SOIL and water

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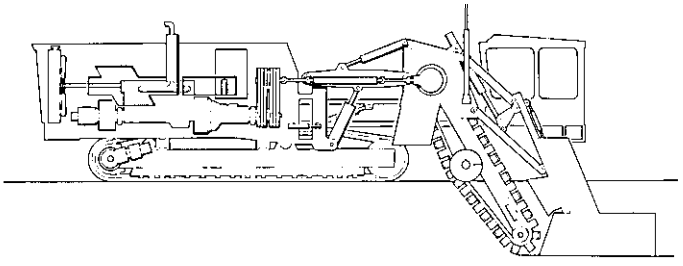
The best in earth

Inter-Drain

Trenchers

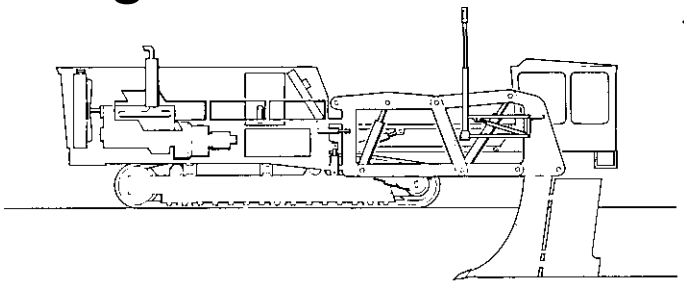


The Inter-Drain trencher concept has proven its qualities and is an example in modern day draining
The whole range has the same rugged design principles providing clean lines and maximum accessibility and is constructed to perform in the most arduous conditions
It offers models from 120 Hp - 4W Hp
Components used are all of the highest quality and of ample capacity to ensure long life, minimum wear and tear and maximum output.
Special attention is paid to achieve [illegible] and automatic [illegible] can be installed.
It is our principle to produce, develop and service machines of the very best quality, tailored for the needs of 'today's contractors'.

Standard features are:

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

Ploughs



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

Standard features are:

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

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

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COMMENT

National loss makers

The reduction in grant aid for land drainage announced by the Minister of Agriculture is unfortunately timed as far as many drainage contractors are concerned. Contracts for installation work were being placed at a lower than usual rate throughout last year, and the announcement of the drop in grant aid has dashed any hopes of an early recovery in the rate at which drainage is carried out.

It is not the concern of an organisation such as SAWMA whether drainage is grant aided or not, but it is of great concern to us that poorly drained land in Britain should not remain so when piped drains could improve its productivity. It should be of great concern to all tax payers and purchasers of food.

Where assessments have been made as to the economic value of new under-drainage schemes, it has frequently been shown that the cost of the work can be recovered within less than three years — sometimes in one year — through improved crop yields, without taking account of the enhanced value of the land. It would be an absurd position for the agriculture of this country if drainage of land in obvious need of it was not economic at current crop values, when we know that a good standard of drainage is vital to reach satisfactory yield levels at acceptable costs. It should be noted that drainage now commonly costs something in the region of one sixth of the average value of agricultural land, yet it can multiply profits, reduce input costs and increase land values. Whatever the level of grant, drainage is good value where it is needed when good crops are saleable at fair prices.

Overall, a more serious and costly situation for British agriculture as a whole is postulated by the discouragement of straw burning. The reductions in cereal yields that have been noted in many experiments where straw incorporation replaced straw burning gives eround for serious concern when considered as a cost on a national scale, which it must be

Last year's cereal harvests are likely to be misleading if we conclude from it that there is no need for concern at the increase in cereal growing costs resulting from the widespread abandonment of burning.

For that reason, we do not apologise for returning to the subject of straw incorporation once more in this issue of Soil and Water. Research on various aspects of the subject is providing useful, thought-provoking and practical information of great value, and we expect to publish more about it during the year, as we also will on the broader subject of nitrogen utilisation and losses.

The scientific assessments are only part of the picture, of course. Last year's typical British compromise of a ban on burning at week ends has reminded many of us that there are important practical considerations, and provided a foretaste of unpleasant problems with quantities of wet straw if there should ever be a total ban on burning.

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College and consultants offer irrigation service

IRRIGATION scheduling based on soil moisture measurements and computer forecasts of local crop water requirements are among the services offered to farmers by Irrigation Management Services, a new consultancy group formed by Atkins Land and Water Management, of Girton Road, Cambridge CB3 OLN, and Silsoe College, Silsoe, Bedford MK45 4DT.

In addition to scheduling and planning, IMS offers assistance with day to day operation and management of irrigation, also checks on equipment operation.

A first step in the IMS service is a rapid, low cost survey to establish each farm's available water capacity. On completion of this survey, access tubes for neutron probes to sense changes in soil moisture content are installed on representative sites. A computer is used to record local weather and forecast crop water needs between readings from the probes at weekly or fortnightly intervals.

Cost of an IMS survey is normally between £2 and £4 per acre: a normal charge for scheduling, for 30 acres served by one set of neutron probe access tubes, is £250 per year.

IMS may be contacted at either Atkins Land and Water Management or at Silsoe College.

Governor retires

Prof J. S. Hall retired as Chairman of the Scottish Committee of the Governing Body of the British Society for Research in Agricultural Engineering on 14 November. Prof Hall, retired Principal of the West of Scotland Agricultural College, has been a member of the Governing Body of BSRAE for 21 years, and Chairman of the Scottish Committee, which is responsible for the Scottish Institute of Agricultural Engineering, for 10 years.

Database on science

A national computer database, to provide up-to-date information on the skills, knowledge and facilities of British universities and polytechnics, is to be established by Cartermill Publishing Ltd and backed by the Longman Group, Electra Investment Trust and the Scottish Development Agency.

Life sciences, physical sciences, medicine, biotechnology, electronics and enginecring are among the subjects to be covered.

Cartermill Publishing, based at the Technology Centre at St Andrews University, Fife, Scotland, plans to make the database available to industrial users within a vear but work will begin immediately on gathering the data.

pH meters

Hand-held pH meters, for use either with remote or clip-on electrodes, and with a claimed resolution of 0.01pH units have been added to the range produced by Coruing Ltd, Halstead, Essex. The meters can also be used for ion-selective electrode work. They have a range of 1999mV with a claimed resolution of 1mV.

Filter sales

Big 'O' Filters UK, of Redditch, Worcs, have announced the appointment of Mr John Brinkman, a graduate from the University of Western Ontario, Canada. as general sales manager.

RESEARCH

Summaries *from* the *1983 Annual* Report of *the Agricultural and Food* Research Council's Letcornbe *Laboratory.*

Crop growth in relation to the environment, especially soil conditions, is the central theme of research described in the Council's Letcombe Laboratory Annual Report for 1983.

