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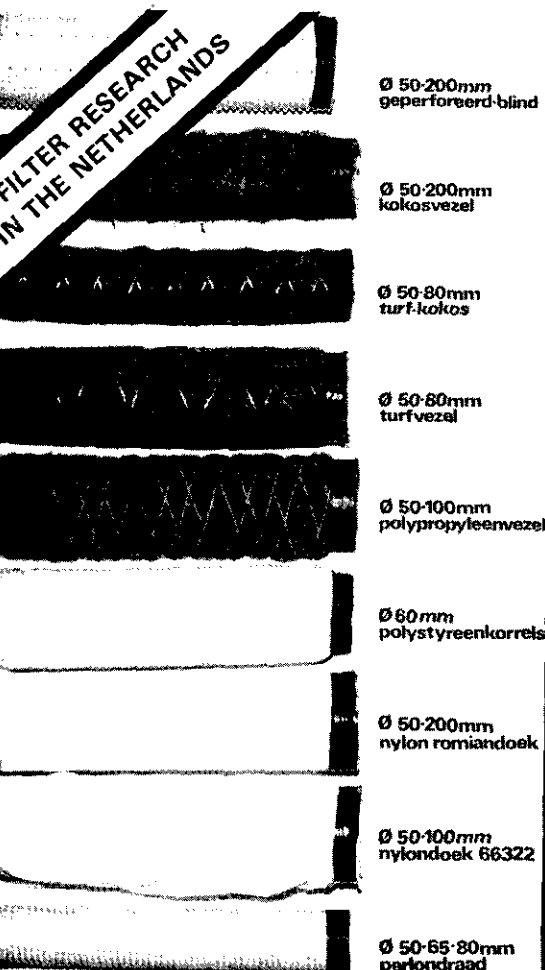

SOIL TEXTURE EXHIBIT

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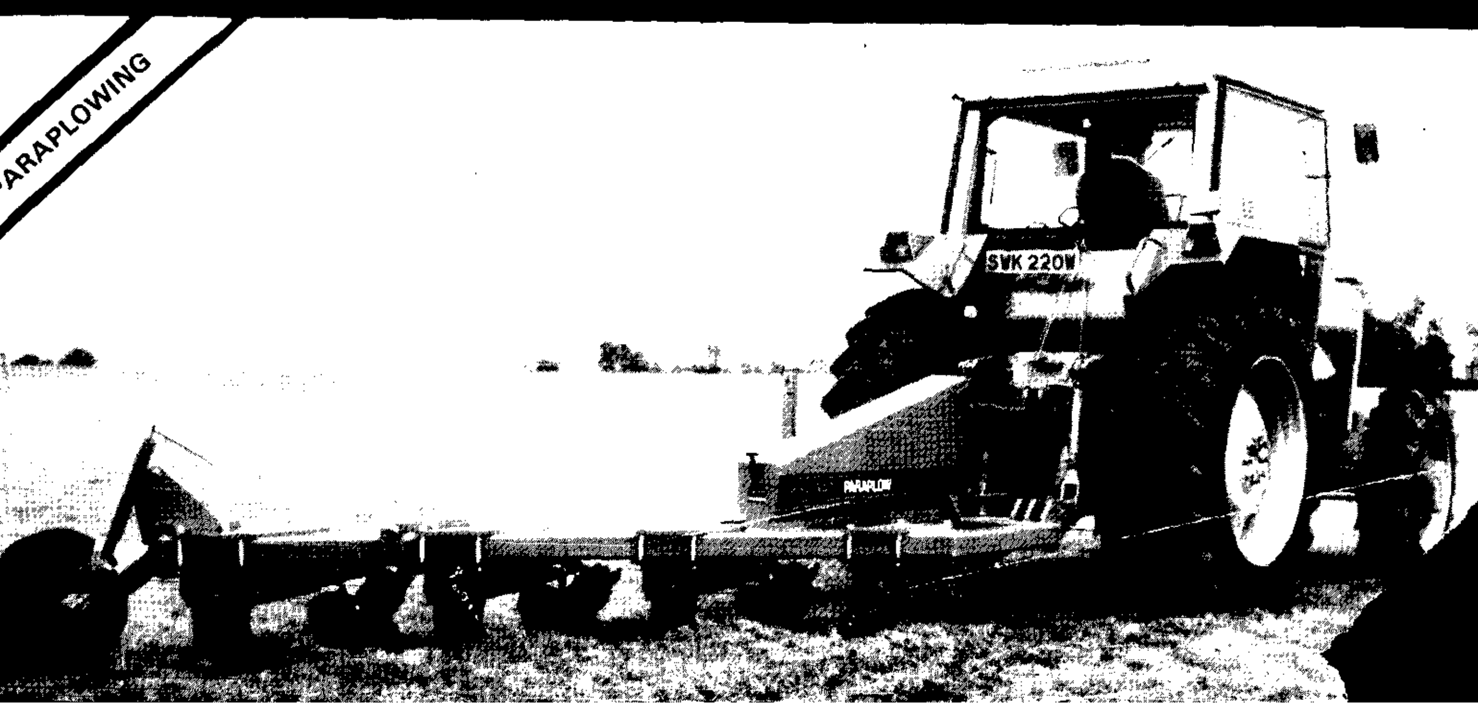

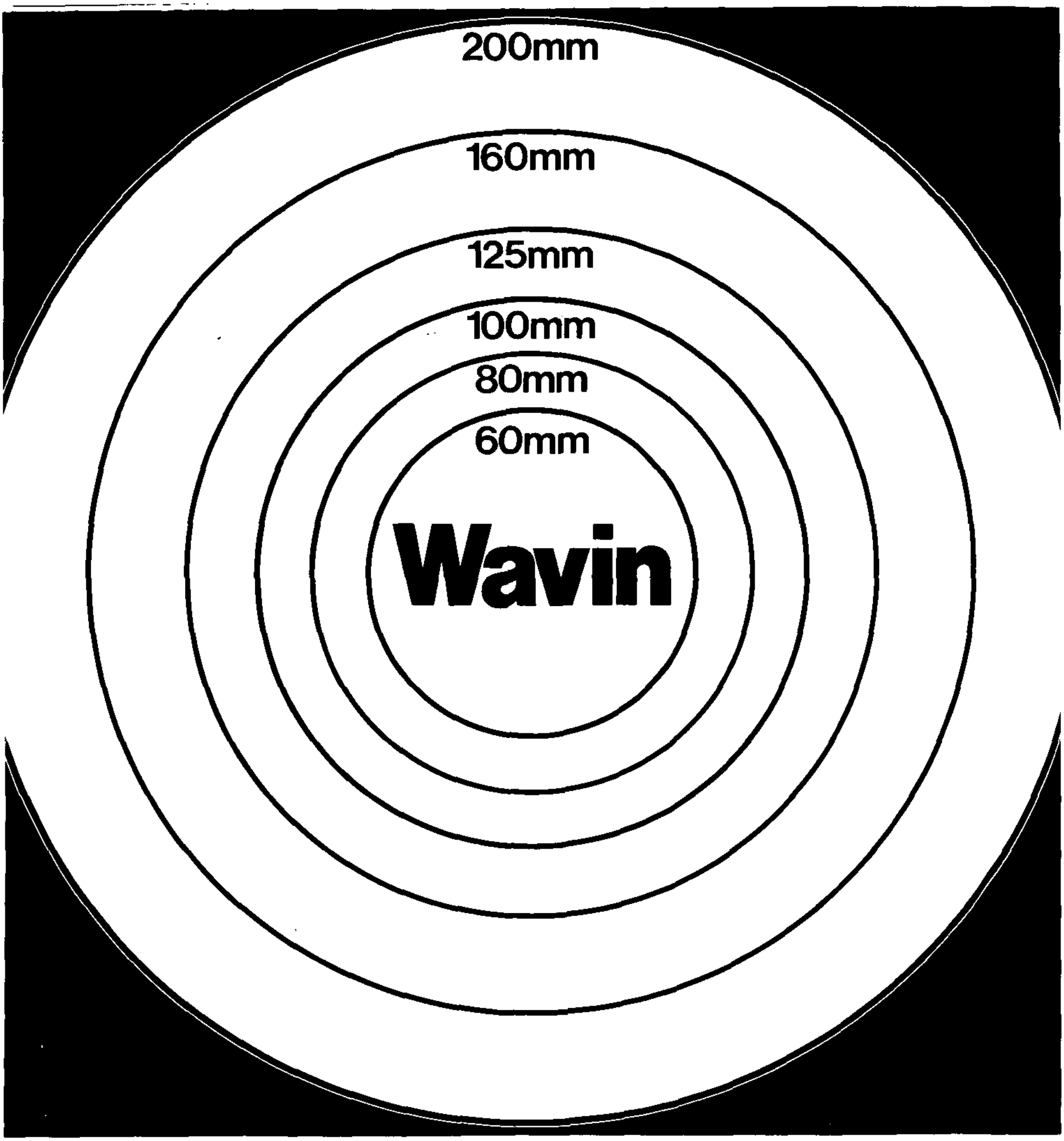

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soil and water

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Contents

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Further copies available upon request.

Cover Photographs
Filter Materials p 31
Visitors to SA *WMA's* stand at the Royal Show — p*3*
The *Howard Paraplow* p 25

1982 sees the start of a more aggressive SAWMA programme. With a full time technical officer, it is now proving possible to put members ideas into practice in the form of new events.

DRAINAGE WORKSHOP

The enthusiasm of Technical Committee Chairman — Mike Darbishire, has led to SAWMA's organisation of a Drainage Workshop — entitled "Our Future With Land Drainage". Many of you may only associate a workshop with tools, nuts and bolts and the dismantling and repair of machinery; and such a down to earth approach is exactly the aim of this workshop. Designed principally for the contractor, manufacturer and consultant, SAWMA's drainage workshop will give delegates a chance to air their views and talk drainage.

Contentions and topical speakers and subjects will guide discussions, and include the conflicts between the use of clay tiles and plastic pipes, trenchless and trencher machines; the problems of financing a contractors business, health and safety, laser plane operation, transportation of machines amongst others.

This national gathering will be at the Novotel, Long Eaton, Nottingham, on the 27th – 28th January 1982. The floor is yours!

LADY WINS SOIL TEXTURE COMPETITION

Response to the SAWMA soil texture competition and exhibit at this years Royal Show was most pleasing. The standard of entries was particularly high, and at the end of the day, the winner of a spade donated by Spear and Jackson, was Dr. C. Moore a bee farmer from Worcestershire. To her we pass our congratulations, however where were our gentlemen farmers!

SOIL EROSION

Is soil and crop loss a significant problem in Britain?

A conference organised by SAWMA and the RASE will provide answers to this question and look at the practical methods that a farmer can use to control or prevent such losses. More details are enclosed.

SOIL MANAGEMENT

In combination with the NCAE and ADAS, the Association is holding a Soil Management Course on the 16th – 19th February 1982, further details will be circulated later this year. Aspects to be covered are Soil Mechanics, Tillage fundamentals and choice of equipment, including field demonstrations of tillage subsoiling and moling equipment and soil/ plant/water relationships.

NEW NUMBER

Please note that as from 1st October 1981 the SAWMA office has a new phone number — Coventry (0203) 555100

This course will be backed-up by local field visits later in the year. The popular Drainage and Irrigation short courses are being held once again this December, more details can be obtained from this office.

MEMBERSHIP

The increase in subscriptions for this year has had a mixed reception, however the number of new members is on the up. It is pleasing that the Soil Survey of England and Wales now have a corporate membership; their active participation can only help strengthen the work of SAWMA.

Circulation and readership of Soil and Water is on the increase and we trust that there is something for everybody in this edition.

Mr. F. W. Perowne who farms at South Creake, Nr. Fakenham, Norfolk sent the Editor a series of 'before and after' photographs which illustrate the problems that can occur due to untimeliness of operation.

Fig. 1. February 1977.

The first (Fig. I) taken back in 1977 shows that no matter how low the ground pressure or how wide the tyres, problems can still occur if the soil is in a plastic state. Figure 2 taken 4 years and 2 months later shows the results of a top dressing operation where the soil has obviously still not fully recovered, and the tractor wheels sunk back into the originally damaged soil.

We are always interested in receiving photographs of this nature and would welcome your letters even if they are only asking for advice or passing comment.

Fig. 2. April 1981.

Fertiliser Consumption Up

Fertiliser consumption in the United Kingdom rose by 6.6 per cent last year compared with the year before, according to a report published by the Fertiliser Manufacturers Association.

The report, covering the fertiliser year 1st June 1979 to 31st May 1980, states that total nutrients in compound form were 4.9 per cent higher than last season, but the average analysis of compounds changed, with the nitroge content declining whilst phosphate l pot increased. This was caused, says the report, by the high demand for winter cereal fertilisers.

The report, entitled ***"Fertiliser Statistics"*** covers all mineral fertilisers consumed in the United Kingdom. It is available, price £2 per copy, direct from the FMA office at: ***Alembic House, 93 Albert Embankment, London SE1 7TU.***

Land Drainage Guide Up-dated

The second edition of *Landline*, a 20 page guide to the do's and dont's of agricultural land drainage, is now available.

Landline is published by the British Clayware Land Drain Industry and written by Yorkshire drainage consultant John Binnington, ARIBA, who has been personally involved with the design of more than 10,000 schemes.

It covers most aspects of drainage in depth in a readable and authoritative style. Charts and diagrams demonstrate different types of layout and the factors which can affect choice of materials.

A step by step guide takes the reader from the initial site survey, through supervision of work in progress, to the procedures for claiming grant.

Copies of Landline ***are available free from the British Clayware Land Drain Industry, at Weston House, West Bar Green, Sheffield, S1 2DA (telephone 0742 730261).***

Farrow Irrigation Win Nigerian Order

Farrow Irrigation of Spalding, Lincolnshire, have been successful in winning a contract worth over £500,000 to supply irrigation 'equipment to the Lower Benuė River Basin Development Authority in Nigeria. The order includes nearly 70 miles of 3" aluminium pipe, all in 30ft. lengths with couplings, 5.000 sprinklers and 80,000 individual fittings and the equipment is to serve the irrigation needs of a 4,500 acre block which will be split up into 450 separator smallholder projects each to be equipped with one hydrant and one eleven sprinkler lateral line.

Dear Sir,

We would like to inform your readers of the change in the structure of our business.

A new company 'Fleming International Machinery Ltd' has been formed to encompass the activities of R. J. Fleming Developments both at home and overseas.

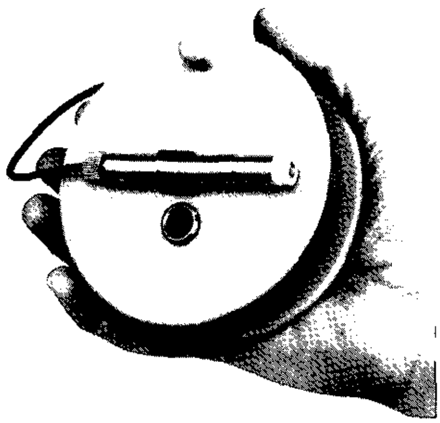
Over 60% of our production is exported to 28 countries throughout the world specifically for irrigation systems and waterways. The range of machinery covers digging, bank mowing, weed cutting and silt removal with outreaches from 5 metres up to 7.5 metres fitted with buckets from 0.3 metres to 2.5 metres wide.

To improve our European Marketing we have set up a company in Holland to cover sales and service to the Netherlands, Belgium and Germany. This will have showrooms and demonstration equipment together with full spares and after sales service.

M. J. Fleming
Fleming International Machinery Ltd. 1 Cosgrove Rd, Old Stratford, Milton Keynes

Pocket Dipmeter (Water Level Indicator)

Soil Instruments have produced a 'Pocket Dipmeter' a miniature version of their standard Water Level Indicator. It incorporates an audio alarm circuit, 10 m graduated cable, probe and long life battery, and is



ideal for those Engineers involved in site investigation, hydrology and water resources who require to measure the depth of water in drill holes or below ground level. The instrument which fits into the pocket or in a briefcase is made of tough almost indestructible ABS.

Telephone Ukfield (0825) 5044.

A.D.A. Demonstration — 7th & 8th July, 1982

The Association of Drainage Authorities is pleased to announce that their fourth 'National Demonstration' will be held at Oldbury Naite near Bristol on 7th & 8th July, 1982. Ten years ago the first event was staged close to Peterborough for the sole purpose of displaying various methods of aquatic weed control. More recently, the format has been slightly changed to encourage participation from Companies whose activities are connected with Land Drainage business in the widest possible sense. Thus the Demonstration has developed into *a* common market place where prospective customers come to meet and exchange ideas with their own manufacturing industry.

The South Gloucestershire I.D.B. will act as hosts for next year's venture and the static exhibition will be located in grounds opposite their Offices at Oldbury Naite. Working demonstrations in respect of weed control will be confined to a compact route along drains within a few miles radius of the main showground site. Local arrangements will be in the hands of Messrs. W. Dixon and T. Hodges, the Board's Chairman and Engineer respectively and firms wishing to set aside plots for aquatic herbicides should contact Mr. Hodges as soon as possible.

Application forms for exhibitors are available. Invitations will be extended to Water Authorities, I.D.B.'s, N.F.U. and M.A.F.F. organisations. Further information can be obtained from:—

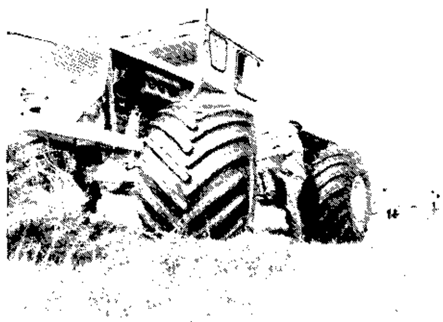
Secretary A.D.A. Technical Committee H. Price, Esq., Chief Engineer, South Holland I.D.B., *"Welland* House': Roman Bank, Spalding, Lincs.

New Distributor for Goodyear Terra-Tires

In an effort to improve the availability of high flotation tyres — Terra-Tires — Goodyear Tyre and Rubber Company has appointed Undergear Equipment (R.B.P.) Limited as its sole U.K. distributor.

The American made Terra-Tires have not, until now, been widely available in the U.K., despite their high reputation with a wide range of customers.

They are suitable for all types of machines primarily involved in non-highway service such as agricultural implements, tractors, powered golf carts, horticultural equipment, skid-steer loaders and recreational vehicles (such as "dune buggies").



The Terra-Tire is a tubeless high flotation tyre, and compared with a conventional tyre, has a wider cross-section, larger air volume, a more flexible carcass, and operates at lower inflation pressures. The large ground contact area effectively distributes load over a relatively broad area, providing a reduction in unit ground pressure resulting in less soil compaction and less ground disturbance. The net result is a "flotation" effect, for go-anywhere performance — whatever the terrain or load.

A spokesman for Goodyear said: "The need for low ground pressure, high flotation tyres for farming has increased in recent years due to a significant swing towards autumn-sown cereals. These relatively new methods have led to the increasing use of minimal cultivation and direct-drilling techniques which although offering savings in time, machinery and power, have done so at the expense of more complicated weed control programmes. As a result there is a rising market potential for high-mobility vehicles to apply chemical sprays and fertilizers during the autumn to spring period".

Effective June 1st, 1981 Undergear will become the sole agent for the sale of Terra-Tires in the U.K., handling both the original equipment and replacement tyre business.

For vehicle manufacturers and also machine conversions they will offer availability of wheels to suit customer requirements.

For more details contact:
Undergear Equipment (R.B.P.) Ltd.
Black Lake Works
West Brom*wich*
West Midlands B70 ***0PD***
Telephone: 021-553-1606

Macaulay Institute Annual Report

Virtually all of the soils of Scotland have now been mapped at 1:250,000 (approx. ¼" to 1 mile). As well as soils information, an assessment of the land's capability for agriculture has been made and maps of land graded from Class 1 – 7 are being produced. This information, to be published shortly, will be of interest to planners and others making decisions on future land use as well as to all who are interested in soils, their intrinsic properties and their management in the best interests of agriculture.

The important part played by some of the organic components of soil in influencing the availability to plants of essential trace elements has been further demonstrated.

Nitrogen-fixing bacteria associated with the roots of wheat and barley-are being investigated in a range of soils from the north east of Scotland.

For further information please contact: Miss E. M. Watson (Information Officer) at Aberdeen (0224) 38611 (day and evening)

The Future of the Tile

When a farmer takes the decision to invest in a land drainage scheme he is faced nowadays with a bewildering choice of methods and materials. There are open trench machines, "trenchless ploughs", backacter diggers, a choice of imported backfill materials or the installation of pipes only without permeable fill and a multitude of permutations of drain spacings and secondary treatments. As if all this were not enough to confuse the best of us there is also the matter of the choice of pipe to be used — clayware tiles with their proven performance characteristics or plastic tubina with its ease of handling by the contractor.

Many farmers exverience some difficulty in making the choice between the two types of pipe and so rely on the advice of their contractor where they really should use their own judgement, after all, the contractor will be on site for only a few days before moving on to the next job but the farmer will have to live with the resulting drainage installation.

Having accepted that the choice is his the farmer must now examine the factors which may influence that decision. Firstly let us consider the 60 mm corrugated plastic tubing — it is light, extremely so, and it is easy to carry, fast to lay and cheap for the contractor to purchase during the present glut of oil-based products. Plastic drainage tube also has a large number of holes which can let the water in very easily and the long continuous lengths mean that even if it is moved out of line it still forms a continuous pipe, just like an alkathene water pipe does, however, drainage water is not under oressure and will not run uphill.

