SOIL and water

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V13-2

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

Soil and Water is published quarterly and 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 farmers and growers, researchers and advisers, consultants, manufacturers, contractors and others making up the membership of SaWMA.

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Front Cover – The SaWMA field meeting at Brandon Fields Estate (courtesy of Frederick Hiam Ltd.). Ian Mathieson, Atkins Land and Water Management, demonstrates the operation of the neutron scatter probe for measuring soil moisture content. A further note appears on page 10.

COMMENT

Our Continuing Role

This is the last issue of Soil and Water for 1985 and although our season's programme is not yet completed, it is time to take stock – of what we have achieved, of where we are going and what we plan to do next year.

By the end of the year we shall have held a workshop and a conference, we shall have arranged four field meetings and we shall have participated at four National events. Additionally, there have been four issues of the journal and we shall have been able to give information or guidance to quite a number of correspondents, both members and otherwise.

It will be quite a reasonable year to look back on. The Workshop was very well attended and the Conference looks likely to be equally popular. The two field meetings in early summer attracted good numbers, but the September one was less successful. In this it probably reflects this year's atrocious weather which has made difficulties not only with hay and harvest, but also sharply reduced attendances at many National and local events.

And thedifficulties at hay and harvest, and at autumn cultivations, do not stop there – they have created problems for next year and perhaps for several years ahead.

After the comparatively straightforward seasons of some recent years we may have thought we had the answers to soil management, to straw handling. But British weather is notoriously fickle and this year it has lived up to its reputation – and now we realise there is still much to learn. Modern equipment, services and techniques have helped us through a very difficult year but we have not seen the end of it in the possible long term effects on the soil and how we should seek to redress them.

There will be much to be done and there is clearly still a continuing role for SaWMA in soil management as well as the newer role we have also adopted of resource conservation and preservation.

Which brings me back to the question of next year's programme. At the time of writing, this is shortly to be discussed in detail by the SaWMA programme committee. This is the new committee succeeding the previous technical committee – made up of specialists in many different areas of soil and water management and the chairman this year is Professor Dick Godwin of Silsoe College. Ideas from the Programme Committee will be passed to the Management Committee and the final programme drawn up according to our resources and finances.

Which in turn introduces my third point, that our programme will require full and adequate resources. As you will see from the note sent to members with this issue, we have felt it sensible to bring our membership fee back in line with the cost of achieving the services we are trying to offer. The £13.50 (not counting VAT) we have now set still represents a lesser fee (allowing for inflation) than the £4 per member set when SaWMA was first set up in 1973.

We hope that members will continue to support the Association and take pride in its aims and achievements. And for those members falling in the tax paying category we do ask you particularly to consider making the further step and completing the Deed of Covenant. As a registered charity this will allow SaWMA to benefit still further financially. I am very pleased to report that all members of the Management Committee have already opted henceforth to covenant their subscriptions.

I look forward to giving details in our issue of a full and active programme planned for 1986.

CONTENTS

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

New Corporate Member – Geomorphological Services Ltd.

We are pleased to welcome Geomorphological Services Ltd as a new Corporate Member of the Association.

GSL is an earth science consultancy, dealing with a range of problems in soil science, hydrology and geomorphology both in the UK and abroad.

Mr Mark Lee, spokesman for the company, explains that GSL has considerable experience of soil survey work and, together with the university based Reading Soil Sciences, GSL soil scientists can provide a low cost, comprehensive farm survey package, ranging from basic mapping and iand quality assessment to chemical analysis and soil fertility assessment. Also they can provide independent advice on irrigation, drainage and soil erosion problems.

GSL has considerable experience of soil survey for British forestry, having carried out numerous surveys for windthrow hazard and land valuation.

For further details please contact Mark Lee, GSL, Old Court House, Trinity Road, Marlow, Bucks. Tel: (06284) 75258.

Continued growth in use of pesticides and fertilisers in the UK

Detailed analysis of the UK pesticide and fertiliser market is presented in two reports lately prepared by Marketing Strategies for lndustry (UK) Ltd.

The report on pesticides covers the three principle types available in the UK, outlining the usage by major crops and reviewing the schemes operating for pesticide labelling. 1984 consumption of formulated pesticides is seen as 7 per cent higher in real terms over the previous year – an impressive growth though well below the 26 per cent growth seen in 1982. UK manufacturers are also doing well in developing exports – France particularly is a major purchaser of UK fungicides. herbicides and insecticides.

In the report on fertilisers, nitrates are seen to be a fast expanding area for UK manufacturers but overall the UK market seems to be more susceptible to imports despite the relatively substantial fertiliser raw material sources in the UK.

A section of the fertiliser report deals with the packaging and handling of fertilisers.

Automatic weather station for farmers and growers

An easy-to-use automatic weather station marketed by the Agronomics Division of ELE International Ltd., Hemel Hempstead, England has been designed to provide a detailed computerised record of the local climatic conditions affecting plant growth.

Optimising crop yield and quality

Factors such as altitude, exposure and the nature of the surrounding terrain can cause marked variations in micro-climate within a small area. By monitoring conditi on his own land, a grower obtains specific information to help him optimise crop yield and quality while avoiding unnecessary expenditure on fungicides. pesticides, irrigation and fertilisers.