This will be the last Annual Report from the Laboratory which is to be closed at the end of March 1985 as part of the Council's Corporate Plan for food and agricultural research. Although some of the research programme will be merged with programmes at Rothamsted and Long Ashton Research Station, the dispersal of the research team is an inevitable consequence of the closure. Only about a quarter of the staff will remain with the AFRC.

Long-term tillage comparison

Detailed measurements of crop growth, soil properties. soil biology and nitrogen utilisation were made on one of the long-term tillage experiments to identify any differences that had developed after 10 years of either ploughing, shallow tillage or direct drilling. In this weakly-structured silt loam, differences were found in soil structure, aggregate stability, organic matter content and earthworm populations.

However, as in recent years, grain yields were similar for all tillage treatments with about 10 tonnes/hectare of winter barley in 1982183.

Long-term drainageicultivation experiment

In a long-term investigation of drainage requirements for crops sown after ploughing or simplifed tillage, the 1982/83 crop of winter oats was sown late in a wet autumn and there was a large tillage/drainage interaction. Yield on undrained land was much less than with drainage, especially after direct drilling: even on ploughed land drainage increased yield by about 1 tonne/hectare.

More nitrogen was mineralised in the drained than the undrained soil. Losses of dissolved nitrate in drainage water were again greater from ploughed than from direct-drilled land, but gaseous losses due to denitrification were least from the drained. ploughed soil.

Continued on p8 col *1*

Plough makers extend range

A FULL RANGE of tillage equipment now available from plough manufacturers Dowdeswell Engineering Co Ltd was seen for the first time at last December's Royal Smithfield Show.

The latest additions to the company's range, which has already been extended during the past year by the acquisition of Pettit cultivation equipment and the introduction of a range of furrow presses, are a series of straw choppers, power harrow and rotary cultivators manufactured by the Italian company Muratori.

Completely new to Britain, the Muratori equipment includes straw choppers with working widths up to 3m, rotary cultivators with widths up to 2.5m and power harrows up to 3m.

Improvements

In addition to the new range, there were many improvements and additions to existing Dowdeswell equipment.

The new Dowdeswell-Pettit 84 Series heavy duty single-offset disc harrows are designed for use in primary cultivations. With a weight per disc of 130kg, the 84 Series has been produced as a straight-forward implement with sufficient ground penetration to incorporate heavy straw crops.

Discs with a single offset have the advantage of leaving a level tilth. The new 84 Series uses different disc spacing on the front and rear gangs to provide the best cultivating and incoroorating action. The front gang has a disc spacing of 270mm (10½in) to do the primary 'ripping-up' after harvest. The rear discs, spaced at 230mm (9in), carry out the finer chopping. The range is planned to include models from 3.65m (12ft) to 6.4m (21ft).

The company has also introduced an improved version of the largest model in the Dowdeswell-Pettit MM Series trailed offset discs. The 4.5m (15ft) hydraulically folding version has been re-engineered to give improved folding with a better hinge mechanism. With a weight of 72kg per disc, this model is suitable for both primary and secondary cultivations.

Improvements to Dowdeswell's reversible ploughs include a brand-new slatted mouldboard, designed for sticky land.

An improved version of the DPXB mounted revernble plough incorporated a new offset assembly allowing spannerless adjustment of sideshift and beam angle. Hydraulic front furrow width adjustment is now available as an option.

Hydraulic front furrow adjustment is also now available as an option on the new type DP7 fully-mounted reversible ploughs and on the DP6 semi-mounted models.

A further addition to Dowdeswell plough options is a new design of straw board with greater curvature for an improved cutting action. The forging also has a concave cross-section, which helps prevent trash rising over the top of the boards.

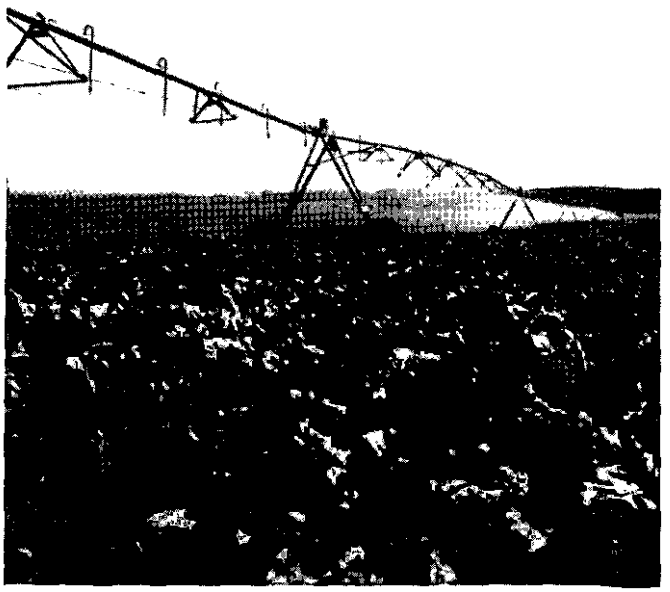
Measuring pH

A NEW Philips portable pH and mV meter, the PW 9419110 produced by Pye Unicam Ltd, Cambridge. is claimed to make accurate measurements in the field.

The new kit includes hand-held battery operated pH/mV meter, (providing a pH reading to 0.01 unit between 0-14pH or redox potential values in the range ±1999mV), robust epoxy-bodied combination electrode. buffer sachets and bottles and batteries.

160 acres at a time

This *1,435ft* long Valley Cenfre Pivot, large scale, *irrigation* system at Apley Head Farm, *Worksop*, *covers* a total of 160 acres of sugar beef and spring barley in adjoining fields. *Install*led by E. Rand & *Sons* (Engineers) Ltd., of Wetherden, *Stow*marker, Suffolk, *the* system *consists* of *10 spans* each *sup*ported by purpose-built towers containing *the* drive *units* which are confrolled from the *centre pivot*. "An average *17 per* cent increase in yield on sugar beef compared wifh rain gun irrigation; with a best recorded 23 per cenf over the *past three* season", says farmer ***Mr*** Glassford.



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Infiltration in Australia

PROBLEMS affecting cultivation land in Australia stem from moisture deficiency followed by wind erosion, or impermeability caused by inpenetrable barriers such as hard pans.

The conventional plough may break up an impenetrable harrier but cannot guarantee to prevent its speedy reform, and once the soil is broken, drying is enhanced and wind erosion can take over.

A solution to the Australian problem is to concentrate on maintaining and developing the root system to prevent erosion and encourage growth through pans to prevent the barrier reforming and permitting water to infiltrate. Roots reduce the collapsing and sealing effects of soil and create an aggregated structure.