The 3 in. clay tile on the other hand possesses great strength under the type of crushing load which modern agricultural machinery imposes upon the land so naturally it is heavier than the corrugated tube in direct comparison although it is possible when one compares the relative crushing strengths of the two that the 3 in. tile is 'lighter' than the 60 mm tube strength for strength. Clay is a natural material taken from the ground to which it will be returned after processing into pipes. Simple mathematics based upon the calculation of cross sectional area show that the 3 in. clay tile has more than double the water carrying capacity of '60 mm' plastic tube (internal diameter 53 mm) and thus up to double the life where siltation presents a problem as it eventually does in so many cases. Modern self-unloading lorries and mechanical handling methods have removed the need for hand work by farm staff when the tiles are delivered and many leading contractors have virtually eliminated handling on site by the use of specialist equipment.

All in all, from the farmers point of view the case rests overwhelmingly in favour of clayware and the small extra cost at present day prices pales into insignificance when one deducts the grant payment and then depreciates it over the life of a clayware drainage system, additionally it is unlikely that the oil from which plastic is derived is going to do anything but increase in price over the next few years and such price advantage as plastic may possess at the present time will then quickly evaporate — Richard Sturdy Chairman British *Clayware* Land Drain Industry Sales Director Henry *Oakland* and Sons Ltd.

Comments please — Ed.

One of the Oakland fleet **ofcrone-equipped vehicles** *unloading in a farmyard.*

Dunlop Completes Drip Irrigation Contract for Libya

Dunlop Irrigation Services has announced the successful completion of a contract to establish one of the first orchard drip irrigation schemes in Libya. The site of the scheme is a 30 hectare apple orchard at El Marj and sections which have been operational for one growing season are already showing the benefits of this type of irrigation.

Contracted by the prestigious Jabal-El-Akhdar Agriculture Authority to design, supply and assist with the installation of the scheme, Dunlop recommended a layout whereby filtered water, injected with fertiliser, is pumped through a network of underground pipes into overground lateral ones. The water is discharged through drip emitters in measured quantities at the root zone of each tree.

Other DIS projects have been completed in Egypt, Saudi Arabia, the United Arab Emirates and the lvory Coast. Full details of the company's experience and expertise in this field are available from:

Dunlop Irrigation Services, P O Box *1*, Thame Park Road, *Thame,* Oxon.

AIR YOUR VIEWS THROUGH Feedback AND SAWMA

'ROOTS AT WORK'

AGRICULTURAL RESEARCH COUNCIL
LETCOMBE LABORATORY
SILVER JUBILEE
SUBJECT DAYS

ARC Letcombe Laboratory will be demonstrating its research on plant growth in relation to the soil at the Silver Jubilee Subject Days on 18th and 19th May 1982. Responses of crops to waterlogging, effects of simplified cultivation systems on crop growth and soil properties, uptake and loss of fertilizer nitrogen, and the physiology of root growth and function will be among the topics of laboratory and field displays. For further information about these Subject Days write to:

Dr. R. S. *Bruce,*
Agricultural Research Council,
Letcombe *Laboratory,*
Wantage,
Oxfordshire *OX12 9JT.*

TOO WET, TOO DRY: CLAY SOIL PROBLEMS

Dr. **Ian Reid** and Robert Parkinson outline the work of the Department of Geography, Birkbeck College, University of London, which indicates that careful timing is essential to successful clay soil management.

Clay soils are traditionally regarded as problematic and provide cause for management headaches throughout the year. Historically left till last, the clay soils of the English lowlands — the Midlands, the Weald, the London Basin and so on — were cleared of native woodland and put down to arable only after the Saxons had established their new culture and introduced a heavy plough. Even today the unit-cost of achieving good tilth in clay soils outweighs the same costs of those lighter soils of the Chalk downlands and the Jurassic escarpments of Northamptonshire and the Cotswolds. Not only is draw-bar pull greater but even brasional ear of the ploughshear makes this a real cost of planting, d the differential is increasing as autumn sowing in soils still recovering from summer drought, and therefore possessing summer shear strength, takes an increasing amount of acreage.

Yet clay soils offer many advantages. The distribution of pore-sizes means high available water capacity between field capacity at the one end of the water regime and permanent wilting point at the other. Plants with early established and suitable rooting systems can take advantage of an abundant water supply in contrast to the lighter more droughty soils of Bedfordshire, East Anglia and parts of the Vale of York. Clay soils also have high cation and anion exchange capacities (a property that depends to a large extent upon the proportions of different clay minerals in the soil) and this provides a huge reservoir of nutrients that means lower rates of fertilizer application. This may however help offset the other costs of cultivation that arise from high shear strength of clay soil.

So where do the problems of clay soils arise? They largely stem from control of the physical status of the soil by the annual soil water regime and arise because of management decisions at critical times of the annual cycle. Yet there are only a few long term published records of the water regime for British clay soils (see Goss *et al*, 1978, for example), and therefore little quantification of the varied response of clay soils to both rainfall and evaporation in winter and summer. Information becomes even more important considering the peculiar vagaries of climate since the Drought of 1975–76, with low autumn and early winter rainfalls common and wetter summers a seemingly more regular weather feature.

Fig. 1. Cattle poaching and wheel-mark damage in winter permanent posture clay soils.

Soil Water and Winter Management Problems

At Birkbeck, we have been examining various aspects of the water regime of clay soils since 1975. Particular attention has been focused on the behaviour of soils at Enfield Chase where the parent material is largely reworked London Clay, and the soil most closely resembles the Windsor series (a surface water gley). A high clay content (40 – 60%) means a swelling soil whose surface rises and falls annually through *c.* 5 cm (2 ins) and in which substantial shrinkage cracks penetrate to the subsoil — a factor that led to so many building foundation problems in 1976.

Winter management problems stem from high water retention and resulting plasticity of a soil that lacks the structural benefits which derive from high proportions of otherwise largely inert sand and gravel particles. The soil is readily poached by cattle. Out-wintering of as few as 14 dairy cattle during 1980 – 81 destroyed the superb structure of a long-standing permanent pasture within the space of two weeks (Fig. 1). Structural deterioration is so readily achieved by normal arable practices that access is usually restricted to those rare mornings following particularly heavy frost. Figure 2 illustrates the degree of compaction achieved early this year by cattle hooves and tractor wheels in an old pasture soil which had excellent (hut fragile) structure.

This period of restricted access varies from year to year and depends upon the length of time that the soil remains at its winter moisture content. It has been demonstrated that the winter mean value of soil water content reflects, on a dynamic basis, the field capacity of a soil (Reid, 1975). Figure 3 shows the water content of a clay soil under permanent pasture for the period autumn to spring in the 3 years 1977–78, 1978–79 and 1979–80. Immediately striking is the varying endurance of the winter plateau of water content with soil at this time of the year too plastic for cultivation practices or grazing over at least 18 and 16 weeks in 1977 – 78 and 1979 – 80 respectively and an extended 22 weeks in the wet spring and early summer of 1979.

Wetting to winter levels of water

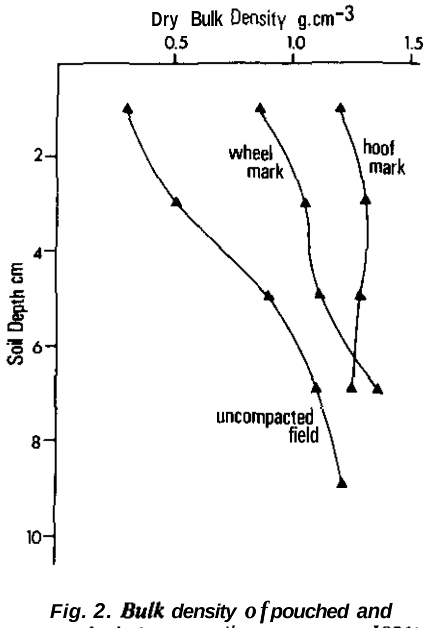


Fig. 2. Bulk density of pouched and unpoached clay topsoil (from Cook, 1981).

content appears reasonably consistent in its timing, though the later rise of the 1978 – 79 curve reflects the marked autumn drought of 1978 (compare the weekly rainfall pattern of Fig. **3).** The fall-off from the values of winter water content depends upon the balance between the evapotranspiration and rainfall. Spring 1980 saw the glorious sunshine of Easter with high potential evapotranspiration, and this is reflected sensitively in the 1979 – 80 curve of soil water (note the April and May 1980 rainfall pattern). In contrast the heavy rains of May and June 1979 dictated a prolongation of soil vulnerability which was marked at Enfield Chase and no doubt elsewhere by machinery temporarily abandoned axle-deep.

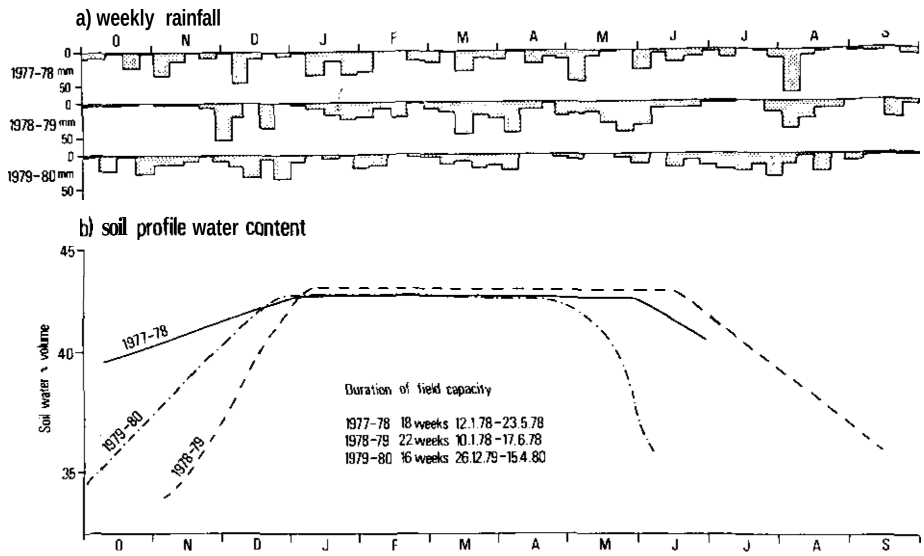


Fig. **3.** *Water content of Enfield Chase clay soils and weekly rainfall for 3 winters.*

Summer Drought and **Plant** Growth

Clay soils have a large reservoir potential because their pore-size distribution favours those meso- and micro-pores whose capillarity retains water against the gravitational force and drainage. However, capillarity draws water, albeit slowly, under conditions of high potential evapotranspiration, from deep in the profile. Clay soils therefore tend to lack a self-mulching quality that is possessed by sandy loams. As a result, they feed the evapotranspiration process more effectively and over a longer period of time. Soil moisture deficits can be large and the drying front very deep. But how large and how deep? And how best to optimise plant growth by choosing crops with adequate rooting depth?

Figure 4 illustrates the progress of the drying front at Enfield Chase for 2 sites: one a grazed permanent pasture and the other an adjacent enclosure in which the exclusion of grazing has provided a full development of pasture grasses and other perennials. Soil water profiles for 1980 are depicted, though it must be borne in mind that 1980 was characterised by an early (April) onset of summer and by comparatively high June – July rainfalls. Three positions of the drying front are illustrated. Figure 4a shows a penetration of the drying front to c. 40 cm over a 10 week period from 6 March to 5 May.

By 16 June the drying front had reached c. 90 cm (Fig. 4b) and the soil moisture deficit had climbed to 95 mm and 98 mm for the grazed and ungrazed sites respectively. The topsoil is approaching wilting-point and crops relying on a shallow root system would inevitably suffer restricted growth. Clearly, deeper rooted crops or leys such as lucerne, vetch and turnip would benefit from their use of a greater soil volume, drawing on the still plentiful water supplies of the subsoil. In fact, barley grown on the Enfield Chase soils during the exacting conditions of the drought 1975 – 76, achieved a stalk length of little over 30 cm (12 ins), reflecting an inability to tap deeper moisture supplies. The water profiles of 6 October (Fig. 4c) illustrate maximum penetration of the drying front at c. 120 cm for both sites. The difference in the intensity of desiccation by grazed and ungrazed sites is interesting. The ungrazed site has produced a soil moisture deficit of 184 mm, or 36% of the March – October potential evapotranspiration. The grazed site with reduced evaporating leaf area, lower aerodynamic roughness and a less well developed root system has exacted a toll of only 150 mm or 29% of potential evapotranspiration.

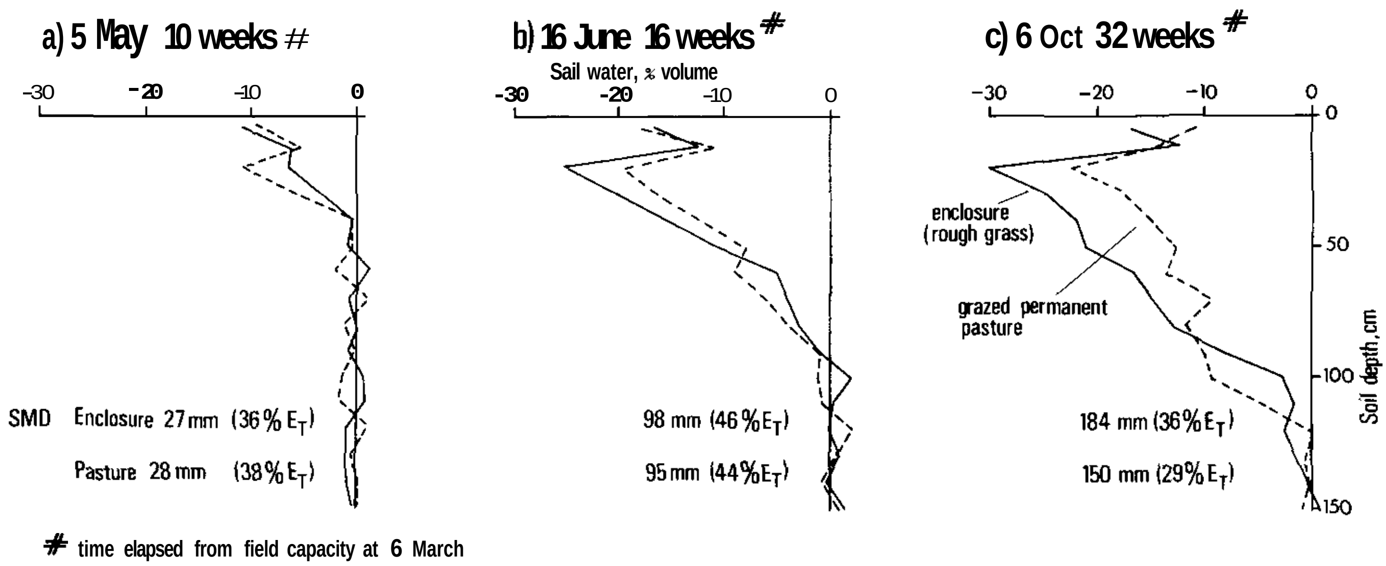


***Fig. 4.* Soil water** *profiles* **ond** *soil water* **deficits** *for ungrazed enclosure and adjacent grazed permanent pasture* **at** *selected* **dates during** *1980.*

V9-2

Fig. 5. Surface soil lamina produced by sheetwash erosion on soils with low infiltration capacity.

Concluding Remarks

Clay soils possess a notoriously delicate structure when fully wetted up. Underdrainage does little to reduce their sensitivity to structural damage at the height of winter since low hydraulic conductivity and high capillarity maintain high water contents and soil plasticity. Additionally, low infiltration capacities can lead to sheetwash that strips upper slopes of soil and seed and deposits a lamina of clay on lower slopes which here reduces infiltration and encourages standing water to the detriment of growing crops (Fig. 5).

In summer, the shrinkage of soil clods and the rapid advance of the drying front produces a desertified rubble that threatens any crop yet to develop a ramified and deep rooting system. It is clear that the improvements in structure which result from an increase in direct-drilling and brought about through a minimal disturbance of mineral-organic bonds and through the elimination of the multiple machinery passes of seed-bed preparation can only benefit management f clay soils. Infiltration is increased and evaporation reduced. But the lessons of easily inflicted structural damage reported here, indicate very clearly that very careful timing is a vital prerequisite in the successful management of clay soils.

Acknowledgements

We wish to record our gratitude to Dr. L. Frostick and Dr. D. Lee for assistance in both field and laboratory, and to Mr. Colin Pains who farms the land on which the experiments were carried out.

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ECONOMICS OF DRAINAGE

by M. A. Molyneux, Agricultural Superintendent, Midland Bank, Leicester.

Late drilling, delayed application of fertiliser and sprays, poaching of grassland, difficult harvesting conditions, loss of crops and poor yields are some of the problems encountered on poorly drained soils. This year's wet spring has again highlighted these problems, particularly on the low lying and more impermeable soils. Manv arable and livestock farmers are again contemplating the installation of drainage systems and wondering if there will be a worthwhile return on the invested capital.

The aim of better field drainaee is to enable water to be removed more rapidly from the soil profile and to provide a depth of well drained friable soil. This should give better surface conditions for grazing, cultivations, germination and harvesting. In addition, soil structure should be improved allowing crop roots to develop more fully, giving higher yields due to better crop responses to nutrients and soil moisture.

Cost of Drainage

The cost of drainage is dependent on the type of soil and the proposed cropping. These factors affect the distance between the drains and the need for backfill (normally gravel) and a subsidiary treatment such as mole ploughing and subsoiling. On heavy clay soils it is often necessary to lay drains 20m apart with gravel backfill and to mole plough across the drains. Drainage schemes such as these cost in the region of £600 per hectare (£243/acre), whereas on the more permeable soils with wider drain spacing and no backfill or mole ploughing/subsoiling, the cost can be reduced by as much as 50% to £: per (£121/acre). Where drainage is part of a land reclamation scheme or where it is necessary to provide a pump system on low lying land, the costs can be considerably higher.

Grant assistance provided by the Ministry of Agriculture towards the cost of field drainage and the rates of grant ruling at the present time are shown in Table 1.

Rates of Grant for:	Lowland %	Hill Areas %
Agricultural and Horticultural Grant Scheme	37.5	70
Agricultural and Horticultural Development Scheme	50	70

Table I

Since a grant will only be paid for schemes which conform to the standards set by the Ministry of Agriculture, it is always worth while discussing the proposed scheme with the Local Drainage Officer who will also be able to offer helpful advice and guidance.

When planning a drainage scheme it is necessary to consider the indirect costs such as the loss of production while the land is being drained. For this reason many seek to have land drained after harvest, however it is not possible to cater for all arable farmers at this the optimum time. Consequently, on many farms drainage takes place on wet land in the late autumn and if weather conditions are poor the short term soil structure can be adversely affected, reducing the yield of the next crop. In this situation, it may well be better to consider drainage through the crop in the spring when soil conditions are often better and the following crop will not be affected. It is calculated that yield losses with draining through the crop are in the region of 15% and this cost is often far less than the price paid for mistimed autumn work. Also, where yields are increased, additional capital may be required to provide extra storage, more livestock and buildings for overwintering.

Is it economic to drain land?

The need for drainage and the likely benefits will vary with rainfall, the system of farming and the condition of the soil. On some farms the drainage is so poor that without an improvement the farming system would have to be altered with low output enterprises replacing high output enterprises such as potatoes and vegetables. Here the yields are often so low that the viability of the business is endangered. However, for the majority this is not the case. On many farms drainage enables the returns from present cropping policies to be increased through the achievement of higher crop yields and by the more intensive stocking of grassland with more meat and milk being produced from the land.

Crop yield responses to drainage have not been fully documented but where for example the crop to be grown is potatoes, the cost of a failure is obviously far higher than it would be for a crop of spring barley. In addition, the timing of a wet year cannot be predicted but the sooner one occurs, the sooner there will be a return on the capital invested in drainage and the more likely it is to prove worthwhile.

Net Capital Cost of Scheme £/Acre	80	I20	160	200	240	280
Capital cost amortised over 10 years Q 15% £/ac	16	24	32	40	48	56
Increase in yields required						
Cereals (@ £110/tonne) cwt/ac	3	4	6	7	9	10
Potatoes (@ £45/tonne) cwt/ac	7	11	14	18	21	25
Sugar Beet (Q £25/tonne) cwt/ac	13	19	26	32	38	45
Milk production (@ 13p litre) litres/cow						
Stock Rate 1.0 acres/cow	123	184	246	308	369	430
1.2 acres/cow	147	221	295	369	443	517
1.5 acres/cow	185	276	369	462	554	645

Table 2. Crop and Livestock Reponses required to break even in relation to the cost of drainage.

Since the timing of a yield response cannot be predicted, it will be necessary to calculate the average yield response required to meet the cost of the drainage and break even. The break even yield to be achieved will depend on whether capital has to be borrowed, the period over which capital is repaid or depreciated and the business's marginal rate of tax. Table 2 assumes an interest rate of 15% with the capital repaid over 10 years and since each business's position is different, tax has been excluded from the calculation.

The calculation of the stocking rate and the crop yield shown in table 2 required to break even does not include the cost of periodic operations such as mole ploughing/subsoiling and cleaning of ditches. Each of these tasks if required must be carried out to maintain an efficient drainage system and their cost included in the annual charge.

Once land has been drained there are often other benefits including greater flexibility in the cropping and stocking of the land and more timely field operations. These benefits and the potential to achieve higher crop yields can be reflected in the higher value of the land.

Financing field drainage

In assessing the benefit of field drainage to a farm there are many important factors to consider, but the overriding consideration must be whether the farm business can afford the investment. The capital cost of drainage is often high and if there was no immediate benefit from enhanced yields, because of dry weather, then the capital expenditure would have to be serviced out of the business's existing cash flow.