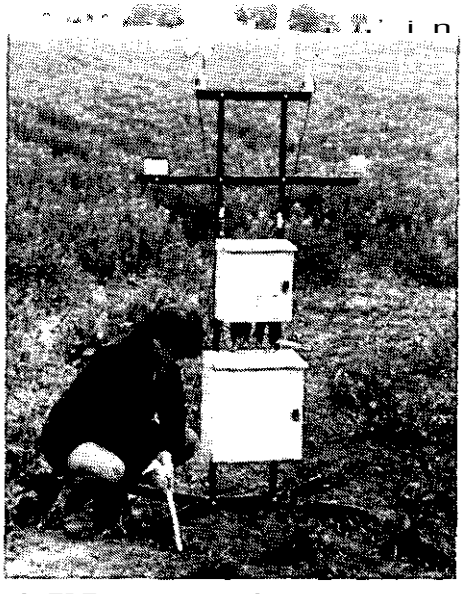
Each weather station is fitted with 8 sensors to measure air and soil temperature, relative humidity, surface wetness, rainfall, wind speed and direction and daylight hours. The interval between readings is variable from I minute to 6 hours. Each record carries a date and time, and a statistical summary for the preceding 24 hours is recorded daily at 9.00am. The built-in data logging unit can store 1000 sets of records; thus, if recordings are made every hour, there is enough memory to last 40 days before the memory is full.

Monitoring environment

The ELE Automatic Weather Station is readily transportable and can be quickly erected on any site. By fitting various combinations of sensors and using alternative Programs, its logging unit can also be used for such functions as monitoring the environment in and around crop stores, animal houses and feed-holding bins, and triggering alarms or environmental control systems.

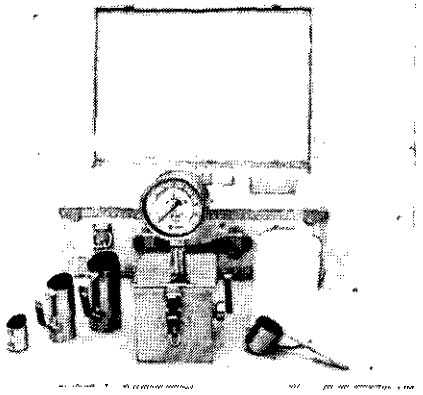
In addition, every weather station can be programmed to give audible and visual warning of conditions favourable for the onset of diseases such as potato blight, barley brown rust, septoria, rhynchosporium, apple scab, and hop downy mildew. Effective crop-saving action can then be taken in good time.

Further information from: ELE International Ltd., Eastman Way, Hemel Hempstead, Herts HP2 7HB. Tel: (0442) 218355.



The ELE automatic weather station

Meter measures slurry nitrogen



The 'Nitrocheck' Nitrogen meter *from Rekord* Sales (GB) Ltd.

A unique measuring device, which enables the plant available nitrogen in a sample of slurry or manure to be accurately determined in minutes, is now available for the first time in the UK from Rekord Sales (GB) Ltd., of Atherstone, Warwickshire.

The nitrogen content of slurry and manure can vary enormously depending on the type of livestock, feeding, litter material. water admixture, etc., and it is impossible td utilise slurry or manure in the most cost effective way in a modern farming system unless the nitrogen content can he accurately determined. The new Rekord 'Nitrocheck' nitrogen meter provides just this ability, giving an instant and accurate read-out of plant available nitrogen in kgs/m^3.

The unit is very compact, 14.5cm wide by 26.8cm high by 14.3cm deep and measurement is simple to carry out and takes only a few minutes. The gauge on the unit is graduated directly in kg. nitrogen per cubic metre manure and provided with three scales, according to the type of manure to be tested. All components of the Rekord 'Nitrocheck' are made of stainless steel and the complete kit is priced at f325.00.

Further information from: Mike J Wilks, Rekord Sales (GB) Ltd, Manor Road, Mancetter, Atherstone, Warwickshire CV9 1RJ. Tel: Atherstone (08277) 2421.

Reducing atmospheric pollution

A brochure entitled "BP gas ~ the alternative fuel" has been produced by the Gas Branch of BP Oil Ltd.

Already being increasingly used for grain drying, the brochure explains that emissions from engines burning BP Autogas are non-toxic, low in sulphur content, and the product itself is entirely free of lead. BP Autogas is thus a contribution to reduced atmospheric pollution.

Wide ranging technical back-up and free surveys for prospective users are amongst the features presented in the brochure (available from Gas Branch, BP Oil Ltd, BP House, Victoria Street, London SW1E 5NJ).

V13-2.

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

Sports field drainage in *progress recently* on the *Imperial Metal Industries* Ltd *recreation ground* or *Shipston on Stour, Warwickshire, where a cricket match was played later on the day the pitch was drained. Drainage was required on this area despite the fact that it had previously been drained with pipes at 8 metre spacings, relying on slits containing gravel and sand to carry excess water to the drains. New machinery and techniques developed by the Clark Group make* it *possible to put* in *adequate, piped drainage, at* close *spacings,* for less than half *the* cost nor*mally associated* with *sports pitch drainage.* The pipes may *also be used* for *irrigation and frost protection. Manufacturers Drainage Equipment Ltd are based at Willington, Shipston* on *Stour, Warwickshire CV36 5AS.*

Biotechnology – links between Industry and University

Microbial Resources Limited and King's College, of the University of London have signed a broad cooperative agreement on research and development on the use of microorganisms as alternatives to chemical pesticides.