A relatively new piece of machinery designed to reduce these problems is the Agrowplow, produced by Agrowplow PTY Ltd, New South Wales, Australia. It uses a low-angle digging profile with round-nosed shanks and rounded, contour-shape digging tools to dig deep, loosening and aerating the soil and leaving a series of undulating valleys deep in the soil — leaving the surface largely undisturbed.

By using the Agrowplow during autumn and spring, in pasture or previous crop residue, it is claimed that existing root systems are retained, and as moisture is mostly available during this period, quick root growth results.

Agrowplow claim cereal crops are showing consistently better than 50 per cent increases in yields over those produced conventionally. Farmers are reported to have stated that they have recovered the cost of an Agrowplow within the first year of its use.

Water-analysis expertise

THE scientific instrument company of Philips — Pye Unicam Ltd of Cambridge, provide equipment for monitoring water purity in research, development, utilisation and conservation aspects of the water industry and associated concerns.

The PU 8600 series of single-beam spectrophotometers are microprocessor controlled instruments for determination of concentrations of both organic and some inorganic pollutant substances. The air-path PV 8250 and vacuum-path PV 8350 instruments are claimed to be capable of determining up to 40 elements in one sample in one function.

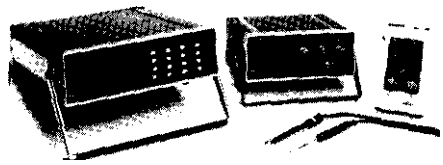
For tracing oil and pesticide contamination of high viscosity, the PU 4000 liquid chromatography series is capable of detecting their high molecular weight.

A new family, headed by the PW 9527,

New journal

'Research and Development in Agriculture' published by Longmans Group Ltd, Harlow, Essex, aims t< report on potential and actual practical projects connected with all aspects of agriculture.

An annual subscription of £40 pays for three issues released for April, July and October.



Conductivity meters from *Pye* Unicorn *Ltd* of Cambridge, measure *the complete* range of *electrolytic conductivity*.

the first microprocessor conductivity meter, measures over the complete range of electrolytic conductivities from pure water to concentrated acids, salts and alkalines.

Drainage quotation programme

DRAINAGE quotations can be produced within minutes, it is claimed, with a new programme designed specifically for drainage contractors and now available from Multiloader Ltd, 2nd Floor. Franklin House, Blueschool Street, Hereford HR1 2AZ. The quotations programme is included in a complete package for contractors, including computer, printer, data base and programmes for word processing and accounts.

Training in the use of the computer and the programmes is included in the price of approximately £2,500 for the complete package.

SAWMA pollution conference

A PROGRAMME is now being prepared for a SAWMA conference covering the most important forms of pollution of farm land. It was originally intended that this should take place in the spring of this year, but pressure of other work has caused the management committee to postpone the date until the autumn.

Drainage of saline marsh soil

by M. G. Jarvis, Soil Survey of England and Wales

IN 1953 large areas of coastal marshland in Eastern England were flooded by the sea. This disastrous event was followed by major works to strengthen coastal defences and improve the arterial drainage of the marshes. Then in the 60s and 70s, with better protection and the installation of in-field drainage, much of the permanent grassland was ploughed up and arable cropping commenced. The drastic and largely unforeseen results of this change in land use were the subject of a seminar entitled Drainage and related *problems* on saline clay marsh soils held by the MAFF Field Drainage Experimental Unit at Trumpington, Cambridge on 29 October 1984. About 80 people attended the meeting including advisors, research scientists and farmers to hear staff from the Unit, ADAS Soil Scientists and the Soil Survey of England and Wales and Southampton University report on the present condition of the marshes and the efforts being made to understand and solve the problems of drain blockage, mole channel collapse and the surface ponding of water.

The background to the problem was outlined by Mr John Rands (FDEU). Participants were told that the first difficulties came to light in 1969 on marshland in Essex. The very wet autumn and winter of 1968-69 had delayed the harvest and made subsequent cultivation and sowing extremely difficult not only on the marshes but over much of England, and the concern felt by the farming community at that timeculminated in the publication of the Strutt report. Some of the marshland remained fallow through 1969 and in an attempt to improve the drainage, the land was remoled. But the autumn of that year was also very wet, so waterlogging was again serious on the marshes and investigation showed that the recently drawn moles had collapsed.

The following winters were drier and the symptoms did not reappear until the late 70s, when they became particularly evident in north Kent. In some affected fields there was serious crop loss because of waterlogging and surface ponding. Since then, FDEU assisted by ADAS and the Soil Survey have been attempting to unravel the reasons for the drainage failures on the marshes.

The principal reason for the drain blockage is clay deflocculation, the process by which clay particles cease to adhere together and aggregate into structural units or peds but form a sludge of separate particles with no mutual adhesion. Mr Maurice Harrod (ADAS) explained the reasons for this. Because the soils are derived from clayey marine alluvium, they are sodium saturated and therefore potentially unstable. But as long as they are kept permanently wet by high groundwater there is limited deflocculation of the clay. After drainage, however, the watertable is lowered and the soils dry out. Then, in autumn when they are subsequently rewetted, the clay particles disperse and the soil becomes very unstable. Dr Peter Bullock (Soil Survey) showed how this dispersed and mobile clay is washed down through the soil and is redeposited at depth, particularly in the porous fill over the drains, so reducing soil permeability.

Map of North Kent marshes

Most of the drain failures reported so far have been in soils of the Wallasea series but there has been little information about the amount of land potentially at risk. A detailed soil survey had been made earlier of a small area of marshland near Burnham-on-Crouch in Essex, but because of the need to identify more precisely the magnitude and likely occurrence of future problems, the Soil Survey was asked by MAFF to map the soils of the north Kent marshes. Mr John Hazelden (Soil Survey) described this project which looked at land separated as the Wallasea 1 association on the National Soil Map.

Fieldwork had shown that differences in salinity and potential risk were related to soil type and the marshland microrelief, and there is a need to extend this work to other marshland areas. Studies of affected fields in Essex and Suffolk were reported by Mr Robin Chase (FDEU). He suggested that to minimise the risk of drain failure, restoration and farming operations should be timely. Low ground should be filled with suitable material, outfalls should permit good drainflow, plastic pipe should be used and installed by trenchless methods to reduce disturbance and make subsequent jetting easier. Backfill material should consist of smooth gravel to minimize clogging by the deflocculated clay. Mr Mike Marks (ADAS) emphasized that clay dispersion was favoured by high sodium and magnesium contents, low conductivity, low organic matter contents and mechanical stress induced when soil was disturbed by cultivation of subsoiling.