Therefore, the investment of capital in land drainage must be regarded as a long term improvement to a farm. In view of the uncertainty of when a response to drainage will occur, a cash flow budget may need to be prepared to assess the effect of the capitai investment on the business's viability. It would be prudent in many cases to omit the likely yield improvements while taking full account of the costs to be incurred.

Where bank facilities are required, consideration should be given to seeking Loan Account facility from the Bank for repaying the capital investment over a period of up to 10 years. Banks recognise that drainage is a worthwhile long term investment for a farm and will consider the provision of loans over a longer neriod if required.

Conclusion

On many farms the provision of better field drainage is a worthwhile long term investment, improving not only the business's profits but also the value of the land. In the short term the costs can be high and therefore careful consideration has to be given not only to the planning of the-drainage scheme but-also to-the provision of finance. It should also be remembered after having invested in field drainage, that maintenance is important if its efficiency and consequently its value to the business is to be realized.

THE ROLE OF THE INTERNAL DRAINAGE BOARD

P. R. Charnley, M.S.E.., M.I.B.M.., Engineer to the North Level Internal Drainage Board, clarifies the position and responsibilities of Internal Drainage Boards in the field of Land Drainage Legislation and explains their uniaue function in the farming society.

History

Before one looks at the work of an Internal Drainage board, it is important to realise that they have not just been born from a politician's idea, but have grown out of a real need for local drainage over the centuries:-

- An act of 1427 — created the Commissioners of Sewers — whose Dowers included "Local drainage".
- The first Land Drainage Act in 1585 — created Commissioners of Sewers for individual districts and attempted to separate responsibilities for "main" and "local" drainage.
- Land Drainage Act 1861 — Establishment of elective drainage boards. a major forerunner of the IDB.
- 1930 Land Drainage Act finally produced a legislative split and formed catchment boards and IDB's.

Constitution

The Internal Drainage Board is a body corporate, independent of the Water Authority except that the Land Drainage Act, 1976, requires the Water Authority to ensure that I.D.B.'s operate in such a way that the district derives benefit or avoids danger as a result of drainage operations and can take over the functions of a board should they fail in their statutory duty.

The Board consists of elected Members, together with Members appointed by contributing District Councils and are responsible to the electorate.

There are some 300 *I.D.B.'s* in England, whose districts vary in area from below 10,000 hectares to above 30.000 hectares. However, it is accepted that for a board to economically employ engineering, legal and financial staff, together with direct labour and plant, it should have a district area greater than 30,000 hectares. The North Level is 32,000 hectares. There are many smaller boards whose members voluntarily contribute toward the functioning of the board utilising contractors for maintenance and where engineering design and supervision is carried out by Consultants. Such an arrangement has overated most satisfactorilv in the past. I feel it is doubtful that members' active participation on boards' ,functions will be able to continue, as more and more farmers are reducing labour and involving themselves, thereby reducing their time available for drainage board work.

Eleven drainage boards combined to form the North Level Internal Drainage Board in 1973, the new Board embarking on a major updating of drainage at this time.

Finance

The I.D.B.'s income is derived from levying rates on agricultural land and other hereditaments, i.e. property and industrial development. At the present time an owners' rate is laid which covers improvements together with an occupiers' rate, which covers the cost of maintenance, including pumping. This split was made originally on the basis that improvement increased the freehold value of land and should be paid by the owner, and maintenance enabled the land to be farmed and should be paid for by the tenant.

Improvements at this point in time, attract a 50% grant from the Ministry of Agriculture, Fisheries and Food but for how long? Agricultural drainage grants were reduced from 50% to 37.5% last year; will our political masters place a further financial load on agriculture?

Responsibilities and Powers

The Land Drainage Act gives I.D.B. 's powers to carry out works of improvement and maintenance in order to derive benefit or avoid danger to all land in their districts.

The Benefits of an I.D.B.

The financial benefit occasioned by improvement works is considered over the life of the scheme. The financial calculation is complicated and outside the scope of 'this article. However. I consider that practical benefit can be measured in practical terms; we should ask the question, "Does the Main Drainage system allow the land to be underdrained and if so, can water levels be controlled to prevent submergence of underdrains for periods in excess of 24 hours".

The function of the I.D.B. is to achieve these standards and maintain them.

The above comments apply to soil conditions which benefit from underdrainage but there are obviously many subsoil situations which require different treatment. i.e. veat and gravel areas.

Danger

Danger is avoided by preventing flooding of property and land within practical limits. It would not be economically viable to cater for rainfall of 5% inches in 24 hours, as occurred in my Board's area in 1968. However, an I.D.B.'s drainage system, if properly designed and maintained, will reduce flooding to a minimum.

Powers

It should be remembered that I.D.B.'s powers are permissive and apply to all watercourses in their district. A Board may improve and maintain any watercourse, relinquishing one which, in their opinion, declines in its drainage importance.

In comparison the Water Authority may only take over or give up "Main River" with the approval of the Ministry of Agriculture.

Supervision

The Land Drainage Act states "An internal drainage board shall exercise a general supervision over all matters relating to the drainage of land in their District".

This puts the I.D.B.'s in a unique position in the agricultural community inasmuch as they are able to influence many factors which affect efficient drainage in their district.

(a) A Board should be ensuring that all private ditches are "maintained" ***sufficiently to give egis to I.D.B. drains, and lack of maintenance should not be allowed to affect neighbours' drainage.***

(b) Farmers requiring "improvement" of private drains through neighbours' land (e.g. in order to allow underdrainage), have recourse to the Land Tribunal should difficulties arise. However, good sense usually prevails and combined grant-aided schemes are carried out to take advantage of the levels attaining in the main drain system.

(c) I.D.B.'s should be ensuring that underdrainage schemes are not installed below maximum designed water level in the main drain system in order to avoid future difficulties and inadequate underdrainage efficiency.

Too many underdrainage schemes have been installed over the years on the basis of an observed winter water level. This may be satisfactory where gradients are relatively steep, but in many I.D.B. areas gradients are less than one fool in a mile and therefore design surface water levels are the prime consideration.

There are good and bad land drainage contractors. Is it not time that the Ministry accepted that detailed survey to Ordnance survey datum with underdrain design levels should be a prerequisite for grant-aid and should they not now allow a realistic

grant figure to cover *preparation* and supervision to enable the farmer to employ a consultant? I know of no other field where a "Contractor" is also the "Designer" and the "Supervisor". I believe that the Ministry should make it clear to farmers *that they* are responsible for installation of underdrains to the required standard and not the Ministry's drainage officers, as this is not *generally understood.*

(d) A board *should* be *extremely* diligent in protecting *agricultural* land from surface water discharges from development by *ensuring* that Planning *Authorities* place adequate conditions on developers and should discourage *the* use of *soakaways* in parts of their district liable to *waterlogging.* I.D.B. *'s* should, in my *opinion,* **be** placed on the *list* of statutory consultations for development within their districts.

3. ***Byelaws***

A board should have Byelaws approved by the Ministry of Agriculture; these are legally enforceable and should be periodically reviewed and updated in order to ensure that drainage standards are protected, not only at the present time, but for the future.

Failure by a board to enforce their Byelaws or even to adopt Byelaws, will result in difficulties and therefore expense to the ratepayer in the future.

How many times does one come across devleopment and tree planting, which restricts or prevents access for mechanical maintenace or improvement today because a board has failed to take the necessary action in the past?

How Efficient is an I.D.B.?

How do you measure the relative efficiency and the effectiveness of an I.D.B.?

Obviously, farmers paying drainage rates will set the rates they pay against their own assessment of the direct benefit they receive. This assessment will vary between individuals and is usually related to their own ideas of drainage standards and the size of the holding they farm. However, I.D.B. districts are in agricultural areas where good drainage is the life-blood and 90% of farmers recognise this fact.

The ultimate goal for all *I.D.B.'s* should be to give all land in their district the same standard of drainage at the minimal cost.

It is difficult to give a comparison of relative efficiency except to point out that I.D.B. rates per acre as a percentage of land rental values are lower today than they were twenty years ago, although the run-off figure used for improvements and pumping has doubled and the required depth of drainage lowered.

How Effective is an I.D.B.?

The effectiveness of I.D.B.'s in dealing with both their overall and particular responsibilities can only be measured by future generations. The next generation of farmers will be able to compare the drainage standards achieved in the present era with those apparent in their grandfathers' day, but having said that, farming standards change as do those of drainage. After 35 years in drainage, I find that the only certain aspect is that drainage allows the land to be worked earlier and later than was possible without it. It is coincidental that this aspect affects crop yields, and therefore profits; in my opinion, all agricultural land benefits from underdrainage and therefore drainage pays.

Problems

The public are not aware of the concern felt by members of drainage boards together with their engineer and consultants for the future of land drainage in their districts. Farmers should be aware of the continual striving to achieve the ultimate drainage flexibility at minimum cost. They should be aware of the detailed examination of all aspects of a Drainage Board's activities considered by board Members and their concern for future generations. Very few ratepayers in a drainage district are aware of the time and effort applied by Members and in particular I.D.B. Chairmen to the furtherance of improvement in maintenance standards.

Members and engineers are continually searching for new methods of advancing the standards of maintenance and improvement they feel is desirable, commensurate with modern day standards. We in the I.D.B.'s too are faced with labour cost problems and need to mechanise operations which used to be labour orientated, I would add, with little or no help from British Industry.

Maintenance

Many Boards have indeed by adaption and innovation produced equipment now used by farmers for mechanical maintenance; this process is continuous. The Association of Drainage Authorities have, through political lobby, managed to keep the aspect of agricultural drainage in the forefront, pioneering developments, both mechanical and chemical for the advancement of drainage.

How is it. you may ask, that in this field we are so far behind our Common Market colleagues in producing purpose made machines for mechanical drain maintenance? I would say, that it is because farmers are not concerned about the maintenance of their own drains when close to their land is a well maintained I.D.B. drain and. therefore, do not demand this equipment from manufacturers.

I have seen drains with a surface water gradient of 4ft. in a mile due to growth in farmers' ditches when it should have been 6 inches in a mile.

Drainage and the Environmentalists

Before I close, I would ask you to bear in mind the apparent effect that the environmentalists are having in relation to both the public and the Government's attitude to land drainage and I would emphasise my support to Geoff Cave's comment in his paper to the Oxford Conference—

> "Land drainage channels are unique engineering structures on which agriculture in the fens and elsewhere rely absolutely. The maintenance of these channels has to conform strictly to the requirements of their engineering design. They cannot be regarded in any way as comparable with natural watercourses."

Natural rivers in their ancient environment can be dealt with on the assumption that controlled flooding can and should occur. Man-made channels designed to drain the land in I.D.B. districts must be maintained to a high standard, irrespective of any environmental consideration and should not be considered in any way differently to a surface water sewer.

We started off as Commissioners of Sewers to drain the land and this should be the only criteria.

Acknowledgements

The Author wishes *to* thank the *North* Level Internal Drainage Board for permission to publish this article. The opinions expressed are his own and not necessarily those of the Board.

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WHAT DEPTH CULTIVATION FOR WINTER CROPS?

Dr. D. B. Davies, Regional Soil Scientist, ADAS, Cambridge.

At no earlier lime in British farming history has there been such widely contrasting cultivation practised for winter crops; there are advocates of every method from none at all to as deep annual cultivation as power can achieve. This article puts forward a logical approach to choice of cultivation based on soil type and identification of soil conditions.

Few dissent from the premise that unnecessary cultivation is wasteful or conversely that no more cultivation should be done than can be justified by careful assessment and experience. Cultivation experiments run by ADAS and the ARC on very many sites since 1970 have shown that within wide limits the type of structure in the topsoil has little influence on yield of winter crops. These same experiments have shown this finding to be true irrespective of whether the experimental yield was low (5 – 6 t/ha) or high (9 – 10 t/ha). Where direct drilling or shallow cultivation reduced yield the cause was either weed competition, severe compaction, inadequate drainage, late drilling or combinations of these factors.

The choice of depth of cultivation for a field therefore turns upon being able to assess reliably whether the tilth and deeper physical condition is good enough not to hinder emergence, root growth or drainage thereby allowing the crop to convert all available light into dry matter yield. If conditions are assessed to be too poor then appropriate cultivation must be carried out.

Soil Examination

The depth of cultivation necessary is best decided by field observation using a spade. The main difficulty is assessing dry soils during the summer; it is preferable to examine land earlier in the season before it dries out. The important zone to examine is from the surface to just below the depth of the last primary cultivation, especially if the field has been cultivated to similar depth for a number of years.

Compact layers in sandy soils are seen as zones of greater resistance to spade or trowel, often ,with platey structure where cracking is horizontal (Fig. 1). Crop roots will be much less numerous than in the looser soil above. Similar observations may be made on light silty soils.

Medium and heavy soils show characteristic large smooth sided, angular close fitting structural units in a well defined layer or zone of the soil. The larger and denser these units, the poorer the structure. On drying, the layer will show some vertical cracking, with the majority of the roots within the layer confined to those shrinkage cracks.

Depth of cultivation should depend on the soil structural conditions revealed. If a poorly structured layer is found, cultivation depth should be just below to break it. If soil conditions are good, a shallower cultivation is all that is needed for winter crops.

Cultivation of Medium Loams and Clays Without Compaction

Shallow cultivation (less than 10 cm) with tines or discs or direct drilling are satisfactory techniques for those soils unless weeds and trash demand deeper working. Repeated shallow cultivation over several years is likely to produce shallow pans which are often absent from the same soil direct drilled successively Fig. 2. Such pans are readily identified with a spade and remedial cultivation must be aimed to loosen the compact zone whilst at the same time avoiding a cloddy seedbed which is likely to lead to patchy establishment and indifferent residual grass weed control.

There are two approaches to loosening this type of condition. More conventionally shallow tine cultivation is followed by successively deeper cultivation until the compact layer is removed. Sometimes this is achieved by several passes or more recently by combination implements with shallow tines in the front and deeper tines behind. These systems referred to as the 'Progressive' approach are very successful in disrupting compaction, but at the expense of cloddy tilths which reduce the effectiveness of residual weed control, and lead to patchy emergence in dry autumns. In the last 2 years the appearance of a new generation of implements has given us the opportunity to loosen compaction while still leaving the surface comparatively free of clods. The Howard Paraplow, the Parker Farm Flat Lift (Fig. 3) and the McConnell shakaerator (Fig. 4) are 3 such implements and experiments by ADAS in East Anglia are already giving information on their effectiveness in a range of conditions.

Fig. 1. Platey structure in a compact sandy soil.

Fig. 2. (a) Compaction showing just below the shallow cultivated surface of a silty clay soil at Terrington EHF.

Fig. 2. (b) Direct drilled soil equivalent to 2 (a) lacking obvious compaction.

Clays With Inherently Poor Structure and Slow Drainage

Many of Britain's slower drainage clays e.g. Denchworth series on Oxford Clay and Ragdale series on Boulder Clay, and other clays which have insufficient drainage systems are characterised by large compact structures in the subsoil and often in the topsoil as well. These soils require several years of deep remedial cultivation to complement an effective pipe and mole drainage system and the deeper drying which higher yielding crops provide. It is in this type of situation that the 'Progressive' type cultivators with banks of tines working progressively deeper in the soil profile are particularly effective. On better structured clays and many types of well structured loams the deep working 'Progressive' method is less likely to be beneficial.

Sandy and Silt Soils

Mouldboard ploughing or deep cultivation is still the best method of cultivation for a wide range of sand and silt soils. Unlike soils of higher clay content the weaker structure associated with these soils tends to slump naturally during wet weather, and annual cultivation of the soil to 20 – 25 cm depth is necessary to provide reliably good conditions for rooting. Shallow cultivation or direct drilling can work well in some years when soil conditions are good but tends to be unreliable in wetter and drier than average years.

Direct Drilling

The need for deeper cultivation on direct drilled fieldsshould be judged by spade observation. Winter observations of the time taken for surface water to infiltrate the surface are also useful.

Experiment and experience suggests that yield reductions are likely after **3 – 4** years on soils with impermeable subsoils (such as clays of the Windsor and Denchworth series) unless the topsoil has a higher than normal organic matter content. The topsoil structure becomes compacted and needs tine cultivation to 20 cm depth every few years to allow continued 'direct drilling'. The Paraplow and Flat Lift appear to be very effective in these situations. Better drained heavy soils such as the Hanslope series do not generally deteriorate and are less likely to require remedial treatment in sequential direct drilling. In general the weaker the topsoil structure and the poorer the natural drainage of soils the more likely the need for periodic topsoil loosening. Oil seed rape is more susceptible to compaction than winter cereals and therefore likely to be more responsive to topsoil loosening.

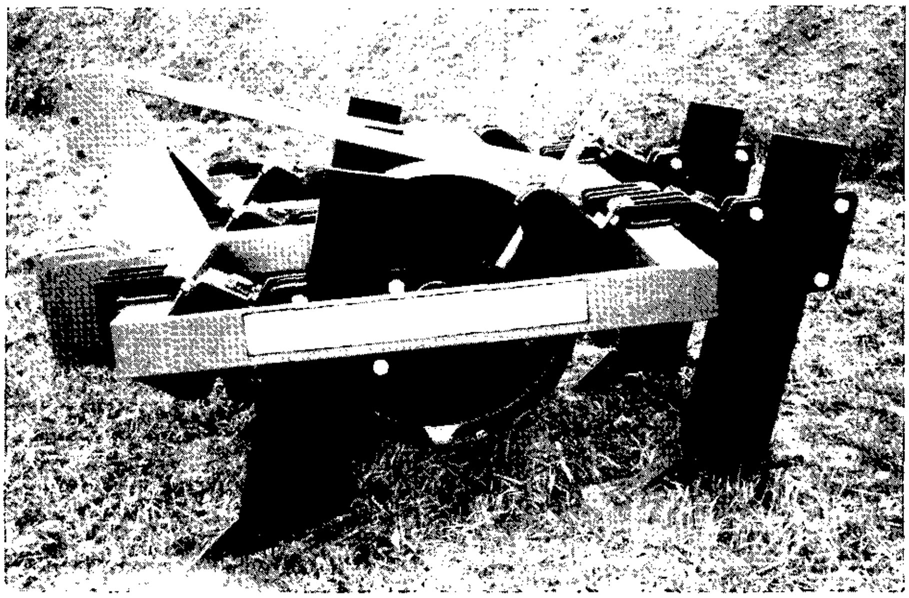


Fig. 3. The Porker Form Flat Lift

Summary

Every year a great deal of time and effort is wasted on unnecessary cultivation when soils are already in a good condition for winter cereals. Conversely other situations require loosening but do not receive it. The logical solution is to examine soils and determine the extent of cultivation required. Where examination indicates that topsoil loosening is needed a new generation of implements are now available which underloosen without bringing as many clods to the surface as their predecessors.

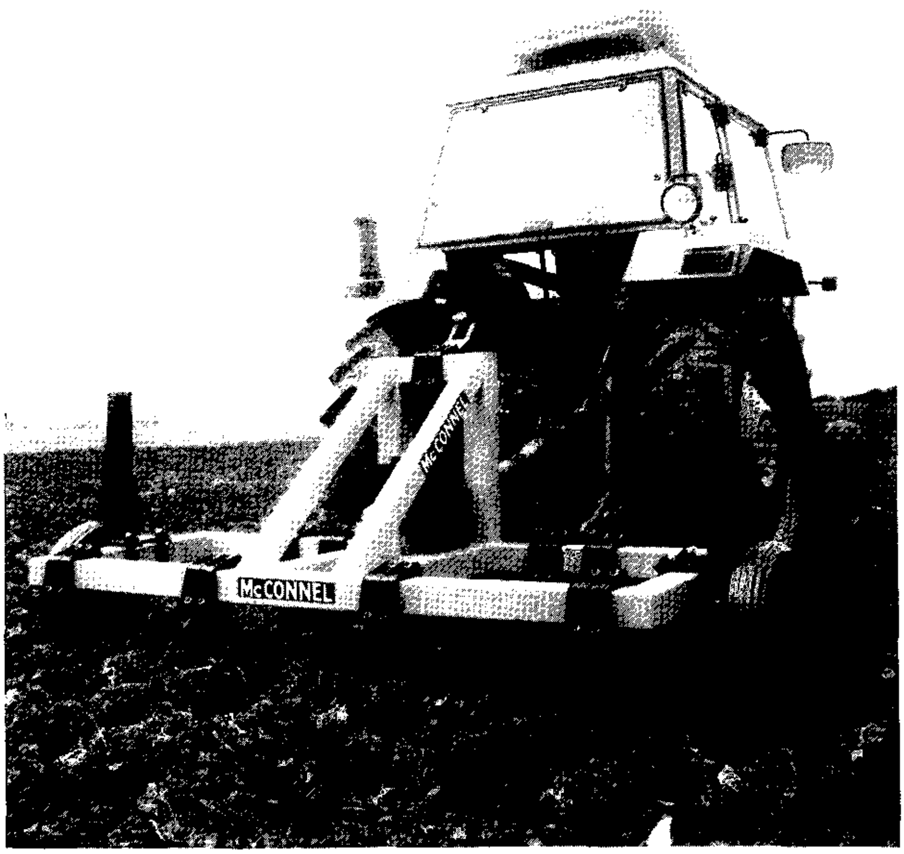


Fig. 4. The McConnell Shakaerator

BETTER USE OF WATER

A Report on the A.D.A.S./U.K.I.A. Irrigation Demonstration

ADAS — Eastern Region in conjunction with the U.K. Irrigation Association organised a demonstration day on 3 sites in the Cambridge and Bury St. Edmunds areas at the end of June.