Under the agreement King's College grants Microbial Resources an–option to develop discoveries from several of their labs and the company gives the college a similar option to perform certain aspects of the company's research programme. Two of the scientists involved are Drs Jim Heale and Paul Markham whose research interests include the genetics and physiology of fungi which attack insects. The third key researcher is Dr Mike Llewellyn whose expertise is in the area of insect ecology.

This agreement with King's is the second such agreement signed between Microbial Resources and a University: the first in July was with Birkbeck College.

Acid pollution – an international problem

The Autumn issue of Natural World reports on an ambitious project by the junior branch of the RSNC (Royal Society for Nature Conservancy).

Recognising that for some years there had been regular monitoring of rainfall acidity at a number of UK research stations it was realised that there was still not enough data to study the precise pattern of rainfall activity as any particular weather system passed across the country.

The project was mounted countrywide to collect this necessary data, and the results submitted to Dr Neil Cape of the Institute of Terrestial Ecology. His analysis has confirmed his earlier gut feeling for what goes on. "Warm, wet westerlies coming from the Atlantic are clean, while air masses associated with continental Europe or sources of emissions are relatively dirty':

This year's project was planned as a pilot scheme and thanks to generous sponsorship from British Petroleum a still more ambitious extended project is now being organised for next year.

Wider look at land use needed, say Consultants

Wider definitions of land quality and usage are needed in relation to location, alternative uses, and Government and EEC policies, according to the British Institute of Agricultural Consultants. It is concerned about the reluctance to release high quality land for mineral extraction despite the progress made in restoration techniques.

In a submission by BIAC to the Ministry of Agriculture it is noted that, as independent consultants involved in planning procedures, BIAC members are in frequent discussion with MAFF on the release of farmland. However, two problems tend to disrupt policy implementation; dependence on the Agricultural Land Classification as a measure of land quality, and the administration of policy relating to mineral planning.

The BIAC submission goes on to point out that progress in land restoration techniques has been retarded by the refusal to release sufficient high quality land for mineral extraction. Given advances in restoration techniques, it is feasible to restore land to its original high quality according to conditions agreed by all parties. Reluctance to release high quality land for mineral working has had the effect of slowing development on restoration techniques by restricting permissions to lower-quality land where the techniques were not required.

Technical Director at Land Capability Consultants

SaWMA Corporate Member Land Capability Consultants Limited of Willingham, Cambridge have recently appointed Dr Keith Jones as Technical Director. Dr Jones, formerly Senior Environmental Scientist with the company, has academic qualifications in ecology and research and practical experience in restoration of contaminated land. Since joining the consultancy in 1983 he has been developing these aspects of the company's work. Projects include a report to the Department of the Environment on restoration of difficult waste landfills, feasibility studies of low level restoration for Bedfordshire County Council and restoration proposals for an old gas works site.

Soil Management in paddy fields

The National Institute of Agricultural Engineering is to set up a programme of investigation into wheels and tyre equipment for optimum performance in flooded paddy fields.

Although a considerable amount of research has been done on the performance of wheels and tyres under dry-land farming conditions, the extent to which this knowledge can be applied under paddy field conditions is not known. Silsoe engineers already believe that there are major differences in soil behaviour under tyres and wheels in the two situations.

The project will begin with a survey of soils in paddy fields in South East Asia, and will also entail the construction at Silsoe of the simulated paddy field. Part of the funding is coming from the EEC and the work is to be carried out in conjunction with the Asian Institute of Technology in Bangkok.

Thefuture scene at the NIAE

Agricultural Training Board – now nearly 700 training groups. Courses in straw burning and crop spraying

The Agricultural Training Board reports 1984/85 as its busiest year ever, with over 1,000 people attending a total of 89 courses at the training centre at Stoneleigh.

Additionally, the Board has now reached its planned target of establishing around 700 training groups throughout the country to ensure that all farmers and growers can obtain reasonably easy access to the Service.

The training group system is proving particularly successful – probably largely due to the fact that farmers and growers are personally involved in the identification of local needs and the provision of local response However, there is still scope for increasing membership of the individual groups and this will be a prime objective of the Board in 1985/86. The Board's report comments that, paradoxically, it is businesses which are already successful that are more prepared to seek out, and pay for the services they need such as training. Apparently, only about a third of those entitled to use ATB services actually do so.

That the Agriculture industry as a whole supports the Board's aims is confirmed by the growing cash contribution (£700,000 in 1984/85) made through training group subscriptions, course fees and purchase of training.

Of special interest in 1984 has been the Board's straw burning course, attended by some 2,000 trainees at over 150 locations. The presentation of the course has been improved by the addition of a video tape and the Board sees this as a significant contribution to the improvement of strawburning standards last summer.

With crop spraying also coming under increasing public scrutiny all the Board's crop spraying training was revised and instructors updated prior to the 1985 season.

d of practice for agricultural lime

Statistics on the UK market for agricultural lime show there is to be a continuing demand at around 3½ million tons applied each year.

Underlying the importance of properly assessing lime requirements, and of correctly applying the lime, APLC (the Agricultural Lime Producers Council) has published a Code of Practice for the industry.