Application of gypsum may help to restore affected fields but onlv if the drainage system is in good order — it will not revive defunct schemes. He advised the use of waste lime wherever available but otherwise gypsum should be applied on land with less than two per cent calcium carbonate at 50t/ha over the drain and 12.5t/ha overall. Because the soils are so difficult and heavy they should be worked very carefully indeed. Straw should always be burnt and crops drilled early in autumn with minimum cultivations. Subsoiling should also be avoided unless there are pans present.

Micro-organisms : an alternative to straw

An interim report on a study of methods of accelerating straw residue breakdown in the field.

FOLLOWING the recent sounds of disapproval in connection with straw burning, there is now a considerable incentive to find suitable alternatives.

Straw represents one of the major lignocellulose wastes from agriculture. Dr J. M. Lynch from the Glasshouse Crops Research Institute, Littlehampton, West Sussex leads studies that he initiated at the Agriculture and Food Research Council's Letcombe laboratory in Oxfordshire to investigate the microbiological treatment process involved in the decomposition of buried straw. The experiments aimed to assess the efficiency of different microbial consortia in the breakdown of cellulose, also their ability to increase the available nitrogen in the soil. The consortia of appropriate micro-organisms was of interest also for its potential to stabilise soil structure and control soil-borne diseases.

Straw decomposition

The first of these experiments carried out, looked for a successful combination of fungi to break down the cellulose, producing simple sugars to be used by a bacterium, for the fixation of nitrogen from the atmosphere in the soil. In turn, ample available nitrogen within the soil increases the process of straw breakdown by the fungi to complete the cycle.

The studies therefore needed to determine the best combination of fungi and bacteria under anaerobic and aerobic conditions.

Celulotytic fungi, among them: *Fusarium spp., Penicillium* spp., Sordaria spp., and *Trichoderma* spp., were tested for soluble sugar extraction during breakdown of a known cellulose material. Dr Lynch found that among the fungi with the ability to release relatively large quantities of sugar, the most appropriate proved to be Trichoderma *harzianum,* especially in combination with *Clostridium butyricum,* an anaerobic, nitrogen-fixing bacterium which does not possess a cellulase. The GCRI found that until a source of cellulase was provided, the cellulose was decomposed without the fermentative end products of the bacterium, acetate and butyrate, being accumulated.

Available carbohydrate energy, in the form of soluble sugars, facilitated the fixation of N_2, which in turn aided the process of cellulose decomposition. Experiments in defined cultures showed that small amounts of additional nitrogen increased the decomposition rate constant. This was achieved by its stimulating effect on fungal growth and the accompanying cellulase production.

Nitrogen production

The team continued their studies on nitrogen fixation one step further by determining the value of straw as a substitute for this process.

A comparative experiment was conducted using wheat straw inoculated with the cellulolytic fungus Penicillium *corylophilum* in association with the bacterium C. bufyricum.

A control column of inoculated straw placed in a solution of mineral salts; a pure culture void of external bacteria, was compared with a non-aseptically conducted study of inoculated straw contained in glass columns and moistened by continuous recirculation of the mineral solution.

The control study showed negative signs of straw rotting until nitrogen was added, when decomposition was initiated. C. butyricum did not fix N_2 while in the pure culture, but grew and supported P. *colylophilum* in a co-culture, presumably due to the new provision of a source of fixed nitrogen.

A combination of inoculants was used in the glass column experiment, which showed an increase in decomposition rates by comparison with the single inoculant used in the flask experiment. The team report that over an eight-week period, the experiment, conducted at a temperature of 25deg C, produced a nitrogen gain of 11.5mg (g straw lost)$^{-1}$ in direct relation to straw decomposition. Transferring this figure in to practical terms, the field scale for straw produced at 7t/ha^{-1} would give nitrogen gain figures of 35kg N/ha^{-1}.

Adding this on to the nitrogen content already contained in this volume of straw, 3.1mg Ng^{-1}, the total N content of straw available for subsequent crops would be 57kg N/ha^{-1}, equivalent to detween one third and one half of the annual fertilisers applied to arable crops.

The team continued their experiments by comparing decomposition rates under anaerobic and aerobic conditions. The anaerobic bacteria, responsible for nitrogenase activity were C. *butyricum* and the aerobic bacteria used consisted mostly of *Pseudomonas* spp. Decomposition was most active under aerobic conditions but within the anaerobiclaerobic interface. Cellulolytic species of fungi proved to be active in both conditions.

The results of the latter two experiments showed that both bacterium and cellulolytic fungi together have the potential to co-operate in the degeneration of straw, particularly where the oxygen supply is restricted but not excluded. The team conclude that a short list of fungi with potential as straw inoculants to quicken straw decomposition and hence

Micro-organisms decomposing *straw* with *attached* soil *particles.*

eliminate the food base for the production of phytotoxic organic acids can thus be produced. Additionally a biological source of nitrogen is provided.

Soil stability

The bacterium *Enterobacter* cloacae not only colonises straw debris but also encourages aggregate formation in soils by reacting with clay particles to produce a cementing action.

The team have found that the fungi *Penicillium purpurascens* and T. *harzianum* show similar qualities. Continued studies showed that aggregate stabilising ability was increased further when these fungi were combined with a co-culture of a range of polysaccharides from bacteria and yeast.

However it appears that there is some limitation on this useful finding under normal fertiliser regimes, since the process worked more effectively under conditions of low nitrogen content of the inoculated straw.

Soil-borne disease

The last in the experiments described by Dr Lynch studied the influence of Trichoderma spp. in the control of a range of soil-borne diseases. The team tested various species of Trichoderma on a variety of pathogens. From the results, the most effective varieties controlling the disease were Trichoderma *Harrianum* and *T.* hamatum.

Work on this subject is continuing, with hopes of following up new developments concerning the effect of fungi in countering pathogens affecting the root itself.

Conclusions

Work and the findings produced at the GCRI under the supervision of Dr Lynch can be listed as follows:

- The acceleration of straw decomposition appears to be most effective with cellulolytic fungi in co-culture with *C. butyricum*. Recent results show that the introduction of E, cloacae creates an even more effective combination.
- Nitrogen is gained by fixation of dinitrogen from the atmosphere; the nitrogen is then used by the fungi.
- Soil stabilisation through the use of micro-organisms is proving to be effective in the development of aggregate soil structures.
- Fungi can be used to control soil diseases.

Scientific staff at the Glasshouse Crops Research Institute are moving from the pure research to the development stage.

In conjunction with their sponsors, the Agricultural Genetics Company, Milton Road, Cambridge, are funding the testing of the experimental consortia of microbes on field straw. The function of the company is to commercialise and market the developments in genetic engineering and biological technology from six of the major AFRC institutes and associated universities. Once they have done this successfully and managed to tune their enzymes to give the best performance, they plan to move into production

Dr Lynch hopes that the future at the GCRI will hold more experiments on many other waste materials other than straw that can be disposed of by the all-powerful microbe.