The theme of the demonstration was 'Better Use of Water' on a range of soils and crops.

Trumpington Farming Co.,
Cantelupe Farm, Trumpington,
Cambridge

This was the main site with a static exhibit supported by a number of organisations. Research into the prevention of scab on potatoes by keeping the soil wet for 4 weeks from the start of tuber formation was highlighted by Rothamstead Experimental Station. The ADAS display included the soil aspects, available water capacity and the water balance sheet, whilst the Institute of Hydrology offered the MORECS SMD approach and the use of the IH Neutron Probe. Fisons Irrigation Advisory Service offered their alternative approach to irrigation scheduling and the University of East Anglia looked at the determination of irrigation need using soil moisture tensiometers. The National College of Agricultural Engineering has a research programme covering bubbler irrigation and the use of computers for irrigation planning and scheduling. The only reference to equipment performance was an update on the distribution characteristics and uniformity coefficients for some of the newer hosereels, by ADAS staff.

The theme of the various exhibits was that the efficient use of water depended on some form of calculation of irrigation need, satisfactory scheduling and control of application and distribution.

The field display at Trumpington was limited to an older Ardleight Swift hosereel/raingun sledge and a small layout of Portagrid equipment. Driving through the farm, there was, however, ample opportunity to see the use and effect of irrigation on many fields of potatoes, sugar beet, peas and beans on soils ranging from heavy gault, through sandy clay loams to chalk marls and lighter gravelly loams. The irrigation requirement of the estate exceeds 200,000m^3 (45 million gallons) annually with some 115,000 m (25 million gallons) available from direct abstraction from 3 rivers in the area.

Four linked reservoirs store 180,000 m' (40 million gallons) some of which is returned to the river to balance direct abstraction on other parts of the estate. Unfortunately too little attention was drawn to the importance of storage or its relative costs/benefits compared with direct abstraction.

Upton Suffolk Farms, Park Farm, Herringswell

By contrast the soils of Park Farm, ranged from sands to loamy sands, being free draining and very responsive to irrigation. The 286 ha grows early and maincrop carrots, early potatoes, strawberries, sugar beet, wheat and barley. The sources of water are 2 boreholes and 2 springs, yielding over 213,000 m? (46 million gallons) annually with further abstraction allowed for frost protection and vegetable washing. The water is pumped direct from source into a ring main, final distribution being by means of 3 Irrifrance TRL 90s hosereel/sledge, 2 Laureau L150s and a Portagrid sprinkler system.

The benefits of irrigation on this land were clearly indicated by excellent tuber development of Maris Peer potatoes sown on 31 March for canning purposes, also the strawberry crop (Cambridge Favourite) looked, and tasted, of good quality. The carrots were being irrigated with one of the Irrifrance rainguns but unfortunately there was a lot of surface water run-off which contradicted the theme of the demonstration.

Static display on this site gave details of the layout and irrigation requirements.

Strutt & Parker Farms Ltd., Street Farm, Gt Livermere

Street Farm introduced the sandy clay loams of the Beccles and Ashley series which are less responsive to irrigation, with the comparison of sands and loamy sands, some with a high gravel content. As with the soils at Park Farm, these are soils which are highly drought susceptible and considered to be uneconomical to crop without irrigation. The crops irrigated are grass and grass for seed, sugar beet, potatoes, wheat and barley.

The sources of water were a large lake, supplemented with water from a borehole, yielding (1,200 m^3/day) which was pumped into the lake, ifs flow into a small balancing reservoir by the pumphouse being controlled by an automatic syphon control weir coupled to the 2 pumps. Final distribution was through 3 Irrifrance 110 hosereels, providing a seasonal application of some 170,000 m^3 (37 million gallons).

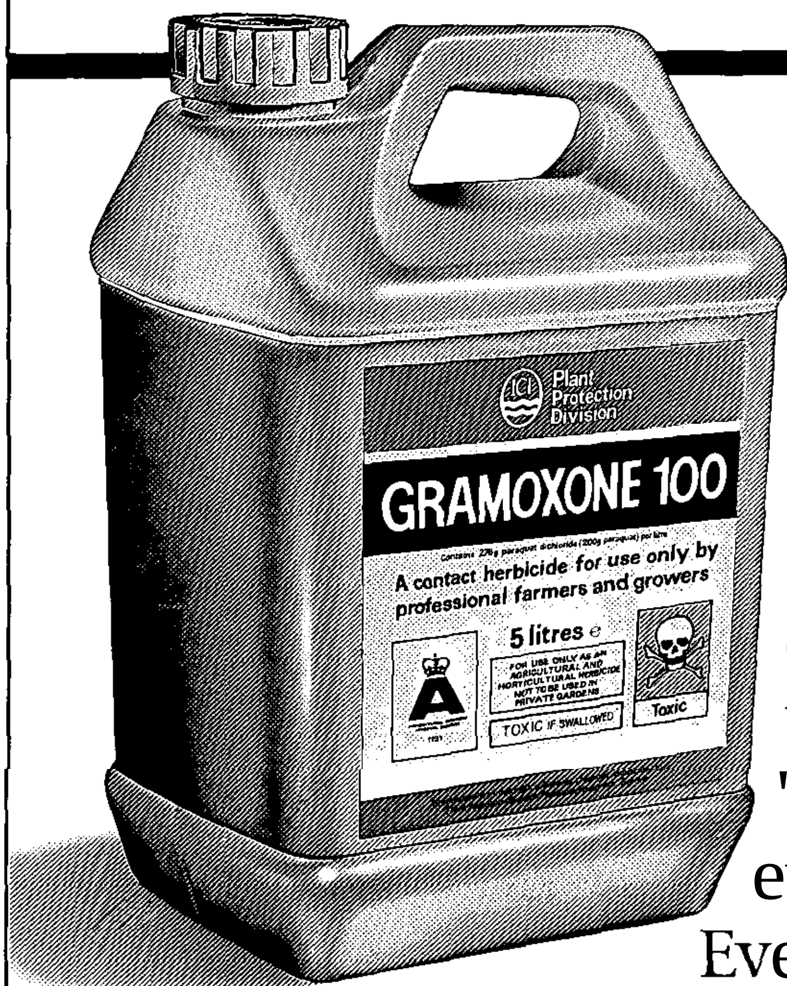
Driving through the irrigated area of this site gave visitors a good opportunity to see something of the benefits of irrigation for the potatoes and sugar beet, the crops looking as good as those on the other sites.

Summary

The demonstration gave a g[illegible]d appreciation of the benefits to be [illegible]ed from irrigation as a part of a well managed enterprise. The three sites provided a comparison of the same crops (and varieties) being grown on different soils with the aid of irrigation, but with little variation in the machinery on display. Although a major criticism might be that the sites were too far apart, this did enable the organisers to show a wide range of soils being irrigated. However, many of the 300 or so attending did not manage to visit all the sites, and those who didn't manage to get to the static display at Cantelupe Farm, missed a major part of the demonstration.

Although irrigation may be thought to be solely for the Eastern Counties, let us hope that similar events can be co-organised by ADAS and UKIA in other parts of England and Wales.

New 'Gramoxone' 100 for even better value.



With a new double strength wetting system, 'Gramoxone' 100 is even more effective. Even better value.

ICI Plant Protection

WATERLOGGING AND CROP GROWTH

Agricultural Research Council, Letcombe Laboratory, Wantage, Oxfordshire.

Progress towards more rational design– of field drainage systems is limited by lack of information on the response of crops to high water-tables at different stages of, growth. Lysimeter and field experiments have therefore **been** set up by Letcomhe Laboratory in conjunction with the Field Drainage Experimental Unit (F.D.E.U.) of the Ministry of Agriculture, Fisheries and Food, to quantify this response.

LYSIMETER EXPERIMENTS

The effects of waterlogging on crop yield are being investigated using lysimeters in which water-tables can be controlled, and rainfall patterns adjusted using a mobile cover and irrigation. The lysimeters cc t) of ; clay soil (Evesham series) d 3 sandy loam (Skipwith series). Treatments are selected as the most extreme likely to occur in field conditions in Britain, and often involve waterlogging to the soil surface (Fig. 1).

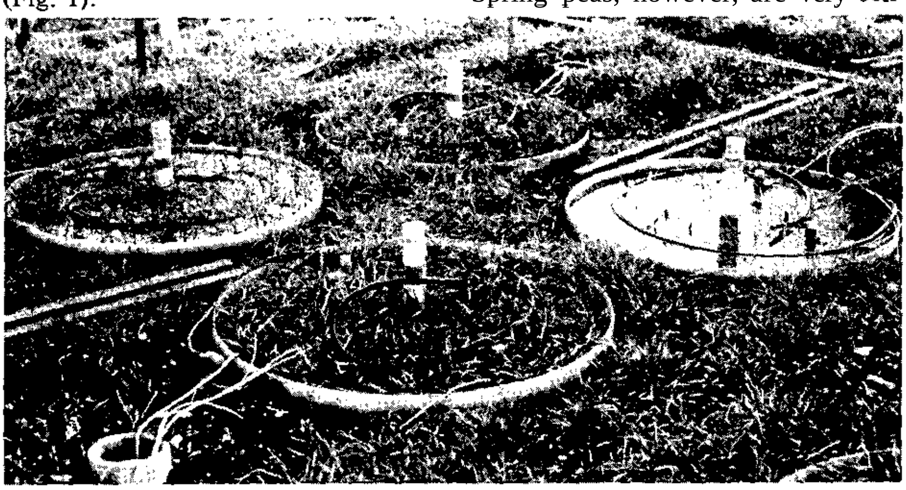


Fig. 1. Winter wheat growing on lysimeters (0.8 m diameter) during a period of waterlogging in February. In the foreground is a freely-drained control. On the lysimeter to the right, few plants survived a previous waterlogging for six days after germination but before emergence.

Winter wheat: Results obtained during four seasons show that wheat is tolerant to waterlogging except in the period between germination and emergence. Waterlogging for 5 or 6 days at this stage delays emergence and can decrease plant populations by as much as **80** per cent. Compensatory growth of the surviving plants, however, has normally limited yield losses to around 15 per cent.

Waterlogging after seedlings have emerged has no effect on plant numbers but depresses tillering and, to a lesser extent, the number of ears at harvest (Fig. 2). Typical losses in grain yield after waterlogging for **42** days in mid-winter have been around **15** per cent when yields were heavy (10 tonnes/hectare), but there was no loss in yields in one experiment when yields were light (3 – 4 tonnes/hectare) after the plants had been affected by frost damage in late winter and by take-all. Waterlogging on more than one occasion. during the growing season, which is likely on clay soils, has a cumulative, effect on yield; with two waterloggings yield was depressed by up to **30** per cent and with three waterloggings by 50 per cent (Fig. 3). Waterlogging increased the incidence and amount of take-all.

Winter barley: In an experiment with winter barley, the sensitivity of vegetative growth to waterlogging was similar to that of winter wheat, although yield losses were small.

Other crops: The vegetative growth of winter oil-seed rape was affected by waterlogging in winter but, as for the winter cereals, compensatory growth later in the season limited yield losses to less than 15 per cent. Spring peas, however, are very sensitive to waterlogging, especially before emergence or just before flowering, when yields can be halved by only 5 days of waterlogging to the soil surface.

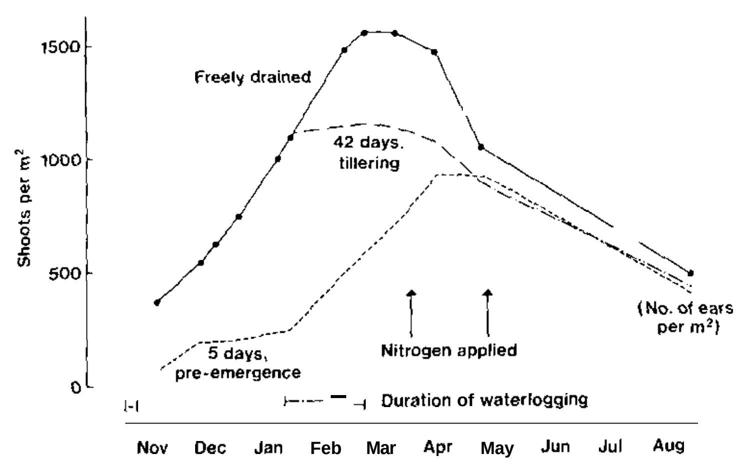


Fig. 2. Shoot populations of winter wheat (cv. Maris Huntsman) waterlogged at different stages of growth on o clay soil. Plants were waterlogged either for 5 days before emergence (early November) or for 4i days or rhe tillering stage (January – March).

FIELD EXPERIMENTS

Several field drainage experiments on clay soils have been carried out by MAFF over the last ten years, however most were unreplicated so that results are not always clear-cut. Increases in yield of winter wheat varied from nil to about **25** per cent when pipe drains were used in conjunction with closely spaced (2 m) mole drains.

In **1978** Letcombe Laboratory started a collaborative field experiment with F.D.E.U. to assess the effects of different cultivation methods on drainage requirements. The experiment occupies a **10** hectare site on a Denchworth series clay soil and two different drainage intensities are being compared in ten-fold replication. For the first two seasons, tine cultivation was used throughout but in autumn **1980** contrasting cultivations (ploughed and direct-drilled) were introduced. In the 1979/80 season, from December to April, water-tables in the poorly drained plots were at about **20** cm and in the well drained plots at **50** cm (close to mole depth). Root and shoot growth of winter wheat and water extraction by roots were impaired on the plots without mole drains and grain yield was depressed by about 10 per cent. Similarly, in a lysimeter experiment on Evesham clay, yields were **18** per cent less when the water-table from mid-December was at **20** cm depth than when it was at **50** cm.

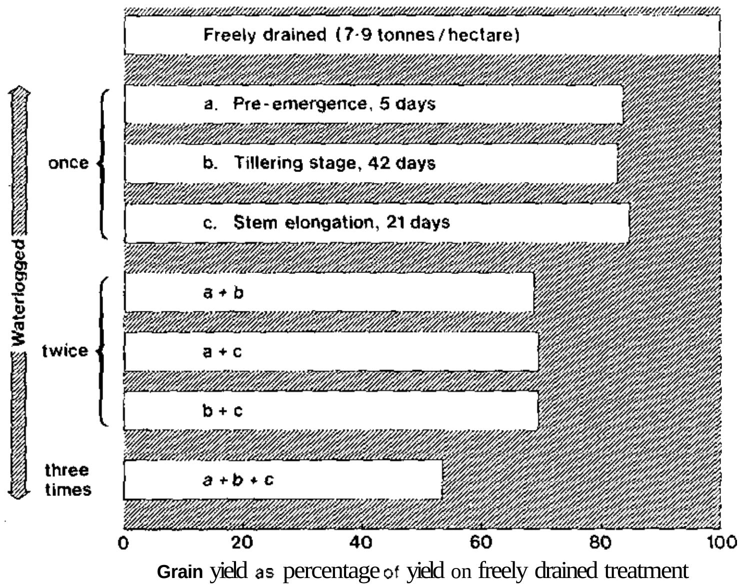


Fig. 3. Yields of winter wheat (cv. Maris Huntsman) after waterlogging of different stages of growth on a clay soil.

CONCLUSIONS

Results available so far from the lysimeter and field investigations indicate that, except for short periods, water-tables should not be less than about 50 cm below the soil surface. Work to define the range of acceptable depths is in progress. If the water-table rises to the soil surface, drainage systems should be designed to remove this excess water within five or six days for winter cereals. If waterlogging before emergence can be avoided by other means. e.g. earlier sowing, then wider drain spacing would be adequate to avoid direct effects of waterlogging on crop growth. For these crops the main benefits of drainage may be from improved trafficability for timely cultivation and sowing, and for application of herbicides and fertilizer.

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THOUGHTS ON DRAINS PAST

By Peter Alsford, Agric Division Shell Chemicals UK Ltd.

The wettest March on record for over 30 years proved that land drainage should be back in fashion. It has been shown that many schemes need updating and that fields without proper drainage will produce poor yields; the yellow patches in many cereal crops this spring are witness to this. Current estimates are that 6½ million acres in the U.K. need draining compared with 7 million acres in *1960.* The wheel of progress turns very slowly sometimes!

In many parts of the country livestock numbers are declining. Permanent pasture fields are changing to crops of continuous corn. Under a grazing system which only uses the fields in summer, the land does not appear to be too badly affected by waterlogging in the winter, however the same cannot be said with winter cereals.

Although work done at Drayton E.H.F. and the experience of farmers with direct drilling have shown that few cultivations are necessary to establish a cereal crop successfully, however for a satisfactory harvest to follow, good unimpeded subsoil drainage is essential. Depending upon soil type, this can be achieved by subsoiling or by establishing a permanent scheme of clay or plastic pipes possibly with mole drains.

Buckinghamshire is a county where the change from cattle to corn is proceeding apace and a lot of drainage work is being done. Twenty-one years ago Shell Chemicals bought a 370 acre farm in the Aylesbury Vale at Ilmer and drained the whole farm to give a flexible cropping programme on a soil type renowned for its poor drainage characteristics.

A look at some of the estimates for this work makes interesting reading. Mole ploughing at £3 an acre would be popular today! See table 1.

Experimental Work

At that time Shell, and some of the companies it supplied, were beginning to develop the use of plastics for land drainage using their CARAG 60–22 plastic. M.A.F.F. agreed to take the opportunity provided by a need to drain the farm, to test various types of plastic drainage pipeware, alongside the traditional clay pipes.

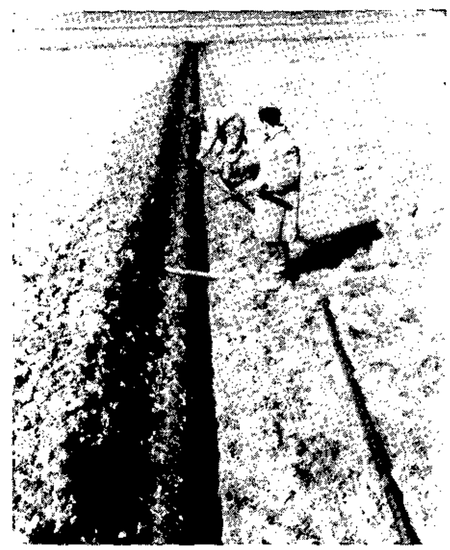
One area of 36 acres was chosen for this work with plastic and clay pipes used on separate adjacent sections feeding to a common ditch. Flow meters were fitted to each outfall so that outputs from the different pipes could be compared, and mole drainage channels were drawn above these.

Some problems were encountered: for instance the original design of pipe included longitudinal slits which tended to close under pressure. This was corrected by cutting the slots crosswise. Another problem was that up until then no scheme using plastic pipes had been submitted for grant aid by the M.A.F.F. Although land drainage experts were interested in this development they showed due caution when committing public funds. The success of the scheme installed at Ilmer, and its acceptance for grant undoubtedly helped to dispel any worries and since then plastic pipes became approved for aid throughout the country.

Satisfactory as this may have been to those involved with the farm at the time, the real test is whether the installation has stood the test of time. The answer undoubtedly is "YES". Farm Manager, Peter Alsford, said "The investment made then at less than f25 per acre after grant must rank as the hest money Shell ever spent on this farm. Without satisfactory drainage we could not manage to keep up our present grassland yields or contemplate winter cereal growing".

With the present universal acceptance of plastic pipes for drainage schemes, including the most recent development of jumbo coils of pipe, we have come a long way from those days when 20 ft. lengths of pipe were slotted together by hand. If they have lasted 21 years, then anybody putting in a scheme today using plastic can be sure theirs will last well into the 21st century.

The junction of two 20 ft. lengths plastic pipe.



Installation of pipes at Ilmer, 21 years ago.

TATE BROS (FARTHINGSTONE) LTD.

ESTIMATE FOR SNIPE FIELD DRAINAGE SCHEME

23rd January 1961

	(A) CLAY DRAINS				
11½	Chains excavate lay tiles & backfill	@ 45/–	per chain	25 : 17 : 6	
8W	× 3 in Tiles	@ 27/–	per 100	10 : 16 : –	
23	cu. yds. Shingle	@ 20/–	per cu. yd.	23 : – : –	
	Haulage on site	@ 12/6d	per chain	7 : 3 : 9	
I	Head Wall wirh measuring chamber	@ 360/–		18 : – : –	£84 : 17
	(B) PLASTIC DRAINS				
11½	Chains excavate lay tiles & backfill	@ 50/–	per choin	28 : 15 : –	
23	cu. yds. Shingle	@ 20/–	per cu. yd.	23 : – : –	
	Haulage on site	@ 12/6d	per chain	7 : 3 : 9	
I	Head Wall with measuring chamber	@ 360/–		8 – : –	£76 : 18
	(C) CLAY DRAINS				
11M	Chains excavate lay tiles & backfill	@ 45/–	per choin	25 : 17 : 6	
800	× 3 in Tiles	@ 27/–	per 100	10 : 16 : –	
23	cu. yds. Shingle	@ 20/–	per cu. yd.	23 : – : –	
	Haulage on sire	@ 12/6d	per chain	7 : 3 : 9	
I	Head Wall with measuring chamber	@ 360/–		1 8 :	£84 : 17
	(D) PLASTIC DRAINS				
11½	Chains excavate lay tiles & backfill	@ 50/–	per chain	28 : 15 : –	
23	cu. yds. Shingle	@ 20/–	per cu. yd.	23 : – : –	
	Haulage on site	@ 12/6d	ver chain	7 : 3 : 9	
I	Head Wall with measuring chamber	@ 360/–		18 : – : –	
6½	acres Moling on A.B.C.D.	@ 60/–	per acre	19 : 10 : –	£96 : 8

Table 1.