The code stresses that soil sampling should be established procedure with due regard to the presence of different soil types and it is noted that modern equipment for lime spreading enables full use to be made of the generally limited time available with minimum disruption to the soil structure.

A new *generation* of gloss *reinforced plastic* Cesspools hove been introduced by *Entec* (Pollution Control) Limited, *Andover.*

Available in o mnge of *sizes from 9000* litre *(2000 galls)* to *36,000 litre (8,000 galls),* the new *lower profile Cesspools* hove been *specially* R-designedfor optimum strength and *efficiency* for below ground opemtion, *and are suitable* for o diverse mnge of *applications* where *effluent control is essential,* in both dry, well *drained,* or poorly dmined locations.

McConnel celebrate 50th Anniversary and win advanced technology award

F W McConnel Ltd, celebrating 50 years of farm machinery manufacture, have been pleased to receive a visit from the Duke of Gloucester and to hear his praise for the way the company is looking to the future.

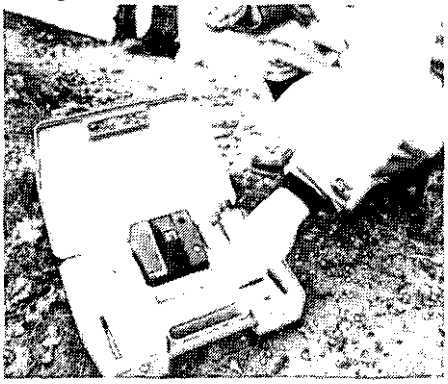
The modern plant now installed at McConnel's already generates an annual turnover of £6m. The company's computerised systems have also won an accolade from the Government – appointment to the list of just 70 British firms which are approved to carry out the Advanced Technology Awareness Programme, teaching other manufacturers how to bring in computer controls and other systems. The company is the only agricultural machinery maker on that exclusive list.

New kit simplifies nitrate testing

Nitratest is a new kit, developed by Wilkinson & Simpson Ltd, which greatly simplifies the procedure for measuring nitrates in drinking water, reservoirs, sewage effluent and industrial wastes.

Until now, nitrate testing has involved fairly complex laboratory techniques. With this new kit, both professionals and non-technical users can obtain accurate results on site. By formulating all the test reagents as a powder and foil wrapped tablets, the test procedure has been made very simple without the difficulty of using and measuring out liquid chemicals.

After addition of the test reagents, *the in*tensity of red colour produced in the water sample is compared with a series of glass standard colours and the reading obtained represents the concentration of nitrate in terms of milligrams per litre of nitrate nitrogen.



The new *test* kit *from* Wilkinson *& Simpson* Ltd.

Within the EEC, the maximum recommended nitrate level in drinking water is 25mg/litre, with an absolute maximum of 50mg/litre. This is equivalent to nitrate nitrogen levels of 5.65 and 11.3mg/litre respectively.

Microbiological perspectives in soil management

by E John **Wibberley,** Royal Agricultural College, Cirencester

Soil fertility was once conceived in terms of earthworm activity with resultant effects on pasture productivity and potential liveweight gains of grazing stock. Such concepts came to suffer accusations of imprecision, of 'muck and mystery'.

From Boussingault's classic trials to Lawes and Gilbert founding Rothamsled in 1841, soil fertility became increasingly perceived in chemical terms. Universities founded departments of soil chemistry, only to be designated soil science departments well into the present century.

Soil management is an even newer terminology associated as it is with the improvement of soil physical properties. Physics came to take over the limelight from chemistry with the fuller **appreciation** of the significance of soil **structure,** embodied for instance in the **Strutt** report of 1972, 'Modem farming and the soil' – which also expressed some concerns about chemical excesses on the land such as high usage of nitrogenous fertilizers leading to excessive lime displacement. More recently emphasis has **been** on compaction and its avoidance, subsoil management (so ably expounded by Professor **Gordon** Spoor and his colleagues) and, more latterly still, on soil erosion in the UK. All this has set the seal on the importance of soil physical **management.**

What then of soil biology? How does it rank as a valid claimant to undergird practical soil management strategies?

Soil Fertility Criteria

Soil fertility has been perceived as a long-term quality of the soil in Britain – "the original and indestructible powers of the soil" as stated by Ricardo in his classic rent theory. Doubt has been cast on the indestructibility of some British soils already.

Soil fertility refers to the total capacity of a soil to produce and go on producing useful crop yields. It is an all-embracing concept, leading logically to a search for sustainable management strategies.

A fertile soil supplies a crop with all its current-account needs now, viz. space, anchorage, water, air, warmth, favourable pH, nutrients and freedom from poisons and restrictions. It needs also to be conserved to supply these to future generations of crops. It needs to be treated like a deposit account in a dependable bank – yielding long-term rewards with interest.

Soil is both the beginning and the ending of agricultural life, in which the role of micro-organisms is foundational (Fig.1). Soil improvement is both the lifeblood and the necessary consequence of any system worthy of the description 'sustainable agriculture'.

It seems obvious that the best likely indicators of a soil's suitability now to support a crop are micro-organisms requiring similar conditions for life to those favouring roots whilst their relative decline is the most appropriate portent of future deterioration in cropping potential.