The Wickham series

The first of several soil assessment articles provided by M. *G*. Jarvis from the Soil Survey of England and Wales

WICKHAM SOILS are found principally in the clay vales of southern, eastern and central England on valley footslopes and bottoms and also on level or gently sloping ridges. They also occur on some high ground, for example, in the High Weald of Kent and Sussex. The National Soil Map shows Wickham series to be dominant over 4,750km^2 of England and Wales, about 3.1 per cent of the total area. It also occurs as a minor constituent associated with other soils over a further 7,660km^2.

The soils are characterized by their slightly or moderately stony dark greyish brown medium or heavy loam (fine silty or fine loamy) topsoils over greyish brown and ochreous mottled loamy subsoils passing to grey and ochreous mottled clay at 25-50cm depth although the clay may be as deep as 75cm in some places. A brief profile description is given below.

Explanation of soils and their properties

Most soil maps identify the soils of an area by their series name, usually a locality where they were first described. Soil series are often referred to by scientists and others when they publish experimental results. Work done on any specific kind of soil in one location is applicable, given a similar environment, to the same soil elsewhere. The soil series is thus a basis for the exchange and transfer of experience from research station to field operation and from farm to farm. It is therefore valuable to know which soils occur on your land, how these soils behave and what research has been done on them. Over the next few months Soil and Water will introduce you to some of the common soils and their properties and will tell you something about their limitations and potential. If you would like to discover which soils occur on land of interest to you, contact your local ADAS advisor, your nearest Soil Survey office or write to: Soil Survey of England and Wales, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ. Telephone 05827 63133.

cm	
0-20 Apg	Dark greyish brown, mottled, stoneless or slightly stony silty clay loam or clay loam.
20-40 Eg	Greyish brown, mottled, slightly stony clay loam; moderate medium and fine subangular blocky structure.
40-60 Btg	Strong brown with many grey mottles, stoneless or slightly stony clay; strong medium angular blocky structure.
60-100 BCg	Grey with many ochreous mottles, stoneless clay; strong coarse prismatic structure.

The upper layers of the soil are wet for long periods in winter because the clay subsoil swells, fissures are sealed and vertical drainage impeded. The resulting surface wetness severely limits opportunities for cultivation and grazing, so drainage is essential for sustained arable cropping. Where drains have been installed there are adequate opportunities for autumn tillage and, in drier districts, some opportunities in spring. Timeliness is essential and in wet springs there are very few occasions when Wickham soils can be cultivated without damaging their structure. Fine seedbeds, especially in topsoils with a large fine sand or silt content, are liable to cap or pan and, on slopes, erode when exposed to heavy rain.

Suitable drainage measures for Wickhams soils usually consist of pipes at 20-40m intervals placed at 75-90cm depth and covered with permeable beckfill, though systems need to be tailored to individual fields and should take account of the variable thickness of loamy material over the clay. Many of the soils have clay within moling depth but mole channels will need renewing frequently and must be drawn in suitable conditions. Where the clay is below 50cm depth, closer spacing of the pipes with subsoiling may be a suitable alternative treatment.

Because of the limitations imposed by winter wetness, Wickham soils are best suited to autumn-sown crops including winter cereals and oilseed rape, though success with these crops may be difficult to achieve in wet districts such as the High Weald and in Somerset. Here grass is the most common crop but yields are again limited either by winter poaching risk, which limits the optimum use of nitrogen, or by summer drought. Harvesting difficulties preclude root crops and the lack of opportunitv for spring landwork make spring cereals poorly suited. Wickham soils are inherentlv acid and need regular liming, and natural phosphorus levels are usually low.

For those with an interest in farm woodlands and conservation, Wickham soils are suited to a range of trees and shrubs including the pines, western hemlock, Norway spruce and western red cedar as well as sessile and pedunculate oak, beech, ash, hornbeam, wild service tree. crab apple, hawthorn, blackthorn and yew. The slowly permeable clayey subsoils and seasonal waterlogging inhibit the root growth of some species however, and there is a risk of windthrow on exposed sites. Ditches help to reduce the incidence of waterlogging and assist establishment.

Straw use and disposal

The state of the art and some of the future possibilities

What are the options available for utilising straw? Present and future alternatives are discussed by Mr A. R. Staniforth, Reading Agricultural Consultants Ltd, Wallingford, Oxon.

When we consider straw production in relation to straw/soil management, the tonnages involved are bigger than those usually quoted.

Assuming a UK cereal grain crop of 28m tonnes and an average straw:grain ratio of 50:50, the total straw — that is the above-ground part of the cereal plant minus the grain — also amounts to 28m tonnes. The average straw to grain ratio may be somewhat lower, depending on the proportion of different varieties sown, but even if this ratio is reduced to 45:55, total straw production still amounts to some 23m tonnes. The much smaller estimates of straw production that are commonly quoted refer to yields of baled straw which ignore all the residue left in the field.

The amount of straw that is annually baled in the UK has been officially estimated in recent years at something between 5¼ and 6½m tonnes. This means that, nationally, and as a rough estimate, around 20m tonnes remain to be burned or incorporated.

Similar calculations apply to individual fields and crops. The total straw yield from an 8t/ha crop of winter wheat may well also amount to 8t/ha. And, even after, say, 4t/ha of baled straw are removed, there will remain a surprisingly large amount of stubble, chaff and loose straw to burn or incorporate.

Straw composition in relation to soil fertility

There are wide variations in straw composition, but the following range covers most samples.