V9-2

MY EXPERIENCES WITH REDUCED CULTIVATION SYSTEMS

Mr. G. . Longbottom - Wallasea Is ,)(or , Essex, outlined his experiences with reduced ltiv ı (systems at the SAWMA Soil Compaction Conf(i Fet — He is a summary of l i paper.

Introduction

The business for which I am responsible comprises five farming units in South Essex ranging from 2,000 acres on Wallasea Island to 350 acres at Layer Marney near Colchester, the total being 4,526 acres.

Three of the units are marsh farms with silty clay soil types typical of the estuarine marsh land of the Essex coast. A further unit near Brentwood is a London clay upland soil with a few gravel outcrops and a very small area of river terrace alluvial soils, while the fifth is on a well structured boulder clay.

All of the farms can therefore be regarded as heavy land with poor natural drainage and the marsh farms which comprise 70% of the total are also low lying, being below mean tide level, so that drainage water can only be discharged through sluices at low tide.

Rainfall in the area is relatively low at approximately 20 inches per year on the coast and 23 inches on the inland farms. Also, being surrounded by salt water, prolonged winter frost is rare on the marsh farms and spring seed beds are freauentlv difficult to achieve.

Extensive field rationalisation and tile drainage work has been carried out on all of the farms in the last twenty years and every acre has a three inch tile drain system one chain apart with the drainage trenches filled with stone or ciinker to fourteen inches below the surface.

Farming Systems

The cropping system has not varied for the past ten years and is the same on all five farms, comprising 1/6th Dried Peas and 5/6th Winter Cereals principally Wheat, but in the last four years approximately 180 acres of Winter Barley have been grown on the largest farm to give a slightly earlier start to harvest.

The other significant *feature* of the farming system which is relevant to this paper is that a mould-board plough has not been used on any farm *for* over ten years. All crops residues are burnt.

Cultivations

The fundamental step of ceasing to invert the top layers of the soil was taken eleven years ago by my predecessor in response to a number of difficulties which ploughing seemed to create. These were:—

Harvest Year	Average Yield (cwt/acre)	Varieties	Comment
1974	*45.30*	*Cappelle, Cama Bouquet, Ranger*	*This was the highest yield recorded up to that year, which was generally favourable for wheat.*
1975	*40.72*	*Coma, Bouquet, Ranger*	*A very difficult autumn latest drilling 13.12.74. Total drilling target nor quite achieved.*
1976	*34.18*	*Atou, Flinor, Bouquet*	*The drought year.*
1977	*47.42*	*Atou, Flinor, Bouquet*	*A good autumn and favourable summer.*
1978	*50.25*	*Flanders, Flinor, Bouquet*	*Again a good autumn and favourable summer.*
1979	*39.93*	*Flanders, Kador, Bouquet*	*The driest autumn on record in 78, plus 5 weeks drought in June/July 79*
1980	*50.76*	*Flanders, Armada, Kador*	*A good autumn, 5 weeks drought May – 6 June 80 thereafter above average rainfall.*

Table 1 YIELDS

1. Cost — The land cannot be ploughed at shallow depth in early autumn when it is usually bone hard and dry. A plough either slides along the top or has to go in below the top eight or nine inches of hard dry clod. There was therefore a high power cost attached to ploughing and in dry autumns in particular, which are frequent in that part of the world, the result is very difficult to deal with. Up to 14 discings to achieve a seed bed are recorded more than once in the Wallasea Farm Manager's diary of that time.
2. Speed — Ploughing plus the necessary subsequent cultivations was time consuming and exacerbated the autumn work load as well as limiting the potential for autumn drilling. The result was that ploughing usually continued later into the autumn than was desirable and late p ougł ıg when the soil had become wet invariably produced a smeared furrow bottom which was virtually impervious to water.

   The result of this impeded water flow then became apparent in the spring when attempts were made to travel on the land early, either to achieve spring cultivation or for operations such as top dressing when the tractors simply fell into the ploughed depth.
3. *Surface Tilth* — Under a cropping system comprising only cereals there is little enough organic matter produced in any event and to bury the fibrous root mat of the decayed cereal plant eight or nine inches deep only to expose a fresh layer of raw unweathered clay did not seem sensible, though the beneficial effects of not doing so could not be established until the system had been tried for some time.

The original basis of the revised cultivation system without the plough was first to subsoil and then to use a tined implement of some kind. In fact Lantrac chisel ploughs were obtained and used as the primary cultivators for a time but they are now scarcely ever used. Over the past ten years the tendency has been to reduce rather than increase the amount of cultivation and the system has gradually evolved to three broad systems of primary cultivation with minor seasonal variations. These are:—

1. On the heaviest soils as typified by the Wallasea series, subsoiling followed by some combination of heavy discs and heavy spring tine cultivators, currently of the Kongeskilde vibroflex type, usually involving at least three passes, either twice with discs and once with tines or vice versa depending on conditions.
2. On the slightly less heavy soils as typified by the Agney series and on the London clay upland farm, no subsoiling on a regular basis, but any problem areas such as hard wheelings being attended to, and a combination of heavy discs and tines as above, but probably only requiring one pass of each and occasionally only one or the other.
3. On the kindest of the marsh land and on the boulder clay farm, direct drilling with a three disc drill.

Farmers Column

In all of the cultivation systems no cultivation other than **subsoiling** exceeds five inches in **depth** and it cannot be emphasised too strongly, that it is in the selection of the implement to use first and the number **of** passes that are required that the **experience** and art of cultivation lie. This is not my decision but lies firmly in the hands of the working farm managers on each farm who have lived and grown up with the system. These are patently not decisions which can be taken from an office desk and my role in this aspect of our management is to try to keep the managers' minds firmly focused on the basic principles and on the end objective which they are trying to achieve, rather than imposing upon them any rigid system of cultivation.

Taking an average season, the balance of the three systems is probably (1) 2,500 acres (2) 1,000 acres (3) 1,000 acres. This balance has persisted now for the past four seasons.

Obviously certain things are basic to all the systems. These are: —

1. *Attention* to the permanent drainage system supported by a regular *moling* programme, *1/6th* of *the* acreage being *re-moled* each autumn.

AND

2. The best burn that can be obtained. To this end straw spreaders are now being used on *all* combines.

Observations

1. Yields — It is obviously pertinent to observe that yields are by no means exceptional (Table 1). Indeed, I often have the impression that we are now the only farmers in Essex who do not average three tonnes per acre. It is also very sobering to note that twice in the last six years yields have not achieved 2 tonnes per acre and even though we think we have rational explanations for these results, they do temper one's enthusiasm with a sense of realism when budgeting.
2. Comparisons between Systems — 'We are commercial farmers and have not been able to make systematic and statistically valid comparisons between our various cultivation systems. Our broad observation over a number of years on all of our soil types on all five farms, is that we cannot consistently observe any difference in yield between the various methods of cultivations. Where we have had them side by side on the soils which are suitable for direct drilling there has been nothing to choose and in 1978 when yields were generally above our five year average, we achieved our highest field yields of a little over 3 tonnes per acre on two adjacent fields on a particular farm, of which one was direct drilled and one minimal cultivated. All other aspects of the husbandry were identical.

   There are substantial differences in cultivation costs between the systems, so clearly one does not maintain machine capacity to subsoil large areas without some conviction that it is justified. Our reasons for persisting with the more expensive system based on subsoiling on our more difficult soils, are based on our observations of crop survival and appearance in the winter and spring. We know that we have areas of very weakly structured soil and these tend to run together on the surface after heavy rain. We noticed that if they have been subsoiled, the water tends to get away from the surface more easily, and invariably about the end of March when the Wheat looks fairly sickly in any area of impeded drainage, we can observe every subsoiler mark as a darker green, healthier looking line of plants. This often persists as a very slight height differential up to ear emergence.

   Overall, after ten years of a non plough system. our farm managers are convinced of several things.
   - subsoiling now is less power consuming than when they started.
   - there is less surface ponding in wet periods than there used to be and such as there is, remains for shorter periods.
   - the top two or three inches of soil is much more friable being full of decaying root systems so that seed beds tend to be easier to achieve especially in the spring.
   - the trafficability of the land has improved in that it is generally firmer and quicker to dry at the surface than when the system began.

   As evidence to support this, all but 150 acres out of a total autumn drilling of 3,750 acres, were sprayed in a timely fashion in the difficult autumn of 1980 with soil acting residual chemicals by the use of ordinary wheeled tractors. *In* the same vein, we seem able to get on with Nitrogen early in March without undue difficulty and without recourse to aeroplanes.
3. Disadvantages — As well as the advantages listed above there are definite disadvantages of these surface cultivation systems principally in Weed Control. None of the systems do a great deal to curb grass weeds and expensive spray programmes seem to be a necessary adjunct to them. Also of course, they do little to control deep rooted perennials, and weeds such as Docks and Creeping Thistle which used to be no problem at all, are beginning to be noticeable. So far we have been able to control them by spot treatments.

CONCLUSIONS

It is extremely difficult to hold fixed opinions about anything so imprecise as cultivation systems but after a fairly long experience over reasonably large areas, I think all of us in this Organisation who have direct responsibility for cultivations, are convinced that what we are doing now is a substantial improvement over what was being done previously. We are also convinced that it is being done at lower cost and in particular, with less input of fuel than ploughing systems. (See Table 2.) We belirve that judged by any measurable criteria other than the number of weed seeds in the top four inches that the condition of the soil has improved over the last ten years, and while they are not exceptional we are not ashamed of our yields taken over large areas which include some genuinely difficult soils.

The acid test as a commercial organisation is whether or not we are sufficiently convinced of the merits of what we are doing as to wish to persist. On this point I can only say that we have no plans to purchase any new ploughs in the foreseeable future.

FARM A	*Mainly Wallasea Series, cultivated entirely by System 1 i.e. subsoiling + cultivations.*	*7.5 gals /acre*
FARM B	*Approximately 20% Wallasea Series, remainder Agney Series or similar, half cultivated System 2. i.e. cultivations without subsoiling and half System 3 i.e. direct drilled.*	*4.8 gals /acre*
FARM C	*Boulder Clay, 1/5th cultivated Sysrem 2, 4/5th direct drilled.*	*3.5 gals /acre*

Table 2. FUEL CONSUMPTION UNDER THREE CULTIVATION SYSTEMS AVERAGE FUEL CONSUMPTION PER ACRE PER ANNUM OVER THREE YEAR PERIOD 1ST JULY TO 30TH JUNE 80

THE HOWARD PARAPLOW — a new concept in soil care

The Howard Paraplow has been developed specifically to meet some of the needs of soil management under modern farming methods. There have been major changes in arable farming systems which have made the maintenance of good soil structure more important and, on many soils, more difficult.

The Paraplow has been designed specifically to assist the natural structure forming processes in the soil to create better conditions for crop germination and growth. The *Paraplow* achieves this by loosening the soil thoroughly and efficiently, breaking up areas of compaction to a depth of 14 inches.

Design Criteria

The basic idea was that to achieve economically a soil structure required by crops, an implement must compliment soil structure formation rather than destroy it. This implied six main criteria to us:

1. The implement should crack the soil along natural patterns, rather than disrupt or invert it, and should do so efficiently.
2. The implement should loosen the soil just as much as needed — not more and not less.
3. The implement should leave a level surface suitable for drilling so that subsequent cultivations, which re-compact the soil due to traffic, are not necessary.
4. The amount of soil loosening by the implement should be adjustable to suit soil type and moisture conditions, rather than the farmer needing to wait till conditions suit the machine.
5. As a necessary economic and commercial factor, theimplement must be operationally attractive in terms of costs, rate of work, reliability etc.
6. In many countries, but not Britain, the implement must he able to work through trash.

Tests have shown that the slant-leg principle is a highly efficient means of breaking up compaction. This is because the leg is designed to move soil by lifting, rather than by forcing it sideways. The lifting action pulls the moved soil into tension, rather than compression, and fractures the soil mass by exploiting natural planes of weakness. A slant leg can operate with 30% less drawbar pull than a vertical tine working at the same depth in the same soil. Another test result, achieved during development work carried out by the N.I.A.E., found that the slant leg could be set to achieve a significantly greater zone of fracture down to the maximum working depth, than a vertical tine.

Paraplow in Grassland

Because the Howard Paraplow is designed to minimise disturbance at the soil surface, it can be used in grassland.

Compaction in permanent grassland and long-term leys builds up through the ground pressure from vehicle movements and the weight of grazing animals. In many situations the Paraplow can be used to reduce the soil density in the compacted layer, without seriously disturbing the surface.

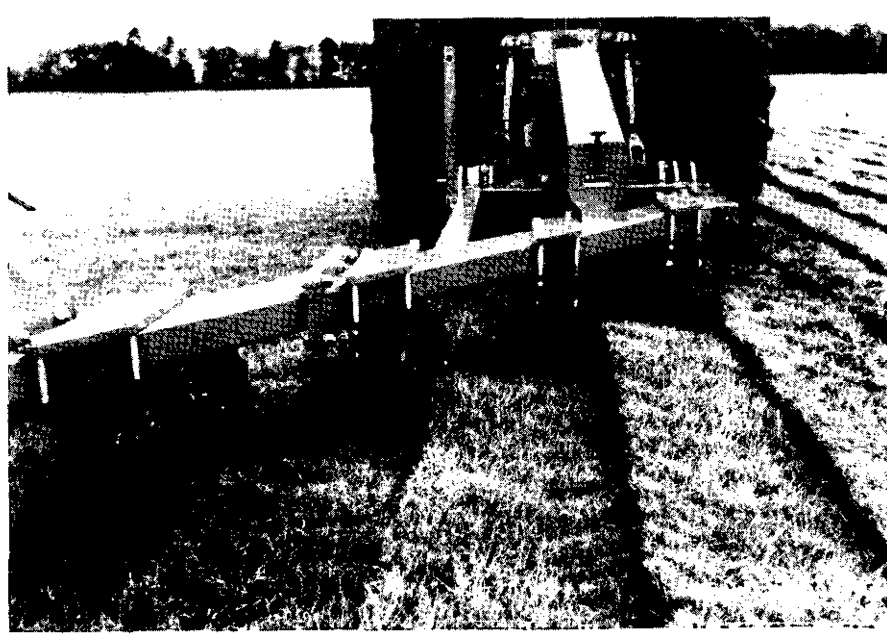
This can make a major improvement in the production of grass and the ability, of the soil to absorb surplus moisture.

The 'Paraplow' in farming systems

When and where the 'Paraplow' should be used is of course, as with any technique, a matter of farmer judgement for individual fields. The following broad guidelines may be helpful in making that judgement rationally.

1. If the soil structure is suitable for the next crop — only weed control by herbicides is required.
2. If the soil structure is suitable generally but headlands have been compacted — loosen the headlands only by 'Paraplow' before drilling.
3. If the soil has a good stable structure generally suited to reduced cultivation or direct drilling, but has been damaged by compaction or a plough pan — loosen the whole field with the 'Paraplow' the first year and then only in subsequent years if it is damaged again.
4. On soil types inherently not suited to shallow cultivation or direct drilling due to poor or unstable structure, loosen each year with the 'Paraplow'.
5. If the need to re-seed pastures arises because of poor soil conditions and compaction, loosen with the 'Paraplow' before direct re-seeding.

'If in doubt, get the Paraplow out
When the soil's OK, put it away.'



The Howard Paraplow in Grassland.

THE DYNA-DRIVE — FOR AUTUMN SEEDBED PREPARATION

Bomford & Evershed Ltd., have combined their twenty years of experience of stubble cultivations with the technical resources of the National Institute of Agricultural Engineering, Silsoe, Bedfordshire to produce a novel design of twin rotor, rotary surface cultivator for high speed, low cost, Autumn seed-beds.

The **DYNA-DRIVE** is the result of joint development between Bomfords and the NIAE since **1979** and testing has been carried out throughout the UK and France. The aim was to develop a machine which would cultivate the whole surface area to a depth of approximately 1½ – 2 inches so that either direct or conventional drills could be used. Experiments proved that fixed tines would leave uncultivated ridges at this shallow depth and produce clods of excessive size if used deeper. Powered cultivators could produce the required result but their energy consumption and running costs would be prohibitive on anything other than a small scale.

The twin horizontal rotors of the DYNA-DRIVE are ground driven and connected together by a heavy duty 1¼ inch duplex chain to give a **3 – 1** speed ratio. The front rotor tines penetrate the soil at a low angle of approximately **10°** and prise the stubble upwards and forwards while revolving at about **40%** of forward speed. The rear rotor revolves in the same direction approximately 1½ times forward speed and breaks out the remaining undisturbed soil backwards and upwards.

By breaking the soil upwards along natural fissures, instead of sideways or downwards, much less energy is consumed and smearing avoided. According to NIAE findings the 'pushing' effect of the rear rotor can reduce the draught by **30%.**

The machine has been designed with the two rotors overlapping so that the machine is self cleaning and virtually unblockable, a particular advantage in messy stubbles associated with wet harvests.

Tine wear should be low as they are only in the ground for approximately **15** m for every **100** travelled. Calculations indicate that a set of tines should last approximately six times the life of a conventional cultivator point.

Two models are available, the **3** m machine will cultivate 8 acres/hr with 90 bhp tractors and a 5 m machine works 14 acres/hr with a **130** bhp tractor. Prices are **£2.950** and **£5.250** respectively.

For more details contact
E. A. McLaren,
Home Sales Manager,
Bomford & Evershed Ltd.,
Tel: Bidford-on-Avon (078988) 3383.

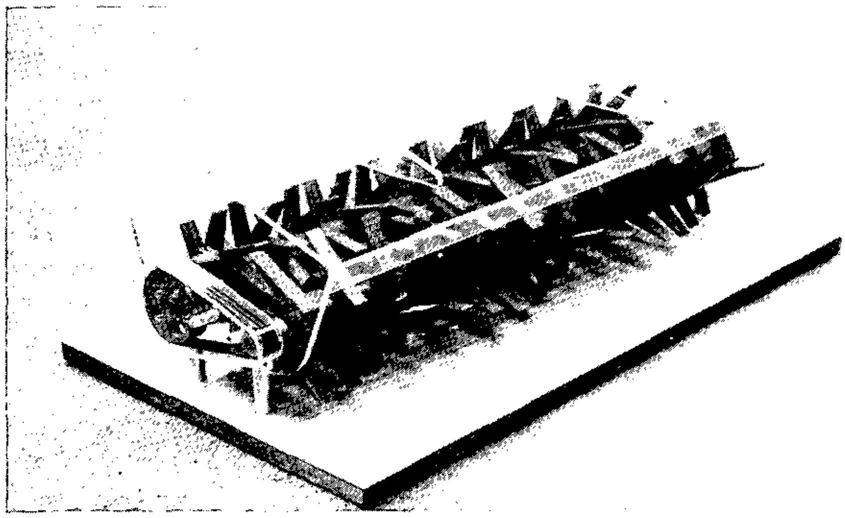


Fig. 1. Cut away section showing the twin horizontal rotors and tines.

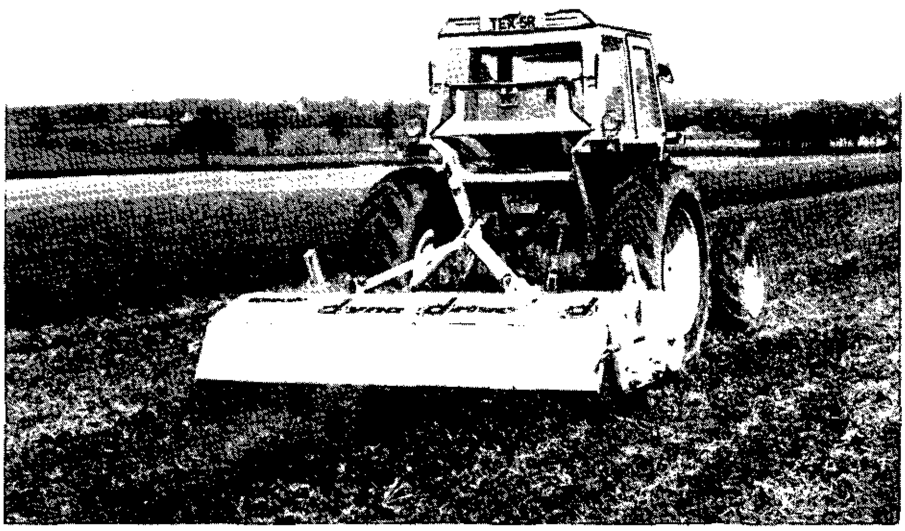
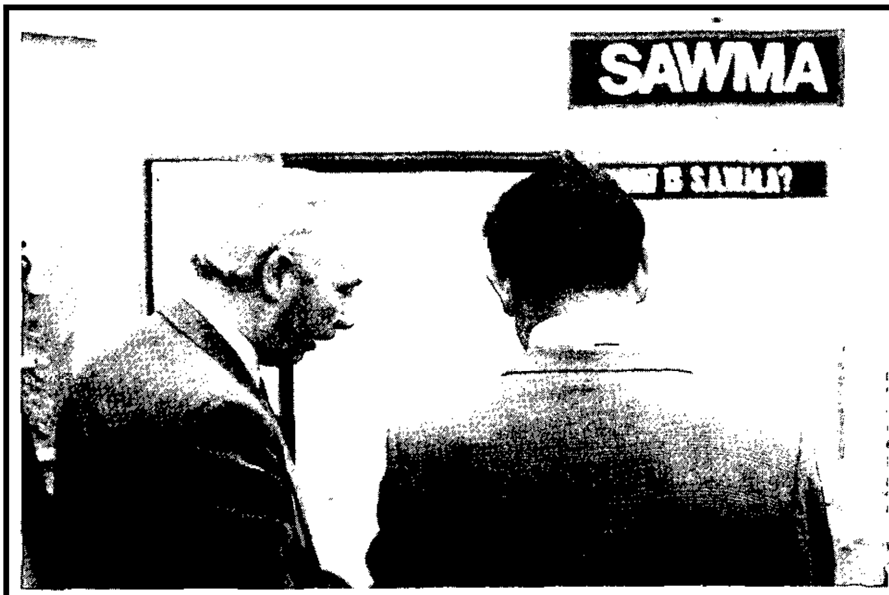


Fig. 2. The Dyna-Drive in action.