Soil is a living system, diverse and intensely competitive at its best. It is possible to detect physical perfection in an environment whilst chemical faults may persist; such a state would result in biological poverty. It is possible to detect chemical Utopia coincident with physical unsuitability of environment. Howwer, biological activity is only optimized when both physical and chemical environments are truly ideal also. Thus a plea is made for a micro-biological perspective as the paramount indicator of soil fertility once more – but with a difference by contrast with last century, viz. that research must supply widence and facts to use as yardsticks in practical soil management with a microbial perspectivc. We must come in farming to value microbes more highly and to understand their diversity and their activities more thoroughly.

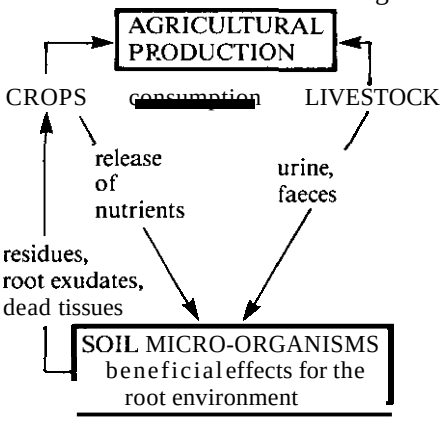


FIG.1 Soil *micro-organisms: Fundamental agents in agricultural production*

Diversity of the Soil Population

The microflora includes bacteria, actinomycetes, fungi and algae. The smallest and most numerous members of most soil populations are bacteria which are unicellular plants around one-thousandth of a millimetre in size. A saltspoonful of soil can contain as many as the human population of the world i.e. approaching 5000 million. Some can produce great-grandchildren within the hour. Far less numerous but also unicellular are the threadlike *actinomycetes* some of which are accredited with producing the characteristic splendid aroma of freshly-cultivated earth.

Fungi often tackle the more tough crop residues returned to soils and being multicellular, threadlike and fragmented are more difficult to enumerate individually so microbiologists often use the term 'biomass' to convey total weight of living matter rather than numbers. Data of the present writer concur with the work of others in showine a decline in the presence of fungi relative–to bacteria as soil pH rises (Fig.2). Furthermore, on a Coombe series calcareous silty clay loam, at a natrual pH of 8.2, I found virtually no fungal activity. Most soil fungi are smaller than above-ground relatives and commonly exist as around 1mm long fragments though many occur also as spores, some being very prolific in this respect.

Surface soils contain various types of algae including nitrogen-fixing blue-greens and silica-coated diatoms of diverse shape. The soil fauna ranges from such large creatures as earthworms, potworms, and springtail insects through eelworms (nematodes) of around 1mm in length to the *protozoa* or microfauna represented by the well-known *amoeba* some ten times the size of the average bacterium.

Activities of the Soil Organisms

Beneficial effects

Decomposition – the largest-scale operation undertaken by the majority of soil micro-organisms is to break down crop residues, faeces and other raw organic matter (O.M.) to form humus (virtually fully-decomposed O.M. of very high nutrient and water-retaining capacity and a valuable soil adhesive). In the process potentially harmful wastes which might otherwise be harbouring

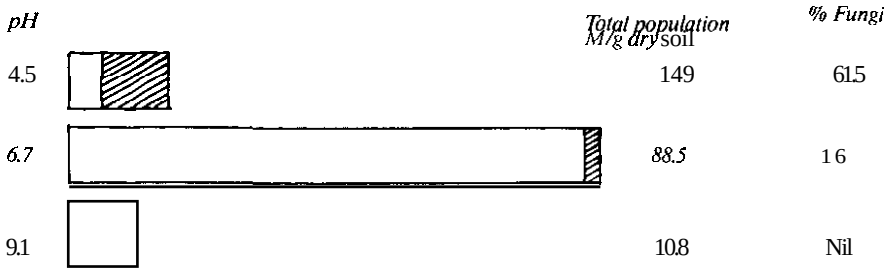


FIG.2 Response *of the* soil *microflora to change* in pH *of a loamy sand*

pests, pathogens and poisons are removed, mineral elements are liberated and humus reserves replenished.

The rate at which a soil can decompose raw O.M. such as crop residues is a function of the composition and toughness of the material involved, the size and diversity of the soil population and its level of activity as governed notably by soil temperature, pH, moisture supply and aeration. In a farm business it is not the amount of capital that is tied up which is so relevant to profitability as the rate of turnover of that capital. So it is with soil O.M. – I believe we should seek to measure O.M. quality and the influence of soil management practices on its turnover rather than absolute amount present at any one time A stagnant pond contains plenty of organic matter but its effects are detrimental rather than beneficial! The work on microbiology of straw decay by Dr E Grossbard, Dr J Lynch and others must be continued within the present studies of straw incorporation.

Mineralization – this involves the release of mineral nutrients from both O.M. and rock-oarticle sources by the action of the enzymes and other substances produced by microbes. These minerals are then available for use by the current generation of crop roots.

Special Chemical Transformations – some microbes carry out very specific chemical changes, for instance nitrification. This involves two genera of bacterium, *Nitrosomonas* and *Nitrobacter* which respectively convert ammonium to nitrite and nitrite to nitrate. Since nitrate is more soluble than ammonium it is more available for root uptake but also more easily leached. Therefore, there is current interest in bacteriostats such as 'didin' which limit the activity of these bacteria so that more. nitrogen remains in ammonium reserves in soil and is more steradilv released. Manv microbes possess the enzyme urease i.e. they are ureolytic – capable of breaking down urea to release ammonium. If this occurs too quickly then fertilizer urea can be a wasteful source-of N wen though it has 46% N in it. It is becoming more used on cost grounds. Measures can be taken to manage this activity of micro-organisms. (Fig.3 shows an example of some of the author's work on this).