	Kg/tonne of nutrients
P_2O_5	1.5- 2.5
K_2O	10.0-22.5
N	0.7- 1.0

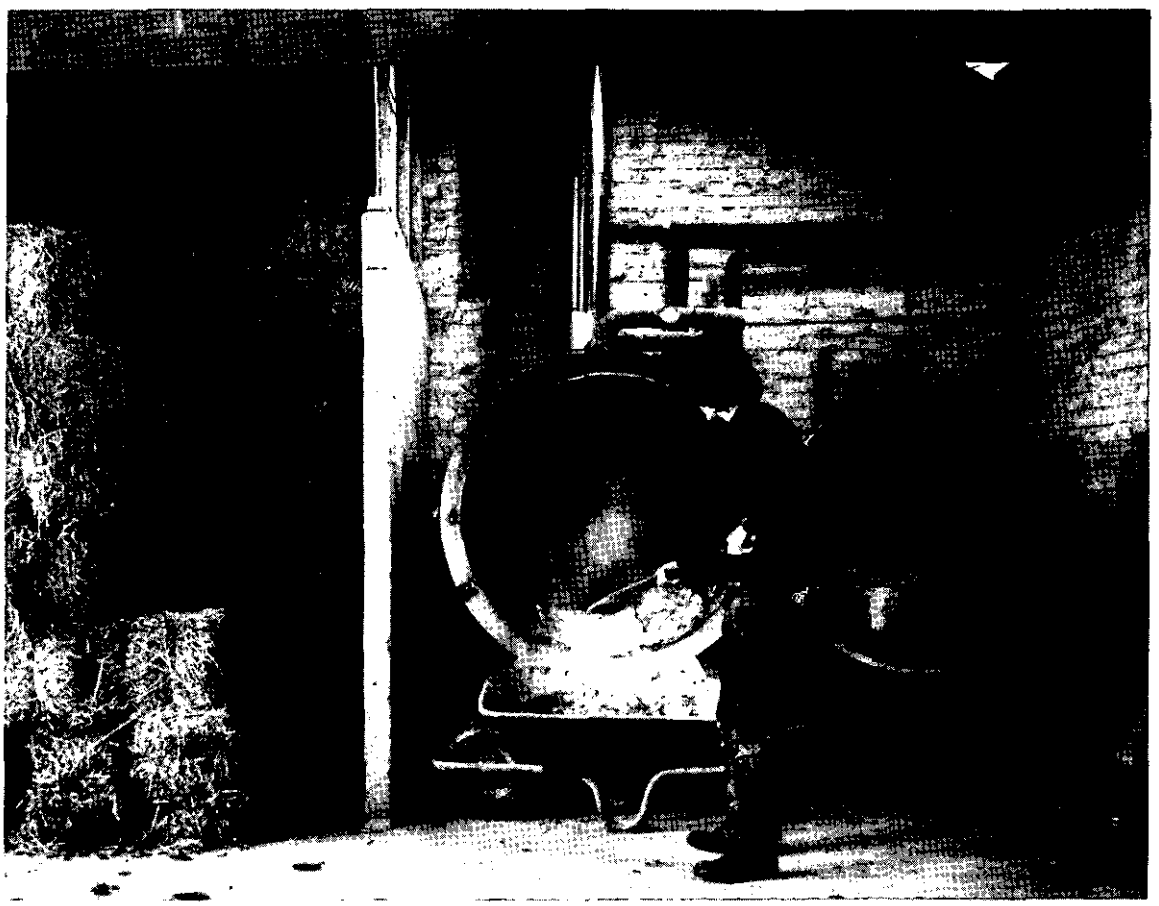
A crop of 10t/ha total straw thus contains appreciable quantities of nutrients — say around 20kg of P_2O_5, 150kg of K_2O and 8kg of N.

The total value of N, P and K in this crop of straw can be calculated at around £30/ha — but of course it is not as immediately available as bag fertiliser.

The straw also contains a large volume of organic matter as well as small amounts of minor elements.

Field burning

The most popular method in the UK for disposing of the huge surplus of straw has been burning in the field. It was cheap, and it had the great advantage of speed at a time when more and more cereals and oilseed rape were being sown in the autumn. I will not discuss methods of burning or the increasing complexity and cost of this method of disposal which



This straw burner has been used for six seasons to heat a large Oxfordshire farmhouse, a bungalow and a workshop.

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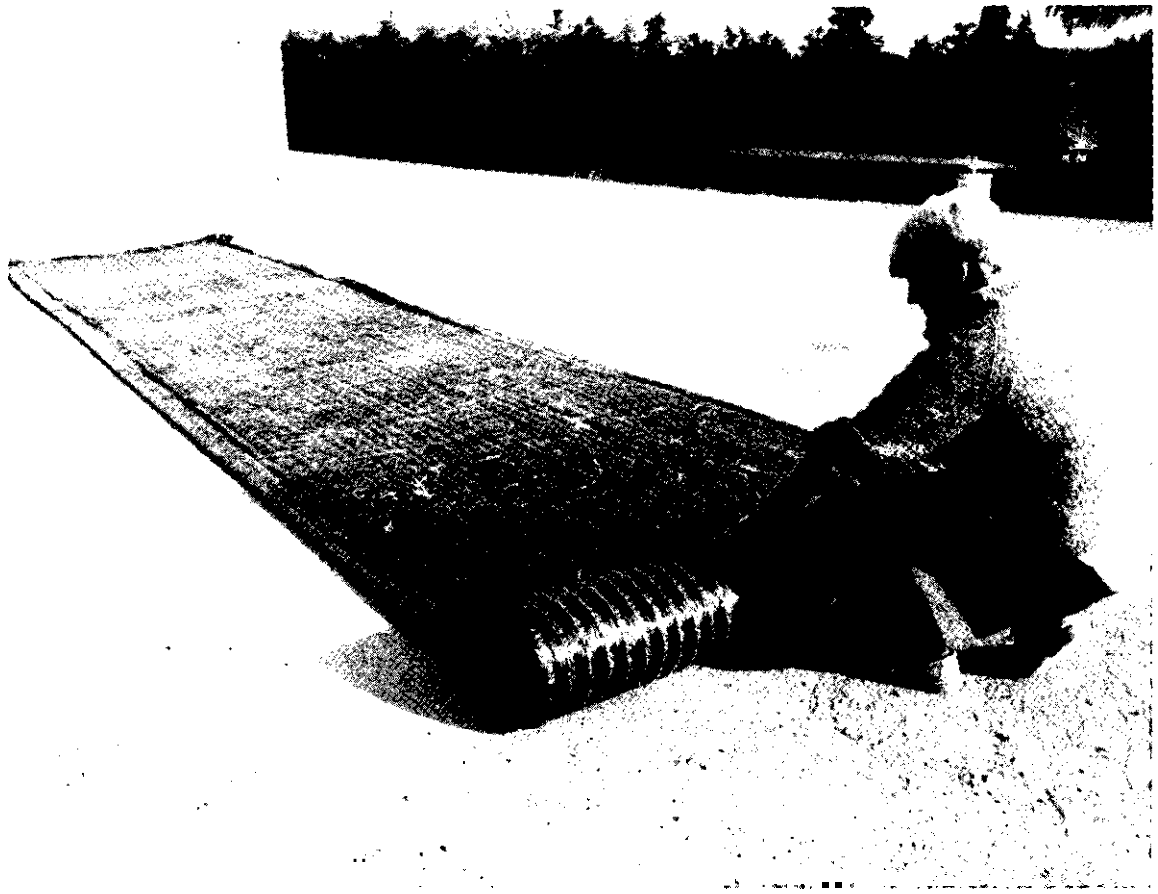

'Polystraw' packing and insulation is *marked* in *the UK* for many purpose.?, including *frost* protection *at* race-tracks *and insulation* of *potato* containers.

arise in meeting bye-law requirements. However, a few points need to be considered as they closely affect comparisons made with other methods of disposal.