JOHN RODDAN — Chairman of SAWMA Council discusses the need for careful soil examination with a visitor to the Association's Stand at the Royal Show.

"SUPERKOIL" – THE EFFICIENCY ROLL

A major contribution to more economic land drainage has been made by the introduction recently of the 'Superkoils' by Aqua Pipes Ltd., of Shipston on Stour, Warwickshire. The enterprise of this new Company in introducing a total concept was described by contractors, who attended a factory and field presentation, earlier this year as 'impressive'.

At this very competitive period for plastic pipe manufacturers, Aqua Pipes Ltd., has chosen to enter the market, using a new material for the production of plastic pipes, polypropelene, which they claim has important advantages over polyethylene and P.V.C.

The particular features are toughness and flexibility throughout a wide temperature range (–20°C to +30°C), it is not susceptible to stretch or distortion, and has a ductile quality.

It is this latter feature which enables the manufacturers to obtain the density of 'Superkoil' with an overall dimension of **2.4** m × **2.4** m for the **3,600** metre coil of **60** mm dia. pipe. Both the 'Superkoils' and the standard **150** metre coils are produced in three diameters, each size being colour coded to correlate with codes used for drainage scheme plans.

Developments in production machinery enable the product to be competitive and gives quality standards exceeding those set under British Standards **as** minimum requirements for Ministry approval.

While the technical features of the basic product are important, the broader approach adopted by Aqua Pipes Ltd., as a supplier of materials to the drainage industry is more than interesting. The Directors have not only designed the product but develooed eauipment to exoloit the advantages.

Great care has been taken to study the customers' requirements and to offer substantial opportunities to operate more efficiently with the consequent improvement in margins. The needs of the contractor and his staff have been fully considered.

The advantages of giant coils affect the farmer as well as the contractor. They include:

1. Substantial increase in output and earnings from existing machinery with only minimal additional investment.

2. Reduced pipe wastage. With long coils, there are fewer unusable short ends to discard.

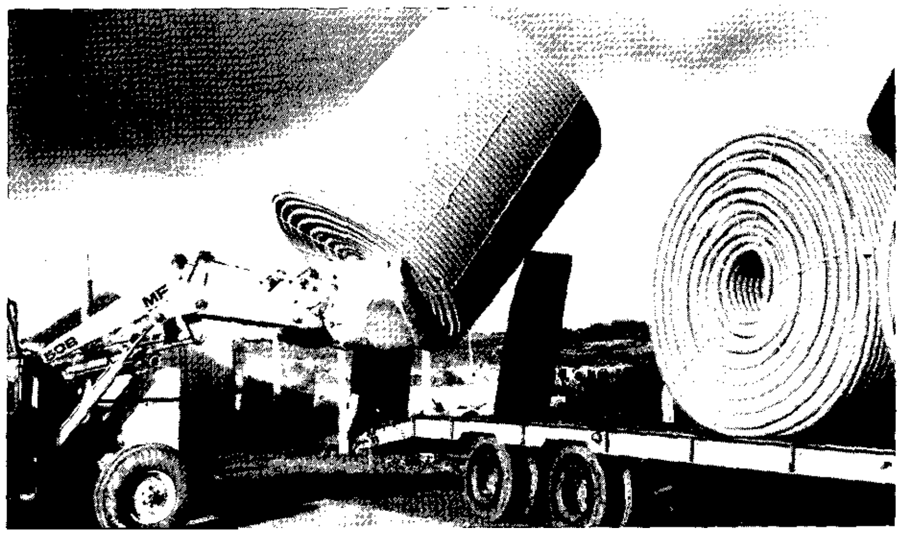


Fig. 1. Superkoils being handled using a simple rhumb extension on a rracror bucket.

3. Lower labour requirement. There is no need to set coils out all over the field: all pipe requirements for a day's work can be left at the field edge at the beginning of the day.

4. More efficient transport. One Superkoil occupies much less space than **20** small coils, needs no superstructure and can be loaded and unloaded much more quickly.

5. Elimination of coil thefts. Many small coils go missing from drainage sites. Without handling equipment, a Superkoil cannot be stolen.

6. Reduced need for joints. The same type of joint is used as for short lengths.

7. Reduced damage to the soil and standing crops when dumping and collecting small coils in the field.

Aqua Pipes claim that the time saved in a day by using Superkoils, can be as much as an hour and a half. producing a **20** per cent higher output from the drainer. This could be worth **£300** in extra work.

This latest development in the land drainage industry will undoubtedly herald other new and exciting techniques in the near future. It comes at a time when serious consideration is being given by many to ways of maintaining margins and levels of demand for land drainage. It is all the more important that these latest ideas originate from people who have personal and long experience of the practical requirements and problems related to land drainage.

For further information contact Cordon Everitt, Aqua-Pipes Ltd., telephone: 0608 61347.

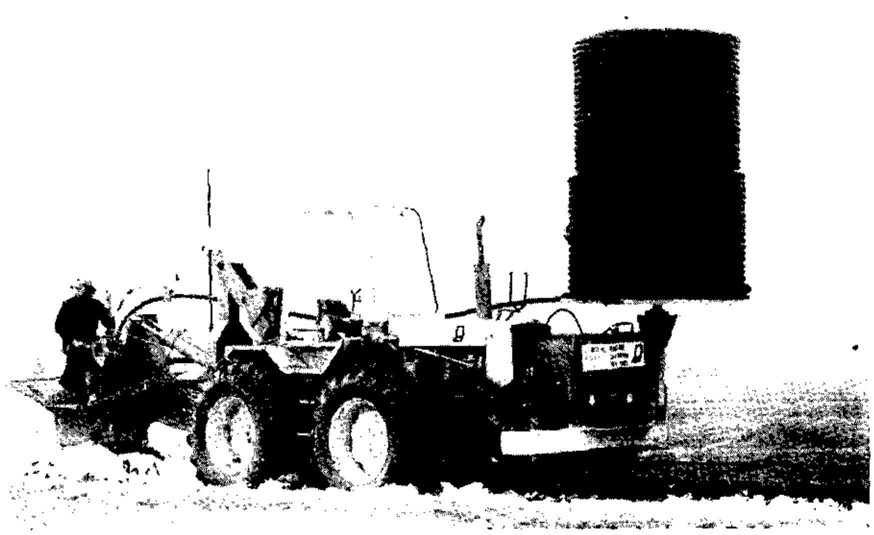
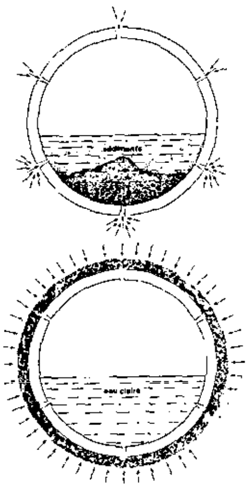


Fig. 2. 60 mm diameter Superkoil pipes being laid by a Bruff ?C3 trenchless drainer.

HAYES PIPES NEW FILTER WRAPPED PVC DRAINAGE SYSTEM



The most effective and economical method of draining sandy soils.

Now, a new poven range of **filter** wrapped pipe to tackle the growing problems of **siltation.**

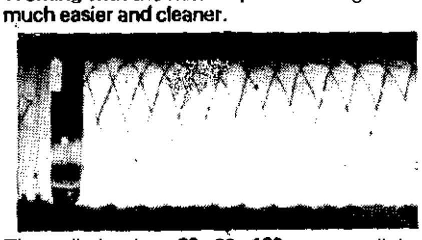
A range which will provide a new era of economy and efficiency to the drainage industry.

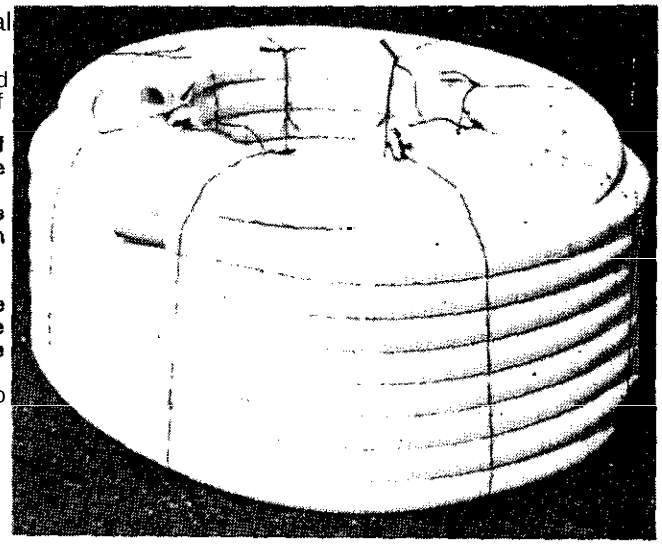
A system of wrapping P.V.C. drainage pipes with a successful 100% polyester filter which will ensure an indefinite working life.

The benefits are extensive.

A better intake of water is achieved by the wrap absorbing water — filtering out the fine silt particals in the process — round its entire circumference.

Working with the new Hayes filter range is so **much easier and cleaner.**





The coils in sizes **60**, 80, **100** mm are light, neat **and compact.**

They are **completely** dust free and can be **stored** outside in all weather conditions.

Finally — as has been **proven throughout** Europe and the **United Kingdom** this system works **superbly.**

Hayes Pipes (ULSTER) LIMITED

Scottish Division
Bandeath Industrial Estate,
Fallin, Stirling.
Tel. **Bannockburn**
(STD 0786)
811618/813574

English Division
9 **Francis** Avenue,
Worsley, Gr. Manchester.
Tel. **061** 790 5312.

Take Lamflex for granted. The Ministry do.

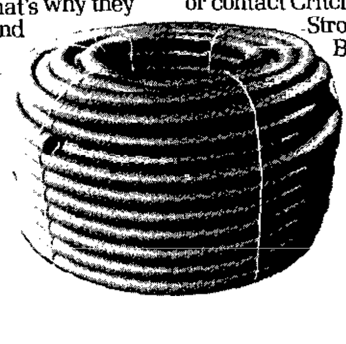
Lamflex is the land drainage tube that wise farmers take for granted - year in, year out.

They know, only too well, that other products can prove more expensive in the long run. That's why they insist on Lamflex, the high quality, PVC land drainage tube.

Lamflex is manufactured in the UK by Critchley - a 100% British company that's renowned for it's genuine interest in British agriculture, valuable advice and real, practical help.

Available in 4 sizes and a full range of fittings, Lamflex is strong, easy to handle and extremely efficient. And it's made to British Standards 4962 which means that not only is it suitable for Ministry approved schemes, it qualifies for their grants as well!

To fmd out more about Lamflex, complete the coupon or contact Critchley Bros. Ltd, Brimscombe, Stroud GL5 2TH. Telephone Brimscombe (0453) 882451. Telex 34194.



Lamflex

Critchley land drainage

I want to know more about Lamflex.
Please send me details.

Name ______

Company ______

Address ______

Member of the Plastic Land Drainage Manufacturers Association pldma

THE AGRICULTURAL TRAINING BOARD

Over the past few months the Association has been in discussion with the A.T.B. concerning the provision of more soil management courses. Here J. Cropley — Information Officer with the A.T.B. outlines the work of the board

Christopher Vavasour a founder member of SAWMA who succeeded Sir George Huckle as chairman of the Agricultural Training Board on the 1 April 1980.

Despite the fact that the Agricultural Training Board has been providing its training service to the agricultural and horticultural industries for the past 14 years, the Board estimates that only around 25 per cent of farmers actually take advantage of it.

Lack of awareness of what the A.T.B. offers is probably the main reason for this relatively small figure, also unwillingness by farmers to acknowledge the need for updating their skills.

At a time when the industry is struggling to maintain its income level, the Board's courses, in improving the workforce's efficiency, present good value for very little outlay.

The Board's training service is available to help employers, the self-employed and employees become familiar with new methods and equipment, and to improve existing skills and techniques. Its training programme can be grouped under three headings — staff management skills training, craft skills training, and new entrant training.

Staff Management Skills Training

The concept that 'training starts at the top' is one that is very much encouraged by the A.T.B., as can be seen from the whole range of courses which are available for the manager, the foreman or the supervisor. This list includes courses such as training as a function of management, office organisation, man management and selection interviewing. Varying in duration from two to four days, these residential courses are held at both the Board's training centre at the NAC, and in the regions.

Recognising the difficulty faced by many farmers in sparing time away from the farm, a programme of one-day supervisory and managerial courses is being developed. It is anticipated that they will be available in the autumn.

Craft Skills Training

These short (usually one-day), practical courses, held for the most part on-farm, and free, are perhaps the best known of the Board's activities. More than 200 different courses covering the skills needed in livestock, arable, and horticultural enterprises are available. Training for specific makes and models of machinery is indicative of just how comprehensive the training service is.

The instructors for these courses are people working in the industry, or its ancillary occupations, who are acknowledged experts in their particular field. These people are trained by the Board in instruction techniques and they receive fees and expenses for each course in which they are involved.

In recent years the demand from the industry has been for more technical training, above craft level. Increasingly farmers, particularly those in training groups, are looking at a 'whole enterprise' approach. With the advice and assistance of A.T.B. training advisers, they are undertaking training for themselves and their staff in the whole range of skills that are needed for a certain enterprise.

New Entrant Training

For people starting in the industry, the Board provides initial training and an Apprenticeship and Craft Training Scheme. Under this scheme a trainee may choose to gain craftsman status either by a formal time-serving apprenticeship, or through the passing of a required number of proficiency tests, with or without attendance at further education courses. There is provision for the trainee to transfer between routes should the original selection prove to be unsuitable.

With very little real increase in the Board's cash limit over the past two years, the payment of grant to encourage employers to undertake training has largely been discontinued — the exception being grants paid to farmers for new entrant career training.

Farmers wishing to know more of the work of the A.T.B., should contact their county Training adviser or phone Miss J. Cropley (Information Officer) 01-6504890

Instructing trainees on a land drainage course on rhe re-piorling of a river, stream or drain which may hove changed course.

Advisers Diary

THE LAND AND WATER SERVICE

E. W. Jones, Principal Engineer, Field Engineering Group, LAWS

On 3 August 1981 the existing Land Service and Land Drainage Service were merged to form the new Land and Water Service in ADAS so that their many and varied duties will become the responsibility of the new Service. These duties are both statutory in relation to capital investment in all aspects of farm buildings and services, such as roads, drainage and water supply, but they also include professional advice on a diversity of very important considerations, such as land use and economics, conservation, etc. The new organisation will coincidentally face the changes in the farm capitalgrant system which result from the streamlining process instituted by the Rayner proposals.

It is however important for the member of SAWMA, whether he be contractor, consultant or farmer, to appreciate that his point of contact in Ministry will still be the Divisional Office. The principal administrative change will be that both Drainage and Land Service Technical Officers will become part of a specialist team directed by the Divisional Surveyor. ***Already the members of the two Services have been able to provide each other with a more integrated approach to a great variety of technicalities.*** Problems such as the conflict between conservation and modern farming methods and drainage should benefit from the multi-disciplinary approach. In addition, new posts of Specialist Field Engineering Advisers are to be created and will be located at the Regional Offices.

The technicalities of the duties involved will for the constituent Services be the same as previously but will benefit from the new organisation in various ways. For example, it is intended that some of the more routine tasks can be undertaken irrespective of the officer's specialism so that a more responsive and efficient service will be provided. The identity of the various specialisms will be reflected in the titles of the Groups in which the new Service will be organised. For example, the Land Use, Conservation and Advisory Group, and the Field Engineering Group.

The Field Engineering Group

This group will provide a comprehensive advisory service on all field drainage, water supply and irrigation matters. Research and Development will enjoy a new priority, and it is intended that the results obtained will be speedily incorporated into advice given to the farming industry. The Field Drainage Experimental Unit at Cambridge will continue to build on the solid foundations ii has already created in research on the basic principles and problems of field drainage. In particular, it is intended that there will be speedy and wide dissemination of the results of its work so that farmers may quickly and effectively profit by them. The Group will, of course, continue to deal with the technical aspects of drainage, water supply and irrigation schemes submitted for grant aid.

The River and Coastal Engineering Group

SAWMA members are already fully aware of the importance of arterial drainage and sea defence. The River and Coastal Engineering Group deals with the schemes of flood protection and sea defence works carried out by water authorities, internal drainage boards and local authorities. These may benefit both agricultural and urban areas and currently there is the prestigious Thames Barrier Project in London which is so large and costly that it has necessitated the formation of a separate Thames Barrier Group. The success of field drainage work depends initially on adequate outfall facilities to an arterial drainage system, the responsibility of the various drainage authorities. The schemes submitted by these authorities take particular care to obtain this objective. The Ministry's Engineers pay particular attention to this aspect, and such considerations as the benefit/cost approach to design are very carefully considered. It will be appreciated therefore that the concept of effective drainage from field to the sea will be as important as ever in the philosophy of the new Service. The contribution and co-operation of SAWMA members to this end will be, as ever, most welcome.

Mike Jarvis

A well known face from the Soil Survey of England and Wales, Mike Jarvis listens to a farmer with a problem, at this year's Royal Show. With IS years of experience with the Soil Survey, Mike is Soil Survey representative on SAWMA Technical Committee and Council and he was closely involved in the design of SAWMA's display at the Royal and Cereals '81.

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DEVELOPMENTS IN RESEARCH ON DRAINAGE FILTER MATERIALS IN THE NETHERLANDS

Louis C. P. M. Stuyt, M.Sc., Institute for Land and Water Management Research (ICW), P.O. Box 35, 6700 AA Wageningen, The Netherlands.

Introduction

In the United Kingdom and continental Europe, over 350,000 hectares of agricultural land are drained annually. Although drainage has been practised for over 2,000 years the installation of an efficient drainage system is often problematic. Some drainage systems do not work properly, shortly after installation. This malfunctioning is often due to clogging caused by mechanical and chemical phenomena around the pipe. Rapid silting-up of pipes and filters, when used, is a widespread problem, which occurs mainly in fine sandy soils.

Looking at the percentage of agricultural land drained in Europe (Fig. 1) the need for research to solve the problem of silting-up is obvious. In The Netherlands, research focused at solving this problem — has a high priority. Those engaged in this research find that silting-up is dependent on soil type and, to a lesser extent, on the method and condition of installation.

The differences in drained soil types occurring in the United Kingdom and the Netherlands are reflected by the extent to which drainage filter materials are used. In the U.K. filters are used in less than three per cent of all drainage projects whereas, in the Netherlands, the figure is 80 per cent. The reason for this difference is that vast areas of the U.K. are covered with heavy, cohesive soils, which are relatively stable and mainly of Mesozoic origin. The majority of Dutch soils are light and of Cenozoic origin. It is the very fine, almost cohesionless sands which give rise to serious silting-up problems. These so-called 'problem soils' (see Fig. 2) are also found in East Anglia and it is in this area where filters are most frequently used in the U.K.

Filter materials (or envelope materials as they are frequently called) have to satisfy two design requirements. (1) Prevention of the entry of soil particles that will silt up the drain pipe or block its perforations, (2) Allow particles that remain suspended under low flow velocities to enter the pipes, these will be washed away with the drainage water. Not too many soil particles, however, should settle out in the envelope as its permeability would decrease drastically within a relatively short period. Therefore, the filter should have a 'selective filtration' process, that prevents relatively large particles from flowing into the pipe yet allow relatively small particles to enter free-

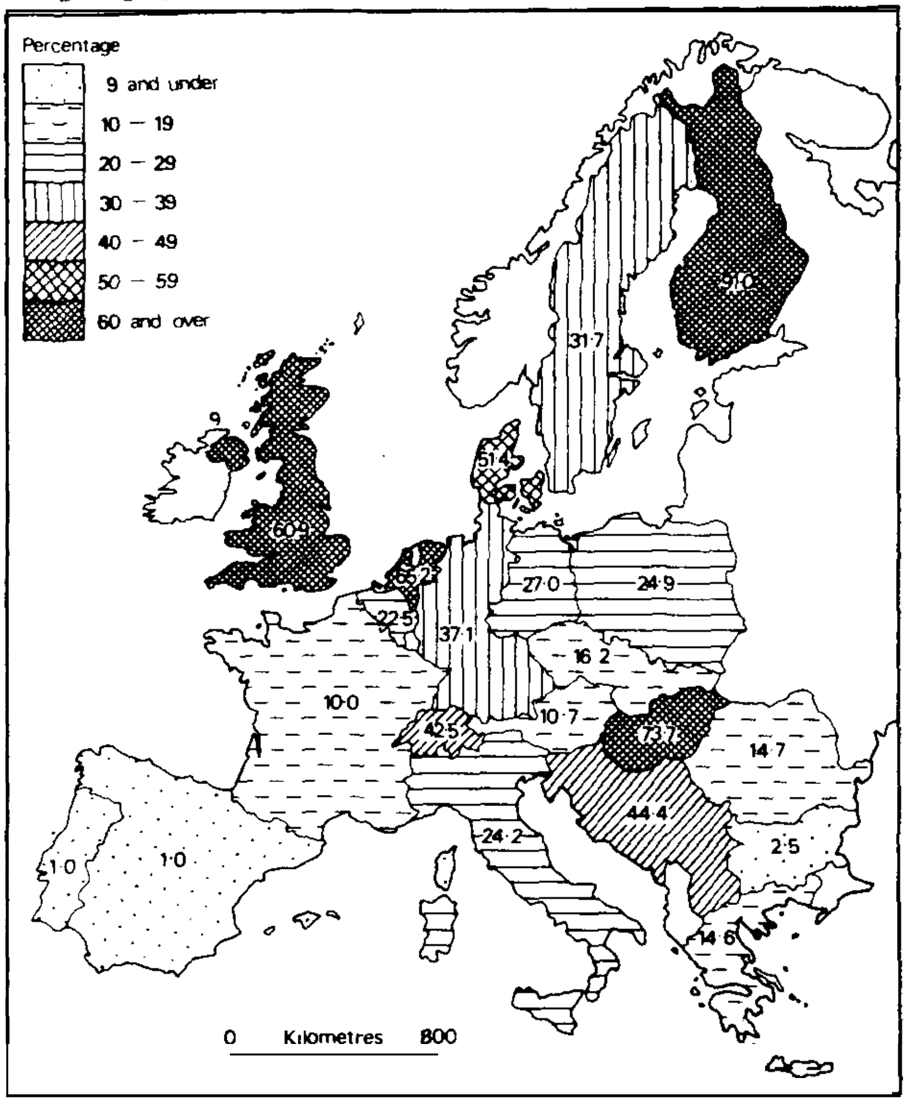

Fig. 1. The percentage of agricultural land drained in Europe. Figures comprise surface as well as subsurface drainage systems. No data from countries unshaded (after Green, 1979).