Nitrogen-Fixation – apart from the well known *rhizobia* which inhabit legume root nodules there are various free-living species of bacteria and blue-green algae in soil which contribute useful amounts of N from air to soil.

Soil Aggregation – many bacteria are coated by gums which act as natural soil adhesives; fungal wefts deposit humus as they die and decay *in situ;* earthworms incorporate O.M. and concentrate calcium in their casts: (2.5 M worms to the hectare can raise over 80 tonnes of casts in a year). All these processes promote the development of a more stable crumb structure in soil. The biology of earthworms has been much studied in relation to reduced cultivation systems and Dr C A Edwards is an established authority. In Cambridgeshire, British Earthworm Technology under Dr J Mullett breeds these marvellous creatures for waste digestion.

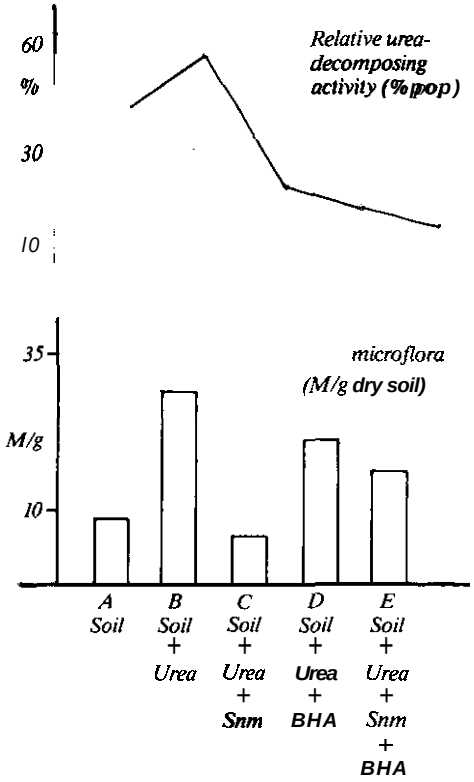


FIG.3 Some microbiological effects of urea treatments in a loamy sand
BHA = benzohydroxamic acid, a specific inhibitor of urease;
Snm = sulphanilamide, a bacteriostat

Antibiotic Production – naturally produced substances which, in small quantities, inhibit the growth of other organisms orginate in many microbe bodies. Certain actinomycetes such as *Streptomyces* are commercially cultured to collect antibiotics. These antibiotics in soil are important in defining territories for their originators. The producers are often decomposers which need to colonize a defined area of O.M. or of living crop root surface (rhizo-plane) – the immediate root zone is the rhizosphere and high microbial activity here results from a supply of root exudates (organic nutrient compounds) and the microbes in turn release minerals for roots. They also produce antibiotics which resist the penetration of the rhizosphere by pathogenic root-infecting fungi, for instance Biological control can occur in other ways – for instance certain fungi can trap and kill nematode pests e.g. Dr B Kerry's work at Rothamsted.

Mycorrhizal Symbiosis – this occurs when certain fungi coat the root system of a crop so benefitting their own lifestyle but also effectively extending the crop's root system and therefore its recovery of less accessible nutrients such as phosphates. Much work has been done at Oxford by Prof. Harley and others especially in connection with trees (where parasitism can also occur with some of these fungi). Recently trials are taking place with *mycorrhizae* in the Fens at Arthur Rickwood E.H.F. on vegetable crops – onions and celery.

Rothamsted work by Stribley *et al* has looked at cereals including spring wheat where cv. Timmo formed a useful mycoorrhizal association.

Detoxification – pollutants arrive in soils through industrialization, accident and deliberate addition for crop protection purposes. We depend on micro-organisms to render all these ultimately harmless by decomposing them. Investigations of their capacity or otherwise to do this must accompany developments in types of material added to soils.

Possible detrimental effects
Putrefaction – producing toxins in badly-aerated, cold soils overloaded with O.M.
Denitrification – leading to loss of N as gases from very wet soils.
Immobilization – the competition for very limited supplies of available nutrient which temporarily locks it up in microbial tissue instead of leaving it available to crop roots.
Pathogenicity – some microbes areagents of crop disease themselves.

All of these possible detrimental effects can be clearly linked to defective soil management. A soil physical and chemical environment favourable to crop roots also favours beneficial microbial activity.

A long-term appreciation of the roles of soil micro-organisms is needed for effective farming d as f: n e t call for and support continued relevant research in this relatively neglected field.

V13-2.

World Soil Tillage workers gather in Canada

Brennan D Soane, Scottish Institute of Agricultural Engineering reports on the ISTRO Conference 1985

The 10th International Conference of the International Soil Tillage Research Organisation, held at Guelph University, Canada in July 1985, provided the opportunity for 219 scientists from 31 countries to discuss the latest developments in soil management throughout the world. The UK delegation of 14 scientists representing ADAS, ICI, NIAE, NVRS, Rothamsted Experimental Station, SIAE, Silsoe College and Wye College was the largest after Canada and the USA. A post-conference tour through Ohio, Indiana and Michigan attracted an attendance of about 70 and gave a first rate opportunity to see tillage practices and research in the Eastern Corn Belt.