If straw is burned, most of the phosphates and potash will normally remain on the field. But the nitrogen in the straw will be lost, and some of the minor elements — for instance, sulphur — will be dissipated and this could have some economic significance over a period of years.

The organic matter in straw is also forfeited by burning, and with a really clean burn, only the organic matter in the root system — amounting to perhaps 20 per cent of the total in the whole plant — is left. On many soils, it seems that the root residues have been sufficient to maintain the humus content at a reasonable level for many years. On certain soil types, however, it is not sufficient to rely on root residues to maintain humus and the colloidal fraction.

The effect that a good burn has on the surface texture of some soils and the way this conditioning fits in with direct drilling needs no emphasising. Discussion of the merits of direct drilling, minimal cultivations and ploughing would need a separate article, and it is enough to say here that the choice of the cultivation system is closely linked with straw management.

Soil incorporation

In the immediate future, soil incorporation offers the only practical alternative to burning as a way of disposing of the many millions of tonnes of surplus straw.

Incorporation returns all the N, P and K and minor elements to the soil, as well as the large amount of organic matter. The very high carbon:nitrogen ratio in the organic matter means that extra nitrogen is required to break it down. Long-term experimental work at Rothamsted Experimental Station, Hertfordshire, has indicated that soil microbes require about 8kg of N. in addition to that supplied by the straw, to break down one tonne. There may be sufficient N already in the soil, but some extra may have to be supplied if available quantities are not to be with-held from growing crops at critical stages. This question of the possible need for extra N on land into which straw has been incorporated is extremely complex. There is no doubt that such crops can he affected by the temporary immobilisation of soil nitrogen. But the timing of extra applications is still not fully understood. On a soil with low N reserves, it may be advisable to give extra supplies, immediately after the passage of the comhine, to speed straw breakdown when conditions of warmth and moisture favour microbial activity. On the other hand, if much straw remains to be broken down it may be best to delay extra applications until the late spring period, when both crop growth and microbial activity make their biggest demands on supplies. After years of proliferation of active soil microbes. it will not be necessary to apply any extra N at all.

There are too many aspects of soil incorporation for the subject to be considered fully here. The production of toxins from rotting straw in wet conditions has to he considered, particularly in direct drilling and minimal cultivation systems. The effects of incorporated straw on slug populations, on weed seeds, on herbicide efficiency and on certain plant diseases need to be taken into account.

The actual mechanics of straw incorporation are the subject of wide discussion. The combine-mounted chopper must surely be the preferred first step in most cases. There is an argument about chop length, but we have to remember that halving chop length approximately doubles the power needed. There is an argument, too, about the need or otherwise to cultivate straw into the soil brfore ploughing.

Fortunately, most of the trials are confirming what a few practical farmers have concluded after persisting in incorporation for years — simple systems are the best for most farms. Chopping. spreading and ploughing with a good set of skimmers generally works well.

I went to northern France this autumn to see how they are managing their straw surplus. They used to burn almost as much straw as we do. but have now reduced the amount from about 4½m tonnes in 1976 to 1m tonnes in 1984. In this

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same period. they have greatly increased the amount incorporated. This increase in incorporation has gone hand in hand with a return to ploughing. The French appreciate that incorporation may be more expensive than burning, but are great believers in maintaining soil organic matter levels, and think that incorporation helps with this. Incidentally, they are not suffering from a public outcry against field burning.

It is impossible to compare the economic efficiency of French and British cereal production — even assuming that soil and climatic conditions could be equated.

We can, however, compare the latest French estimate of their national average wheat yield in 1984 — 6.5t/ha — with our UK 1984 estimate of 7.5t/ha.

Alternatives

Most people agree that it would help to solve the straw disposal problem if we could bale and sell much of our production at an economic price. What are the chances of doing this? The answer has to be that there is no immediate prospect of a large take-up for industrial purposes, though there are some promising possibilities for the future.

The use of straw for fuel is increasing and the amount is creeping towards 200,000t/annum. Some farmers and growers are making a success of straw as a fuel, and I find that it is possible to make economically feasible budgets for some domestic, horticultural and crop drying installations. Improved equipment is being developed, and if costs can be brought down, it is quite conceivable that we might annually use 1m tonnes of straw for fuel.

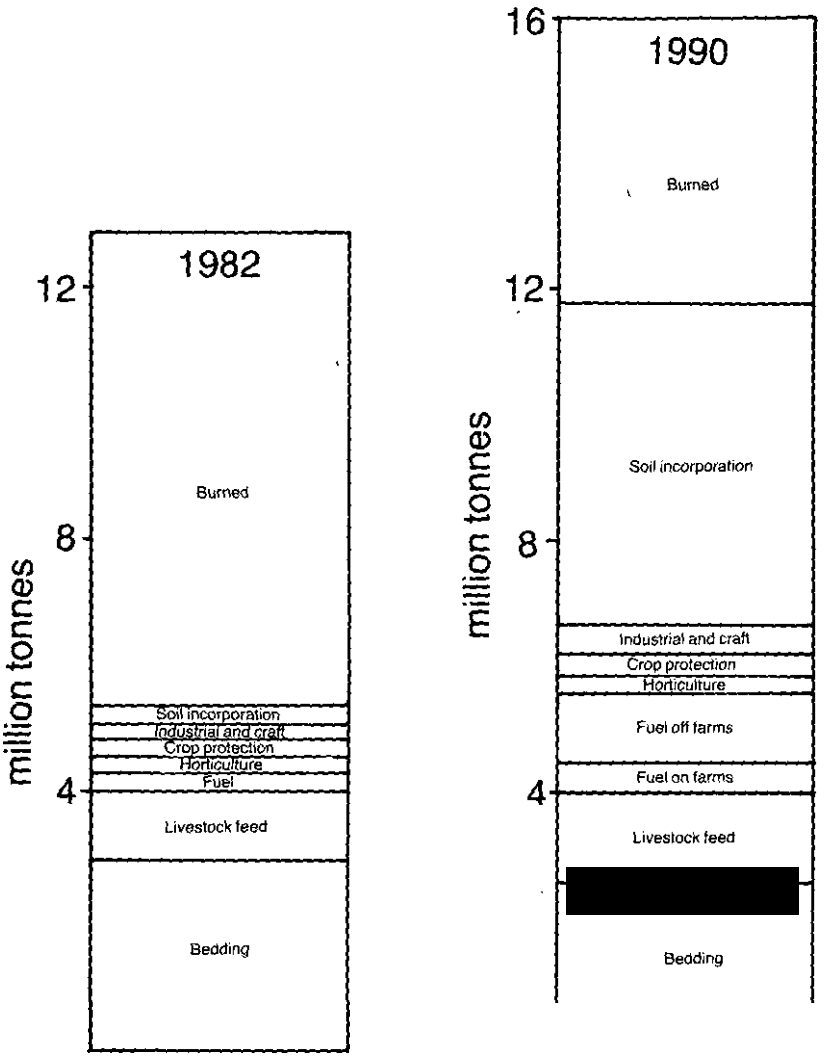
One of the best prospects for the industrial use of a few hundred thousand tonnes remains with the paper industry. The cost of hardwood pulp and recycled paper is currently very high, and there is renewed interest in straw pulping, with several promising, low-effluent systems under development.