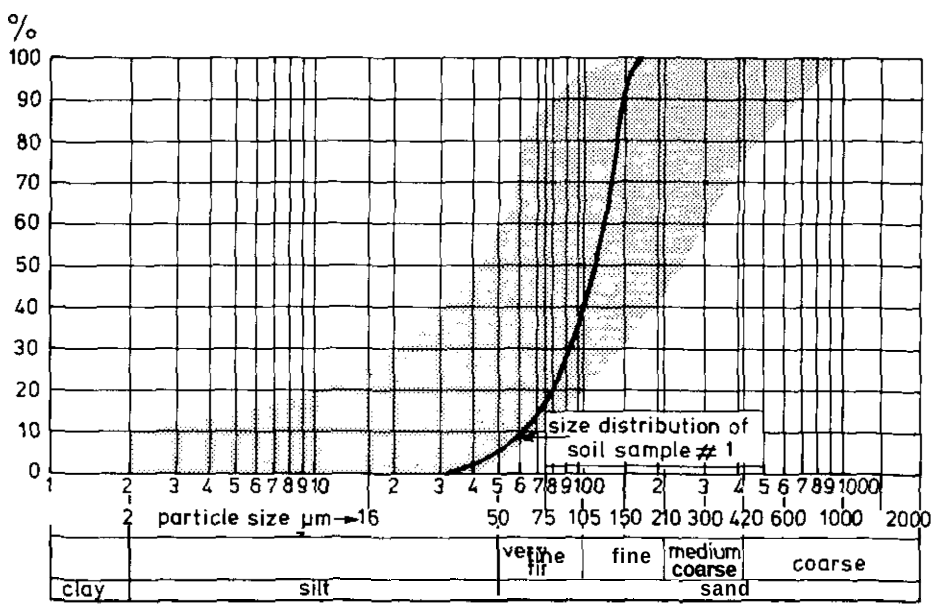

Fig. 2. Range of cumulative particle size distributions for 'problem' soils.

ly. On the other hand, a filter must create and maintain a relatively high permeable zone in the soil around the drain, improving the entry of water. Whereas fine-structured envelope materials would be preferred from the filtering point of view, voluminous, coarse-structured materials are more ideal for hydraulic purposes.

The process of mechanical clogging is complicated and as yet no satisfactory solution has been found. Research is aimed at increasing the knowledge of filter materials. Most of these experiments are of a qualitative character. However, in 1976, a research project was initiated in which a more fundamental approach was followed aiming at developing design criteria for envelope materials. The provisional results of this study are encouraging and have led to an expansion of the project, commissioned by the Dutch foundation 'KOMO' (Foundation for Examination, Research and Assessment of Materials and Constructions).

Developments in t e ıse of Envelope Materials in The Netherlands

Up until the late fifties, drainage systems were installed mainly by hand. Common envelopes were fibrous peat litter, heather combined with straw, straw alone and remnants of flax. Inorganic materials such as gravel (widely applied in the U.K.), lavalite and shells were also occasionally used. In the sixties, rigid smooth PVC-pipes were introduced in combination with synthetic envelopes like glass wool, rockwool and fibreglass sheets. With introduction of corrugated PVC-pipes (see Fig. 3) bands of strip-type envelope material were installed on the bottom and/or on top of the pipes. These bands or mats were either produced from pure organic materials, or from a mixture of organic and synthetic fibres, held together by a twine network. More advanced corrugated tubing was introduced in the early seventies.

Organic materials available today are made of coconut fibre, fibrous peat, cereal straw and flax. However, the durability of some of these is questionable, and the use › synthetic materials is now advocated for drainage purposes. Poor results with some of these materials in the past, has led to reticence in their wider application and usage, however, poor availability, price increases and problems encountered with the durability of organic envelopes has prompted the search for synthetic alternatives. Synthetic materials currently available are polypropylene, polystyrene grains, acrilic fibre mats, fibreglass sheets, typar, bidim and nylon 'socks'. In The Netherlands factory prewrapped pipes are installed almost exclusively nowadays, with coconut fibres (62%), peat-coconut fibre mixtures (30%) and synthetic materials (8%) taking the majority of the market.

Testing Envelope Materials

The never ending changes and developments of new envelope materials place a heavy burden on research institutes whose role is to assess the applicability of the new products. Under this pressure, laboratory testing is the only feasible method that can be used. Promising materials (see Fig. 4) are subjected to laboratory tests, mainly in sand tanks in which groundwater flow in the vicinity of a field drain is simulated. Such research can give consistent and replicable results if performed carefully. Information from such tests is not usually adequate to predict with complete confidence the performance of an envelope in field conditions. In fact, envelopes that prove to be promising in a laboratory test must be subjected to additional field tests to give more reliable information.

During the last fifteen years, a great number of studies on envelope materials have been reported from many institutes in The Netherlands. Although these studies gave a rough insight as to the general applicability of existing materials, as yet no positive criteria can be established to recommend certain precise soil conditions which require filter wrapped pipes. Therefore, a new approach with the following aims is needed.

1) A determination of the pore size distribution of envelope materials;

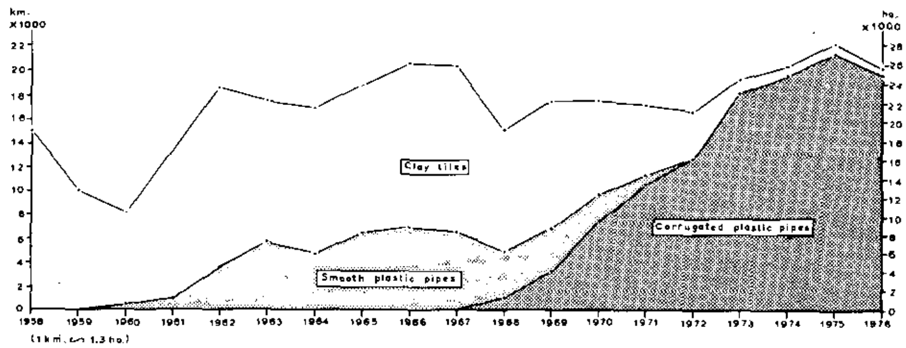

Fig. 3. Annual figures for the use of various types of pipes in The Netherlands (after Van Zeijts, 1979).

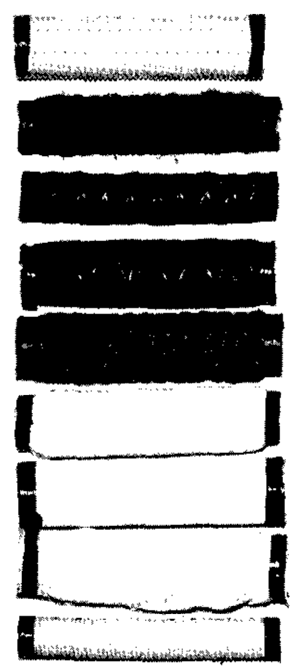

Fig. 4. Some examples of prewrapped drain pipes. Top to bottom: perforated plastic pipe without envelope; envelope coco fibre; peat-coco fibre; peat fibre; polypropylene fibre; polystyrene grains; nylon tricot; nylon cloth; perlon wire.

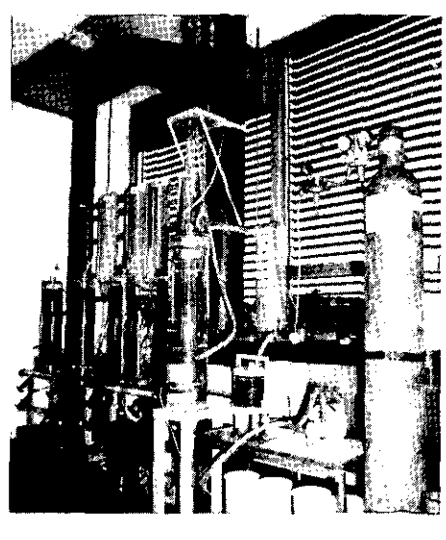

Fig. 5. General view of the laboratory

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2) The assessment of selective filtering *properties* of envelopes;
3) **A** study of the interactions between envelopes *and* soils.

For such a study, a special laboratory has been developed (see Figs. 5 and 6) consisting of four identical vertical plexiglass cylinders (see Fig. 7). Each test is replicated four times, thus at any one time all four cylinders contain identical envelope materials and identical soil samples. Each test lasts two weeks.

Insertion of the envelopes into the iders surrounded by soil is carried our using a strictly adhered to procedure, such care is critical to the-success of the test. The system is a closed circuit: and after it has been filled with demineralised water, no additional water is supplied. Bacterial activity is prevented by keeping the system strictly air-tight and anaerobic. To do this, nitrogen gas is fed in to either the overlow or the supply tank. Hence preventing oxidation of ferric compounds and the formation of 'ochre'. Water is released upwards and passes through sediment traps which collect all the soil material which has moved through the filter.

Piezometers are installed at ten different heights in the cylinder walls to obtain hydraulic head readings and the velocity of flow through each of the cylinders is recorded. A computer programme has been developed to process the data. After each test all data are fed in to the computer; which is presented graphically and numerically.

The soil material must be as close to field conditions as possible, yet at the same time be easily replicated for comparison in other tests. Soil fractions with only a small particle size range guarantee better replications, but do not resemble field conditions. As a compromise, a well-defined soil sample comprising of six fractions of the original soil material is manufactured (see Fig. **2).** Using this sample, the panicle size distribution strongly resembles that of field soils where drainage problems are known to occur.

Upon completion of a series of tests, particle size analysis of the soil fraction entrapped in the envelope and that washed through the filter are determined using an electronic particle counter. Furthermore, the form, roundness and angularity etc. of the particles are assessed using a 'Quantimet 720' image analysing computer.

This extensive experimental work only started in April 1981, so results are not yet available, however it is hoped that the data once accumulated, will help define the best filter material for a given particle size distribution.

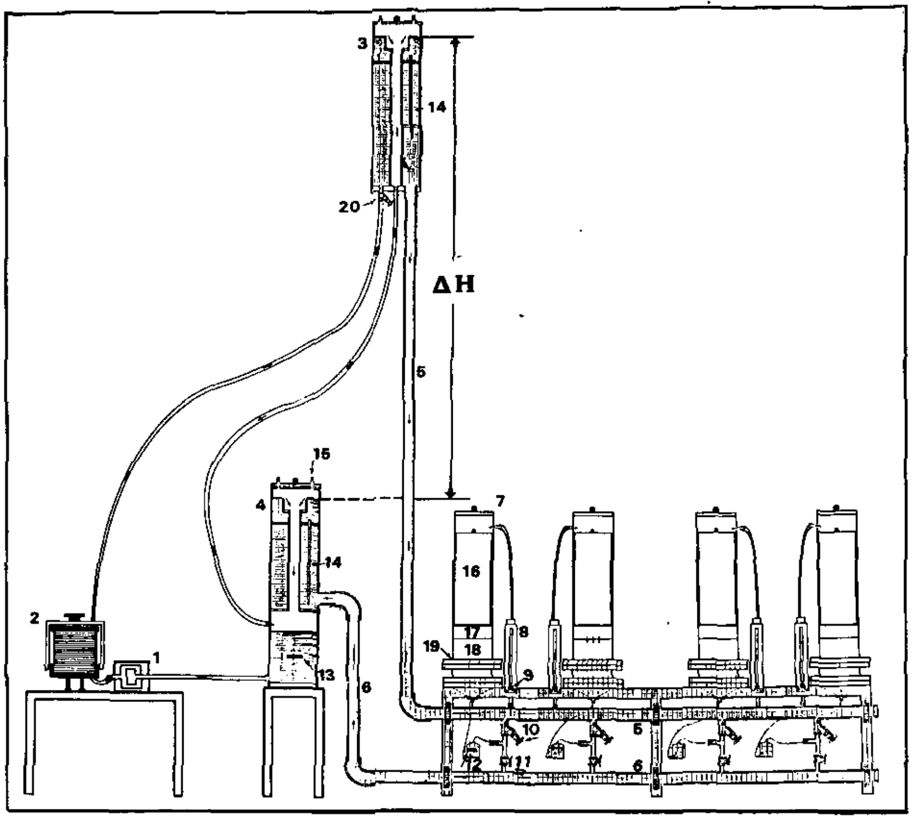

Fig. 6. New laboratory set-up designed for testing of drain pipe envelope materials. 1, centrifugal pump; 2, active-carbon water filter; 3, overflow tank; 4, constant head ond water supply tank; 5 water supply tube; 6, water discharge tube; 7, cylindrical plexiglass tank; 8, flowmeter; 9, needle valve; 10, 11, taps regulating flow direction; 12, sediment trap (10 litres); 13, water healing device (60 W); 14, rhermomerer; IS, supply valve nitrogen gas; 16, merol weights in PVC casing; 17 gravel bed diffuser (height 5 cm); 18, soil sample (height 10 cm); 19, envelope sample disc; 20, tap regulating pump flow; 21, piezometer (10for each cylinder).

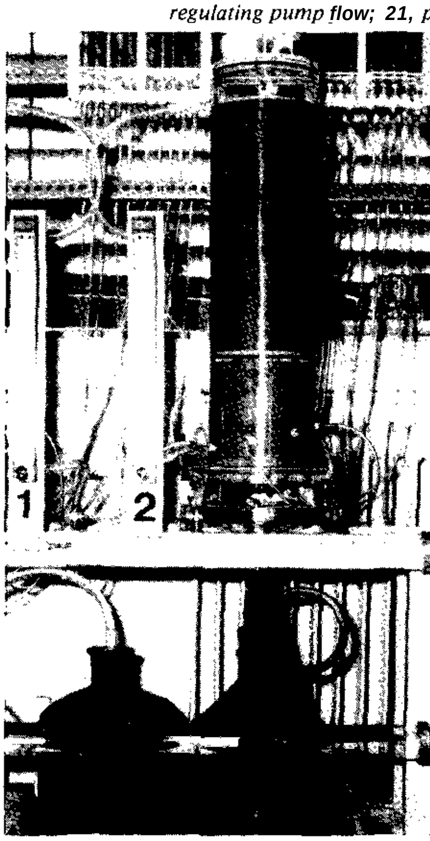

Fig. 7. Plexiglass measuring cylinder in detail.

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Regional Reports

HAYES PIPES FILTER WRAP FOR DIFFICULT SANDLAND OPERATIONS

The problems and solutions to the draining of running sand have always been of prime importance to the Yorkshire agricultural industry.

This was very evident by the large number of farmers and contractors who attended the Hayes Pipes (Ulster) Limited demonstration of their new filter wrapped P.V.C. drainage system.

The event was held on the farm of G. R. Morris and Sons, Hasholm Hall Farm, Holm-on-Spalding Moor, Yorkshire. on 25 acres of difficult sand land:

The scheme where the Hayes new filter was installed replaced a traditional drainage system which had completely failed within a period of only 18 months. In actual financial terms a loss of approximately £20,000.

Consultants for the scheme, R. M. English, Pocklington, York were present at the demonstration with illustrations outlining the previously drained acreage and-the new plan for the installation of the filter which had the full ministry approval for a re-grant aided scheme.

The site itself, was extremely wet with large areas of surface water.

The main drains had been initially laid and when the contractor Jackson Drainage Limited of Bubwith began to instal the laterals with 60 mm P.V.C. wrapped pipe, at 17 metre spaces, surface waters began to disappear.

Backfill was only used when a lateral broke through the old system to ensure a fast passage into the wrapped pipe.

To highlight the full qualities of the new system to the 500 farmers and contractors who attended, a section of wrapping was opened on one of the laterals and a portion cut out of the pipe. This clearly confirmed that the pipe was running extremely well with no evidence of silt present.

Mr. Derek Holman, the consultant with R. & M. English and Sons who designed the scheme said that he was both impressed by the performance of the filter wrap and its inertness which guaranteed an unlimited life expectancy when buried underground.

Mr. Roy Butterworth, Sales Manager of Hayes Pipes English Division summed up the day's event "This new filter wrap system offers so many more advantages than conventional wraps".

"It is made from 100% polyester, is run free and totally inert. The coils are still light, compact and dust free. However, the most important point, as we have demonstrated here today is that it is a most effective method of combating running sand."

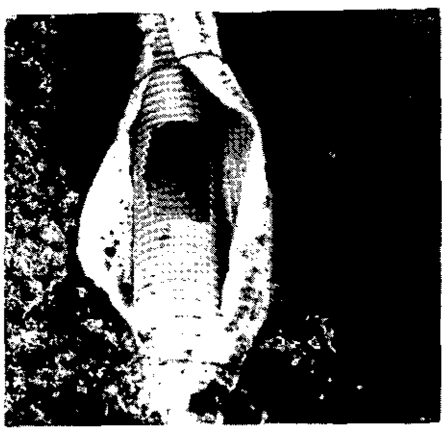
When asked about costs Mr. Butterworth replied that he believed the Hayes new filter wrapped system was one of the cheapest filters on the market today.

He concluded by saying:— "Our three years research and development have been greatly justified according to todav's response".

Hayes Pipes (Ulster) Limited manufacture their new filter wrapped P.V.C. System on 60 mm, 80 mm, 100 mm and 170 mm diameters.

A general view of the installation work.

Mr. Tom Simpson, Sales and Marketing Director of Hayes Pipes (Ulster) Ltd., discussing technical details of the new filter wrap with on interestedformer and Mr. Derek Holman of R. & M. English and Sons.



An exposed section of the pipe showing little evidence of sill.

Mr. Roy Butterworth, Soles Manager, Hayes Pipes, English Division, gets a word of praise on the company's newfilter wrap system from Mr. Fred Lighrowler, a drainage contractor, Howden, Humberside.

NORTHUMBERLAND DRAINAGE VISIT

Last May the Association organised a members visit to look at two Field drainage experimental sites in Northumberland. These offered contrasting results and gave plenty of food for thought. Here the two research scientists closely involved in the work outline the results and their implications for land drainage in Northumberland.

The Association would like to thank Lord Joicey and Professor G. R. Dicksen for hosting such an interesting visit.

THE COCKLE PARK DRAINAGE EXPERIMENT

Adrian Armstrong, FDEU, MAFF

In 1977 the International Drainage Demonstration was held at Cockle Park, Northumberland, and it was clear then that there was a considerable controversy over the correct technique for draining the soils of the farm, which are typical of large areas of the lowlands of North-east England. Consequently the work of the demonstration was followed up by a formal experiment on another part of the farm with similar soils. The aim of this experiment is to examine in some detail the effects of different drainage treatments, both in hydrologic terms, and also in terms of crop yields. Once the hydrologic instrumentation had been established, it also became possible to monitor the effects of drainage treatments on water quality, particularly the loss of Nitrate Nitrogen.

Tests had indicated that the soil was potentially suitable for moling, even though moling is rarely practised in the locality. In addition, excavations had shown remnants of 20 year old mole channels, and it was subsequently established that the same field had been used for a successful mole drainage demonstration in 1925! The subsoil particle size distribution of the field is 35% clay, 38% sand, 28% silt, the bulk density 1.7g/cc, and the measured hydraulic conductivity 3mm/day.

Detailed soil investigations during the winter of 1977/78 showed that the site was uniform in hydrology and soil fertility, so the experiment was installed in 1978 (see site plan) with three drainage treatments in threefold replication:

Control (no drains)
Drains at 12m
Drains at 40m with permeable fill and moling.

The experimental layout also included interplot barriers, and the facility to collect water moving across the surface and through the plough layer. The site was moled in August 1978 at a moisture content of 23%, almost exactly at the plastic limit, and good mole channels were formed.