The conference was an interesting mixture of verbal presentations, poster sessions and visits to research centres and commercial farms. It was clear that tillage research in Ontario was closely geared to the needs of farmers, indeed Dr Terry Daynard considered that farmers are doing 99% of the research in Ontario. The farmers visited and their extension/advisory workers seemed very appreciative of the benefits to be gained in taking advantage of the collected expertise of the scientists while the scientists were impressed by the thorough way in which Ontario farmers were tackling zero-tillage including machinery innovation.

At a time when ploughing techniques and straw incorporation are perhaps the major interests in the UK, the contrasting trend in many other parts of the world is running strongly towards minimum and no-tillage systems with a surface mulch being strongly favoured, particularly for erosion control. Professor R Q Cannell in a review paper attributed the lack of interst in conservation tillage in north-west Europe to the higher rainfall and lower soil temperatures than in say most of north America. Conservation tillage was thought by Dr R R Allmaras of the University of Minnesota to be of interest to American farmers primarily because of the potential for reduced production costs with conservation benefits being of only secondary interest. He estimated that conservation tillage in which 30% of the soil surface is covered with crop residue is practiced on about 25% of the cropland in the USA. Unfortunately tillage nomenclature still shows a confusing variation of usage and even the absence of tillage is variously referred to as "no-till", "zero-till" or "direct drilling" in different countries.

Erosion

Erosion due to run-off during storms has been becoming more serious in Ontario whereas previously it tended to be associated with cropping in lower latitudes. This change seems to mirror the situation in Europe where erosion problems have become much more prevalent in northern regions, even in Scotland. The underlying causes may be changes in rotations, decreases in soil organic matter content, unfavourable structure and compaction in subsoils due to compaction from vehicles. Work on the role of tillage practices in influencing erosion was reported for such diverse locations as Queensland, Alberta and Nigeria.

Professor Jack Ketcheson, Past President of ISTRO with responsibility for the 10th Conference, describes a long-term maize tillage experiment started in 1969 in which continuous mouldboard ploughing has been compared with reduced and zero tillage.

Soils

There was intense interest in the need for better techniques for quantifying those changes in soil structure which are introduced by tillage and traffic and which can be shown to correlate with plant responses. Scientists are still looking for the "wonder meter" to indicate all they need to know about soil physical conditions. Some are following the high tech path with devices such as the computer assisted electronic recording penetrometer as pioneered by SIAE with the "Bush" penetrometer while others, such as G Wilson of Agriculture Canada go for simplicity with the Pedotechnical Spade or a simple soil cultivability test described by Dr H W Chandler and Dr J V Stafford of NIAE.

A new interim Soil Structure Working Group was set up representing 54 scientists throughout the world interested in this topic with Dr Pieter Groenevelt of Guelph University as the Chairman and Dr Tony Dexter of South Australia as Secretary. It was recognised that pore size distribution and pore orientation are of major importance but their measurement on a routine basis tends to be slow and laborious. Dr A R Dexter introduced his new concept of trematotropism of plant roots. He claims to have shown that growing root tips can alter course towards a pore large enough to grow through thus taking greater advantage of the larger pores than would otherwise be possible.

Compaction problems

Vehicle traffic and the resulting compaction is now widely seen as inseparable from tillage problems unless wheel traffic is either excluded totally from the cropped area, as is now the case in several experiments underway in different countries, or subject to severe restriction in both axle load and contact pressures.

An ISTRO Working Group initiated by Dr Inge Håkansson of Uppsala, Sweden, has been active in co-ordinating experiments in several countries to examine the effect on different soils and crops of vehicles having a high axle load. Even though such traffic may be followed by ploughing, the amount of compaction remaining in the subsoil is now known to cause appreciable crop losses. Increasing tyre contact area is not thought to be effective in avoiding subsoil compaction under high axle loads. Certain soils have been found to recover slowly from a single severe compaction treatment but this effect is unlikely to have much relevance if heavy axle loads are employed at frequent intervals. Where straw is incorporated there may be dramatic decreases in compactability as a result of the presence of the undecomposed material.

Recompaction after loosening

Loosened soils are now recognised as being particularly prone to re-compaction. Workers at Silsoe College described the rapid recompaction of deep loosened soils when subsequently ploughed. Some soils may develop a stabilised structure after a number of years of zero-tillage which can resist compaction from traffic and may even show a higher permeability than when ploughed.

Biological aspects of tillage

Apart from direct crop responses to tillage and zero-tillage, there is gathering interest in a wide range of resulting effects on soil flora and fauna. These effects are becoming known since zero-tillage can now provide opportunities to study extended periods of cropping on undisturbed soil. Tillage has been found to influence microbial biomass, while under zero-tillage there are more favourable conditions for the establishment of mycorrhizal associations with crop plants. The rhizomia infection of sugar beet was reported to be influenced by tillage.

Drills and implements

Several contributions described continuing work on the development and testing of new drills and implements. The problems of drilling maize through heavy trash cover seem to have been largely overcome with the use of large cutting discs. Drills were also seen with angled dished discs, either scalloped or plain, set to clear a straw-free strip ahead of the planting coulters while maintaining a heavy trash cover in the inter-row zone.

