has had on the farming community and in general there was a much greater awareness of the fact that short term crop loss can be more than compensated for by the long term benefits of preserving soil structure.

All in all the majority of those attending the demonstration seemed to think that at current rates of around £300 per acre drainage represented a good long term investment. However, it was felt that the recent reduction in Ministry grants, allied with the current low returns from agriculture and high interest rates, is discouraging farmers from undertaking land drainage just at present.

SOIL COMPACTION — 'CAUSES AND CURES'

Self inflicted wounds, the scars of which will be evident throughout this season and probably the next, was the message that came through loud and clear at the conference held at the National College of Agricultural Engineering, Silsoe on February 4th 1981.

No farmer, landowner, farm Manager, or land agent can afford to be complacent whatever the soil type, heavy, medium or light. The delegates, some 290, representing all categories of SAWMA membership, — farmers, landowners, manufacturers, contractors, research scientists, and the consultant services — were all unanimous in their attentiveness and enthusiasm for the papers presented.

The myth that compaction basically results from heavy traffic on wet land, and that it is essentially a new phenomenon with our modern heavy equipment was in part exploded. History indicates, as one speaker pointed out, that concern was expressed in the 19th century due to the smearing by horses hooves, and later with the advent of steam ploughs, which were kept to the headlands to reduce the effect of compaction.

If farmers are to maximise on the very high cost crop inputs of seed, fertiliser, and sprays, Gordon Spoor, of the NCAE, recommends re-equipping with a simple spade. Farmers should then regularly examine fields for signs of compaction, and then undertake appropriate remedial action.

Farmers and Manufacturers should now liase closely to seek equipment and techniques which will reduce significantly the attendant causes of compaction.

The average cultivations programme on a farm comprise some five to six passes from ploughing to drilling and tractor wheelings can effectively compact 90% of the area covered.

The increasing trend to direct drilling, contrary to some opinion can accentuate compaction problems. Ploughing with sub-soilers is a cure for the compacted wheel ruts of the heavy combine or grain trailers. On the other hand, ploughing in adverse conditions causes smear and will accentuate the problem. Compacted soils reduce root development and will cause uneven growth and ripening, and in turn diminish the effective potential of fertilisers and seed.

Timeliness of operations, coupled with a re-assessment of routine cultivation patterns is necessary. Possible solutions are:

1. Reduction of trafficking,
2. Reduction in equipment weight,
3. Increase in speed of equipment over the ground
4. Reduction in tyre pressures.

If one or any of these can be effected then we are some way to reducing our problems.

At the conference was a display presented by the Soil Survey together with literature and books which were available to those attending. This aroused much interest in the brief intervals between papers. Further, on display for the first time was the SAWMA Soil Textural Assessment display backed up with some soil survey monoliths. This enabled delegates to see various soil structures to depths of 0.5m and to examine different textural classes of soil. This will be again on display in the form of a competition at the Royal Show this July.

Various low pressure vehicles, mole drainers, and sub-soilers were available for inspection by courtesy of the manufacturers. Finally, great credit must be given to our hosts at the NCAE for the accommodation and excellent food provided for so many people. It was an outstanding conference.

Copies of the papers will soon be available from the SAWMA office at £5 for members — £6 non-members.

N.C.A.E./S.A.W.M.A
SHORT COURSE IN FIELD DRAINAGE: PRINCIPLES AND PRACTICES.

December 1980

P. D. Breakell, Garstang, Preston.

The course, for me, proved to be one of the highlights of the year. I have always wanted to know 'why'; and here were people ready and willing to explain, and where possible to demonstrate why. From the outset we were kept hard at work, and moved about with a well drilled precision.

The general subject matter was nicely graduated to progress from soil texture to water movement in the soil, and on to the design of culverts including a laboratory demonstration. I found the demonstrations to be of considerable interest and value. Soil water movement and pipe flow are difficult to explain in the field because there is nothing to be seen. To have my own personal beliefs demonstrated and proved correct was a moment of supreme satisfaction. In addition to this rather intensive programme there was an opportunity to examine the very interesting collection assembled in the drainage laboratory.

By the third day we had progressed to the various aspects of drainage design, and covered this in some depth throughout the day. Specific items mentioned in the time table were:— Layout, depth, spacing, and pipe size for underdrainage systems. These together with the design of piped ditches, and the loading of buried rigid pipelines, enabled us to undertake another evening project concerned with our own designs for a

John Gregory (A.D.A.S.) and Doug Castle (A.D.A.S.) demonstrate flow through a culvert model.

piped ditch and culvert system.

One criticism I have of the course, is that mole draining and subsoiling, pumped drainage, final plans, and drainage maintenance, were only allotted a morning within a very tight programme, and considerable valuable work has been carried out at the college. However there has got to be some areas of scant coverage within a course of this length.

1 found the Tutors without exception to be well versed in their subjects, and to have the ability to pass on knowledge in an interesting and often humorous way. Questions were welcomed and the answers were full and satisfactory. The College provides a good standard of catering; and the accommodation, whilst somewhat spartan, was nevertheless quite adequate. Another interesting aspect was the opportunity to discuss means and methods with the other students, many of whom were actively engaged in field drainage. It has always seemed odd to me that so many people should be doing the same job in so many different ways, and each to be convinced that their method was the best.

1 came away from the College with a large collection of facts, figures, and formulae, and the memory of a very interesting interlude. I understand that the course is being repeated next year, and I can strongly recommend it.

Photographs by B. Fletcher (N.C.A.E.)

John *Gregory (A.D.A.S.)* describes rhe *characteristics* of a *soil profile to* course *participants.*

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Event Diary 1981

May 13th	Drainage Systems Maintenance, N.A.C. — organised by S.A.W.M.A. Speakers: P. Boon — Mastenbroek Intercontinental, Holland B. Trafford — Acting Chief Engineer — Land Drainage Service E. Watson — Managing Director — Anglian Land Drainage P. Charnley — Thorney IDB Chairman: E. H. Burton — N.W.C. Evening S.A.W.M.A. Dinner
May 28th	Farmers Weekly International Drainage Event, Moreton-in-Marsh.
May 27th – 28th	U.K.F. Grassland Demonstration — N.A.C.
May 28th	S.A.W.M.A. Field Drainage Day — Cockle Park & New Etal Estate, Northumberland.
June 10th	S.A.W.M.A. Visit, Forestry Commission land reclamation site and Alice Holt Research Station.
June 17th – 18th	Cereals '81 — Kineton, Warwickshire, organised by the R.A.S.E. includes S.A.W.M.A.'s — 'Soil Texture Exhibit'.
July 6th – 9th	ROYAL SHOW — N.A.C., S.A.W.M.A.'s Soil Texture Exhibit is in the Arable Centre Marquee. Members are invited to bring along samples for texturing.
September 23rd – 24th	Autumn Cultivations Demonstration — Cressage, Shropshire — organised by the R.A.S.E., Shropshire and West Midlands Agricultural Society. Includes S.A.W.M.A. subsoiling display.
December 14th – 17th	Drainage Short Course — N.C.A.E.
December 14th – 16th	Irrigation Short Course — N.C.A.E.

Further details from the Technical Secretary, S.A.W.M.A., N.A.C., Stoneleigh, Kenilworth, CV8 2LZ.

Those wishing to publicise other events, please copy by July 31st to the above address.