Monitoring

Monitoring during the winter of 1978/9 showed firstly that a late autumn cultivation had created a smeared layer at around 25cm depth so that water was unable to move down the profile, and secondly that moles had infilled within 6 months of being drawn. Consequently the site was remoled in June 1979, through a growing crop of Spring Barley, at a moisture content of 27%, once again within the plastic range of the soil. This moling operation did not depress the grain yield, which averaged 5 tonne/ha. However no significant differences between grain yields from different drainage treatments were recorded. The site was subsoiled after harvest in October 1979, subsequently ploughed, but left fallow.

the topsoil, moving downslope under the influence of gravity, and that drains without moling serve only to intercept this flow. Only moles lower the water table within the soil. These results also show that the undrained plots discharge as much Nitrate Nitrogen by surface flow as do the drained plots by the pipe system. There is thus no evidence that drainage increases the total loss of Nitrates, merely altering its route to the outfall.

Poaching

In Summer 1980 the site was put into grass, to conform with the general management of the farm. Grazing in a wet autumn led to poaching of the surface, which was most marked on the undrained plots, and least on the moled plots. Consequently large volumes of surface runoff were generated by the control and close spaced drained plots, and only the mole drained plots held the water table below the surface to permit significant infiltration. As a result mole drainage plots virtually eliminated the surface runoff component. As is anticipated under grass, the

	Plot 4 moles & drains	*Plot 5 drains only*	*Plot 6 control*
Total drainflow mm	223	229	
Total surface flow mm	48	53	224
Nitrate loss (kg/ha)	17	20	17
Mean Watertable (cm)	50	25	25

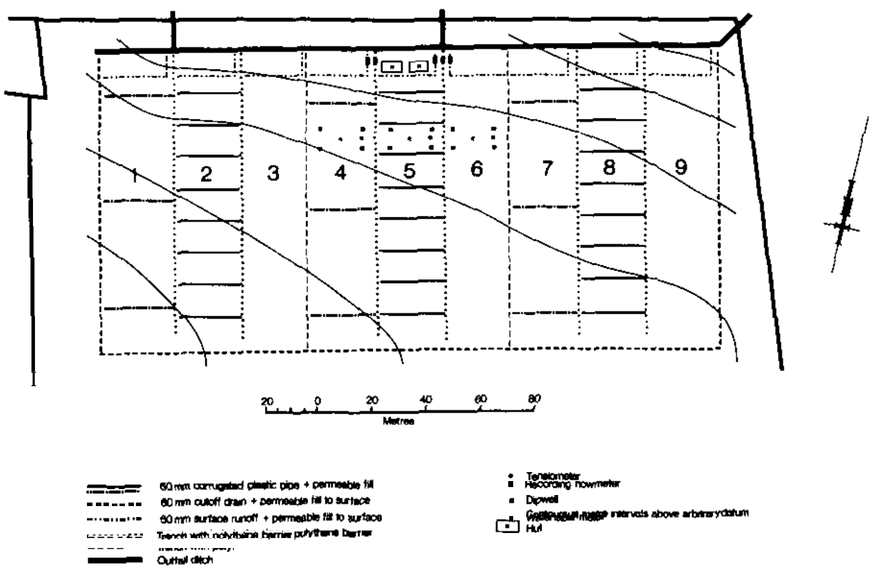
Table 1

Detailed hydrologic monitoring of the winter of 1979/80 is summarised in table 1, which shows that mole drainage alone achieved a significant benefit in terms of water table control. It is clear that the natural soil water movement on site is through

Nitrate losses were very low, being no greater than 1kg/ha on any of the plots.

The moles were still effective in 1981, having lasted two years, and have an estimated life of at least two more years.

Cockle Park
Experimental Site



Implications

On this widespread soil, it has been shown that mole drainage can be successful, and that it offers very significant advantages over close spaced drains. Although they do appear to reduce the poaching risk, close spaced drains offer virtually no water table control when compared to the undrained area. If the period for moling success can be more closely defined, it is clear that mole drainage should be the preferred technique on these soils. More research into the correct timing of moling is called for, but current data suggest that the short period between harvest and autumn ploughing is inappropriate, and that moling through a spring sown crop is feasible without loss of grain yield. However in the mixed farming operations common on this soil type other opportunities for moling present themselves and should be utilized.

THE NEW ETAL DRAINAGE EXPERIMENT

S. Lawrence. Ford & Etal Estates Contracts

New drainage methods are establishing slowly in Northumberland owing to a deep controversy between (a) economy in new designs and (b) traditional sound practice, based on 150 years of experience. Our firm has often found that despite their age, traditional existing systems are important and useful in the design of new schemes.

At New Etal, we have selected a field typical of North Northumberland, farmed under the same mixed rotation as the surrounding area, containing two existing drain systems. We hope to establish what improvements will be achieved by different drainage methods, and also learn more about the mechanism of improvement. Two methods are tried:—

(1) A new drain system typical in our area; at **4** ft. depth and **16** yard spacing, obliquely across the field slope, using natural backfill; all existing drains connected in by gravel; cost **£450 – £500** per acre 'drained' plots:

(2) Shallow drains with gravel fill, at **2' 6**" depth and **40** yard spacing, running across-slope, assisted by subsoiling downslope (using winged subsoilers set at 18" depth, preceded by shallower tines); cost **£240–£290** per acre 'subsoiled' plots. These are compared with 'control' plots, which have only the existing systems — "shoes" at **2** ft. depth and 8 yard spacing, and 1½" diameter tiles at 3 ft. depth and **6%** yard spacing, all running down the slope — linked to a new boundary main which collects their discharge for recording.

The three drainage treatments are replicated three times in a "randomised block" layout. Subsoils in the three blocks are predominantly a heavy sandy clay, a sandy clay to 2' – 3' depth overlying sands and mixed sands and clays.

To date hydrological performance, soil conditions and crop response have been recorded.

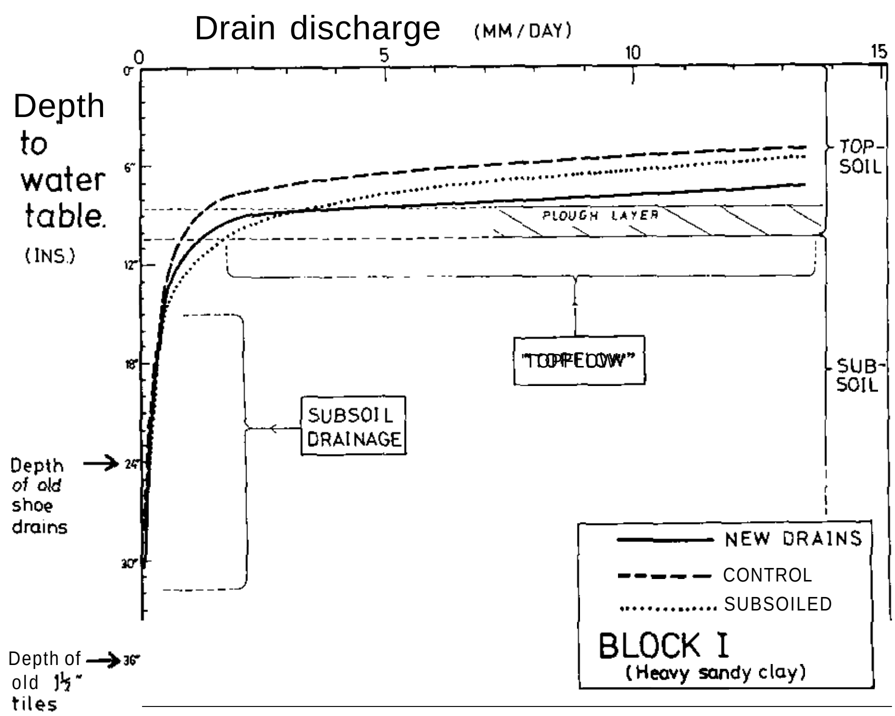


Fig 1. Drain discharge

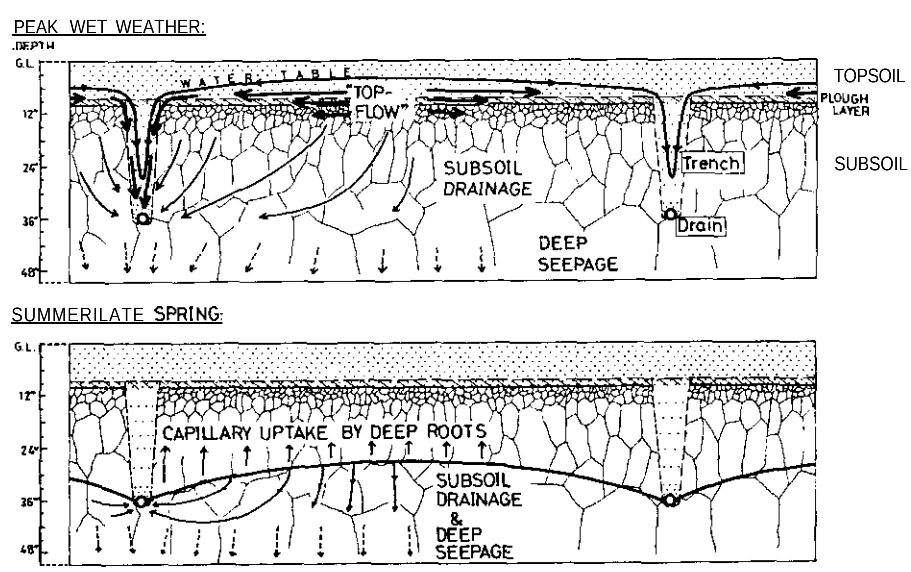


Fig 2. Mechanism of Drainage
(i) Topflow
(ii) Subsoil drainage

Regional Reports

1. Hydrological Results

Water tables midway between drains (6 dipwells per plot) and drain discharge have been recorded every 2 – 12 days for all plots since March 1980. Continuous "V-notch weir" discharge recorders are now installed.

The existing drain systems are still functional. They prevent serious topsoil waterlogging and discharge heavy rainfall over 2 – 3 days.

New "16-yard" drains were soon effective after installation in sand underlying clay (Block II), but required 6 – 10 months to significantly affect water tables in heavy clay areas, apparently doing so by (i) increased subsoil cracking and permeability and (ii) intercepting flow downslope in shallower soil layers.

Subsoiling had little direct drainage effect but increased deep soil structure, crop rooting and water uptake. Discharge from the new shallow drains was insignificant.

Two overall drainage mechanisms were indicated (Figs. 1&2):— (1) short-term . *'topflow',* horizontally through the top 12" – 18" of soil, and (2) 'text-book' drainage, slowly creating a drained buffer-zone (or "emptied sponge") of soil, 10" – 3" deep, during dry periods.

2. Soil Conditions

The typical *soil profile* is consistent with the observed water table and drain discharge behaviour (e.g. Fig. 1):— structure well developed to around 15" depth, although some smearing and compaction below plough depth; prismatic structure below 15", getting progressively larger (i.e; cracks further apart) with depth.

Trafficability tested in spring using a tractor with a continuous wheel sinkage recorder, revealed that sinkage was unaffected by drainage treatments and only slightly affected by soil textures. The tractor "floated" on a 2" – 3" thick "skin" formed by surface drying, above soil still near field capacity. Compaction below the ruts has not yet been measured directly.

IMPLICATIONS

1. Examination of the *existing* drains and soil profile in a field are essential — to DIAGNOSE the problem before any investment in new drainage or deep cultivations.
2. The condition of the top 12" – 18" of soil — the *'topflow* zone' — is vital. It depends on: (1) good long-term drainage at depth, (2) descent of crop roots to dry the subsoil in summer, (3) preventing/remedying compaction.
3. Old drain systems are frequently *still* satisfactory, given careful soil management. Those that are beginning to fail can be a "bonus" for any new scheme, and should anyway be connected in.
4. A new drainage scheme does not exonorate the farmer from careful soil management.
5. Deep shattering with winged *subsoilers* above a functional existing drain sytem does not require new drains with gravel fill, because no lasting channels are formed. Any shallow existing drains must be located and avoided.

SAWMA Events

LAND RECLAMATION FOR FORESTRY

Bramshill Forest in Hants. and Berks. is the site of land reclamation research being carried out by the Forestry Commission from their nearby Alice Holt Research Station. Over 50 SAWMA members were treated to an excellent day, this June looking at two contrasting gravel excavation sites and hearing about the Commission's policy for their restoration back to forestry.

The first site on a permeable quarry floor and was being exploited by R.M.C./Hall Aggregates, the second with an impervious subsoil, was an E.C.C. (Quarries) restoration site on Oxford clay. As a contrast, members saw the old methods of restoration after gravel excavation with trees planted direct into very compact spoils. Indeed, it was difficult to imagine, when attempting to open up a profile pit, how plant roots could exploit such a hostile growth medium.

David Fourt and Bill Binns outlined their modern methods for cultivation which stemmed largely from discussions with Gordon Spoor at the N.C.A.E. and are based on the principals of loosening soil used in agriculture.

Soil loosening however is only one solution to the establishment of a satisfactory tree crop, in many instances, drainage, particularly on the heavy clay spoil, is most necessary. Wherever the ground has a slope of less than 5°, current Forestry Commission policy is to establish a series of ridges of some 30m width and 1.5m height which, with the incorporation of ditches in the hollows, helps provide a well-drained rooting environment.

Soil cultivation at right angles to

Fig. 1. Restored land in 30 m wide ridges.

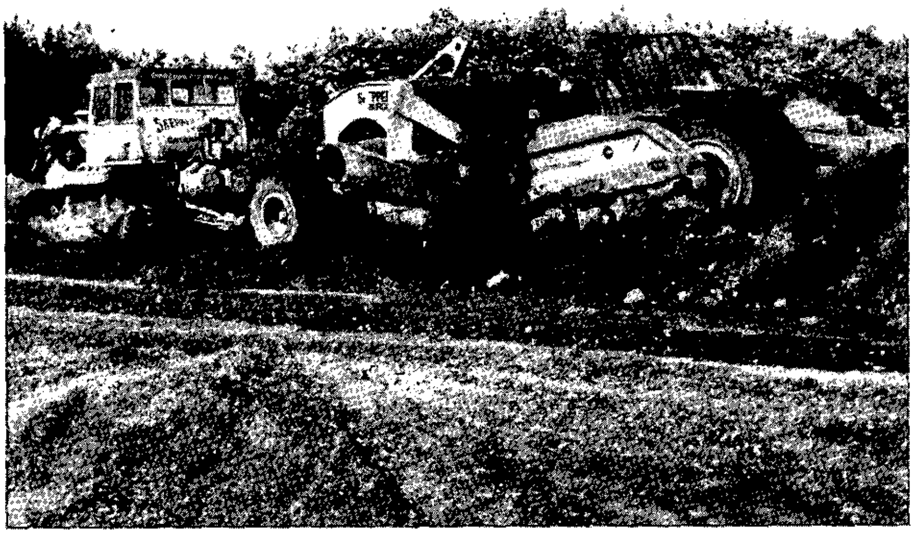


Fig. 2. Removal of topsoil prior ro grovel extraction.

the direction of these ridges, on slopes of 1 in 10, provides loosening to over half a metre in depth using an impressive winged subsoiler.

A very healthy relationship has been developed between the Forestry Commission and those extracting gravel at the two sites and members saw extraction and restoration occuring hand in hand with only some 50m separating the two operations. This means that soil is continuously being removed from one area and then placed adjacent to the site to form ridges, which are then cultivated. This does away with the need for storing top soil material for long periods of time and helps prevent deterioration of the spoil; it also benefits the extracting company who do not need a second operation to restore the land back to a productive state.

Our thanks are expressed to the staff at Alice Holt Lodge Research Station for making us so welcome, their most healthy and constructive attitudes towards land restoration were a lesson to us all.

Advertisers Index

Vq-2

Event Diary

1981

10th November 1981	Soil Management for Cereal Production Conference — I.A.E. — St. Ives.
17th November 1981	"Low Ground Pressure Vehicles" — A.D.A.S. — Essex.
25th November 1981	Low Ground Pressure Vehicle Demonstration — A.D.A.S. & L.E.A. — Worcester College of Agriculture — Hindlip.
3rd December 1981	"Soil and Crop Loss — A Review of Erosion Control Methods" — R.A.S.E./S.A.W.M.A. Conference — National Agricultural Centre, Stoneleigh.
14th – 15th December 1981	Irrigation Scheduling Conference — American Society of Agricultural Engineers — Chicago.
15th – 17th December 1981	Irrigation Principles & Practices Short Course — Organised by N.C.A.E./ S.A.W.M.A./U.K.I.A. — Venue N.C.A.E.
15th – 18th December 1981	Drainage Short Course organised by S.A.W.M.A./N.C.A.E. — Venue N.C.A.E.

1982

5th – 7th January 1982	Remote Sensing in Natural Resource Surveying — Course N.C.A.E. Silsoe, Bedfordshire.
27th & 28th January 1982	"Drainage Workship" — Organised by S.A.W.M.A. — Novotel, Long Eaton, Nottinghamshire.
9th – 11th February 1982	Irrigation Workshop — Organised by the U.K.I.A. — N.C.A.E. Silsoe, Bedfordshire.
16th – 19th February 1982	"Soil Management Course" — Organised by S.A.W.M.A./N.C.A.E. and A.D.A.S. — Venue N.C.A.E.
6th – 8th April 1982	Soils, Pests and Diseases — B.S.S.S. — Joint meeting in London with British Society for Plant Pathology.
28th – 29th April 1982	Spring Potato '82 — Organised by the R.A.S.E. — National Agricultural Centre, Stoneleigh.
9th – 10th June 1982	Breakcrops '82 — Organised bv the R.A.S.E. — Bishoo Burton. Beverley, Nr. Humberside.
5th – 8th July 1982	Royal Show — National Agricultural Centre, Stoneleigh.
7th – 8th July 1982	A.D.A. National Demonstration Aquatic Weed Control Bristol.
22nd – 28th August 1982	9th International Colloquium of Plant Nutrition — Warwick University, Warwickshire.
22nd – 28th August 1982	Weathering, Soils and the Sedimentary Cycle — Symposium sponsored by the Canadian Society of Soil Science — McMaster University, Ontario, Canada.
7th – 9th September 1982	Crop Establishment Meeting — NCAE, Beds. organised by Assoc. Appl. Biologists and N.C.A.E.
13th – 16th September 1982	Autumn Meeting and A.G.M. — B.S.S.S. — Aberystwyth
October 1982	Autumn Cultivations — R.A.S.E.
4th – 9th October 1982	Polders of the World — Symposium and Exhibition — The Netherlands.
13th – 14th December 1982	4th National Drainage Symposium — Chicago, Illinois.

1983

April 1983	Soil Water — B.S.S.S.
4th – 8th July 1983	Biological Processes and Soil Fertility — Meeting of the B.S.S.S. with Commissions III and IV of the International Societv of Soil Science, at Reading University.
LATE ENTRY — 19th November 1981	Soil Management Conference, Shire Hall, Hereford. Organised by ADAS Hereford.

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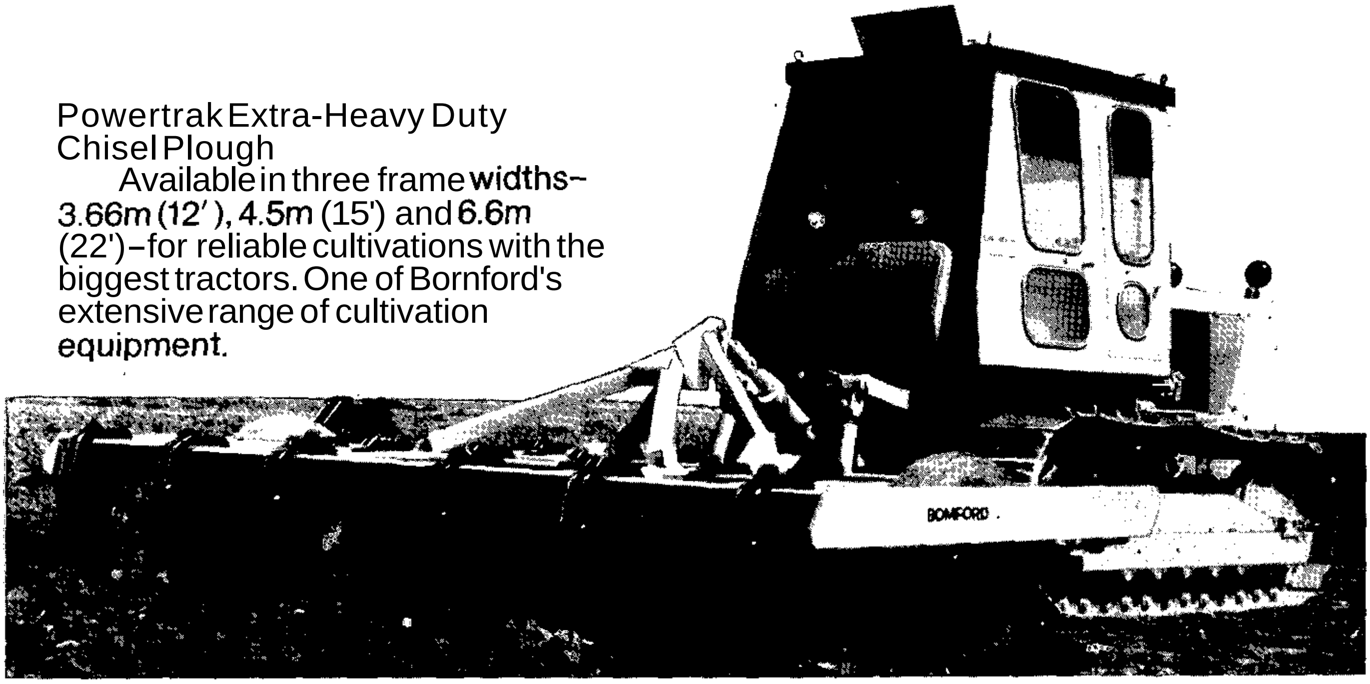

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