Small straw-board factories are now being made by Marshalls of Gainsborough and some UK farms already have planning permission to install them. Straw as a raw material for moulding and for horticultural compost is being researched. Polystraw insulation material (a sort of straw quilting) is now being sold in this country for various purposes.

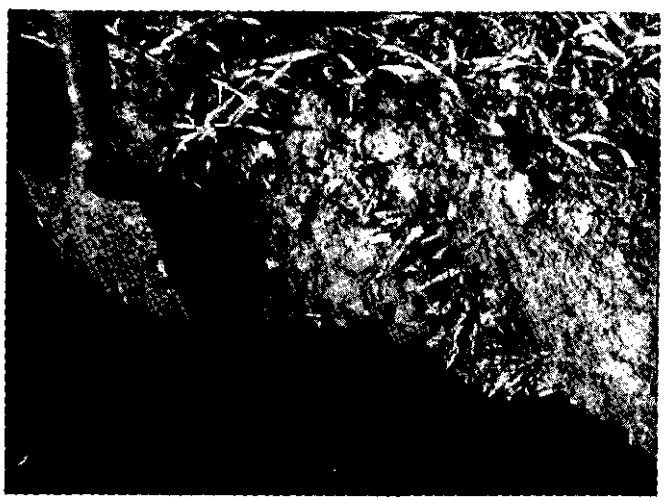
One of the old, die-hard contentions — that reliable procurement of straw in quantity from farmers was impossible — has been given the lie by BOCM/Silcock over recent years in their Viton factories. These have processed up to 250,000t/annum, supplied by contractors. Impmved baling, transport and storage systems are playing their part.

All in all, the problem of straw disposal and utilisation seems to be nearer to solution in 1984 than at any time during the past 10 years. Field burning is not the only solution, though it remains the most economic one, at least in the short term. on some soils and in some situations. Incorporation is not so technically difficult as it has been made out to be, and it may have some longer-term advantages. A number of potentially profitable outlets for more baled straw are showing up.

In 1982, I had the temerity to publish (in ***Straw for Fnel, Feed and Fertiliser*** (Farming Press, Ipswich) a forecast for production and utilisation of straw in the UK over the next 10 years, as shown in the diagram. It still seems relevant and represents a reasonable look into the future of straw utilisation.



Possible changes in straw production and utilisation in England and Wales, 1982-90 (smaller fractions not strictly to scale). Taken from Staniforth, A. R., 1982. Straw for Fuel, Feed and Fertiliser, Farming Press (Ipswich).



A diagonal band of decomposing straw incorporated in heavy land after work with the plough and skimmer.

Arable farming events at NAC

In April 1984, Mr Selwyn Richardson joined the Agricultural Development and Advisory Service team based at the National Agricultural Centre, Stoneleigh, as their soil scientist.

During the winter a full range of conferences and courses will he held at the NAC, from which Selwyn Richardson has chosen three to discuss in the following paragraphs.

Soils Workshop 26 and 27 February

Because of the popularity of the previous workshops, this event is being held for the third year running at the NAC. It is designed for farmers, commercial personnel, consultants and others wishing to improve crop yields by better understanding and use of existing assets rather than increasing inputs.

Research workers and advisers, many of whose names will be familiar to readers will speak on the importance to the crop of soil properties and soil profile features and how they can be improved (or damaged) by the farmer. There will be practical sessions in the laboratory on how to assess soil texture and soil structure. This will be followed by field visits to local soils where participants will he encouraged to descend into soil pits to examine the root environment.

Cereals 85 5 and 6 June

This year's cereals demonstration will be held on RASE land adjacent to the NAC. Although the main emphasis will be on winter wheat and winter barley, there will be a section dedicated to the viability and husbandry of alternative combinable crops. The final decision on which crops to include has not yet been made but definite runners include oilseed rape, triticale, durum wheat, peas, linseed, lupins, borage, fenugreek, coriander, quinoa and evening primrose.

Plant nutrition and drainage aspects will be presented in the indoor technical and educational section. Outdoors there will be the usual soil trench where visitors may inspect the soil profile of the site. It is known that a plough pan is present at about 28-35cm depth, and this will be used as a background to discussion on correct timing, depth and spacing of a subsoiling operation.

Royal Show 1 to 4 July

Since 1982, a Soil Centre has been included within the technical area of the Royal Show. In 1984, this was moved to a new area within the Arable Centre, adjacent to the NIAB plots. In 1985, the effect of acidity on three crops will be demonstrated since this is still a common cause of crop damage. The removal of acidity is basic to soil fertility and this is very easily done by the addition of lime. Sugar beet will be used widely as a demonstration crop within the Arable Centre and the effect of a plough pan on this crop will be demonstratcd. Besides poorly-shaped, sometimes fanged beet, the yield can be seriously reduced by drought where rooting depth is limited. These factors will be among those shown.

Finally, in an adjacent area, there will be a major drainage and drainage aftercare demonstration arranged by the Arable Centre. This will consist of a number of commercial machines, products and systems which will he exhibited or demonstrated to give a technical drainage message to visitors to the show.

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FEBRUARY **1985**

5	RASE conference (NAC, Stoneleigh) — Irrigation: getting it right
7	Barley **'84** follow on conference (Royal Hall, Harrogate)
13	West of Scotland Agricultural College (BP Social Club) — Soil care
26-27	RASE/ADAS conference — Soils Workshop

MARCH 1985

	British Hydrological Society (Royal Society Rooms, Edinburgh) — The effects of upland management practices on water resources
20	Agricultural Management Ltd (NAC, Stoneleigh) — Where are we **going?** The future of land
25-29	Short course (Silsoe College) — **Irrigation**

APRIL **1985**

10-12	BCPC/BGS symposium (University of Nottingham) — Weeds, pests and diseases of grassland and herbage legumes
15-19	Short course (Silsoe College) — Soil conservation: principles & practices
23-24	Short course (Silsoe College) — The measurement of soil water properties

MAY **1985**

1	SEESOIL Spring field meeting — Saline soils on the North **Kent** marshes
8	British Hydrological Society (Wild Fowl Trust, Slimbridge) — Management of **wetlands**
9	Farmers Weekly's International Drainage Event (Veals Farm, Laughton, East Sussex)

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