Tillage implement development is still active and Dr J V Stafford and A Geikie of NIAE described a novel implement involving oairs of inclined discs which loosen by inducing tensile failure.

Minimum tillage requirement

Numerous reports from all parts of the world were presented on the results of experiments to assess crop and soil responses to reduced and zero tillage. The results tend to be heavily dependent upon the soil, crop and weather conditions related to each experiment and the overall picture can be confusing.

With the very wide variety of tillage options now available, it is important to have clear-cut guidelines for the assessment of minimum tillage requirement for maximum yield. Papers setting out important new concepts in minimum tillage requirements were introduced for tropical areas by Dr R Lal of IITA, Nigeria and by Dr B C Ball of SIAE for a northern moist temperature area (Scotland). Their contributions will hopefully lead eventually to a global criteria for identification of minimum tillage requirement based on a unified technique for quantifying relevant crop, soil and climate factors.

There were a number of reports of long-term tillage studies (Brazil, Canada, USA and Scotland). Workers from the Edinburgh School of Agriculture and SIAE introduced the concept of a "rainfall penalty factor" to account for hitherto unexplainable fluctuations in the ratio of barley yields on ploughed and zero-tillage plots over a 15 year period. The factor is based on a simple summation of specified rainfall "deficits" and "excesses" during the early growth of the crop.

Future

Soil tillage studies are certain to have a continuing major role to play in both temperate and tropical areas. In tropical areas the emphasis will be on reducing soil erosion and increasing yields while in the temperate areas the emphasis will be on perfecting techniques which allow reductions in production costs without yield reduction and improved handling of crop residues.

Canadian farmers have followed *the trend with large increases in tractor horse-power (left to right)* but the *problem of compaction* under very high *axle loads* was *a major* concern at the *Conference.*

Prof H Kuipers in reviewing the changing role of tillage research stated that "there is a strong emphasis on crop yield as a criterion for judgements on the effect of soil tillage" and "a growing interest in the explanation of crop reactions on the basis of soil physical aspects". The solution of these problems represents a formidable challenge to the research workers and the way forward seems likely to depend on a greater sharing of experience through international working groups tackling common problems. ISTRO has a vital role in providing the framework for successful co-operation.

Next Conference

Plans are well underway for holding the 11th ISTRO Conference in July 1988 in Edinburgh with a pre-conference tour starting at Silsoe. The first announcement leaflet giving details and asking for intimation of intentions to attend is already being circulated and the author will be pleased to send a copy on request. Soil tillage and compaction research has a major role to play in the more efficient handling of our soils in the evolution of systems of crop production in the challenging times to come as well as the more immediate problems of getting crops established on time and growing well in the context of often highly unfavourable weather conditions. Unlike much scientific research, the aims of ISTRO are to achieve a synthesis of information and ideas for better crop production based on a sound understanding of the scientific principles of soil behaviour.

Reduced *and zero tillage is increasingly* used in *Ontario* as *a means* of reducing *erosion* in *maize crops with* some *interest* in *the use* of *legume/grass mixtures* being *introduced* in the *rotation* to *improve* soil *structure. Note the trash remaining* on *the surface from* the previous *crop except* where *it* has been *displaced* in the *planted row by angled discs* on *the drill*

FIELD MEETINGS

Brandon Field Estate, Suffo

Irrigation Scheduling

There was a good attendance at the July visit to Frederick Hiam Limited, Brandon Field Estate. Four irrigated sites were observed, growing parsnips for packaging, potatoes for crisping, wheat and sugar beet. Farmers were the most numerous proportion of the well balanced attendance, followed by soil surveyors and advisers. As a result, the discussions were both down to earth, yet able to go into considerable depth, and the supporting booklet of papers provided by Dr Mike Carr of Silsoe College and Ian Mathieson of Atkins Land & Water Management was well appreciated.

Mr Sam Jolley, the General Manager of Frederick Hiam's, described the characteristics of the block, which includes 1280 acres of arable land, predominantly sandy, but with considerable variations. The farm is well provided with water, from two boreholes, and two extraction points, and the system of underground mains provides hydrant points in every field at intervals not greater than 75 metres, thereby reducing on manual operations. Potatoes are grown in beds very successfully. Of the wheat and barley grown, 75 per cent goes for on-farm pig feed operations.

Dr Mike Carr of Silsoe College described how the college and ALWM had formed Irrigation Management Services which has been operating at Frederick Hiam's for two years. The full service included a soil survey, irrigation equipment assessment, and a monitoring programme which provided a weekly printout and recommendations for water application for each individual growing area.

In addition to the meteorological data that is fed into the system, the farmer phones up weekly to report the local rainfall data, irrigation applications and the estimation of the percentage of crop coverage in each field. A field observer uses a neutron scatter probe to take soil moisture readings periodically throughout the soil profile at selected sites chosen as a result of a soil survey.

Precision irrigation

Mike Carr referred to the increased interest in improving the precision of irrigation. Some of the main advantages seen for the IMS computer system are as follows:

- The soil survey carried out in each field gives a systematic basis for estimating AWC and potential rooting depth. The computer programme allows for progressively increasing rooting depth through the growing season.
- The possibility of the computer simulation progressively drifting away from an estimation of the real conditions is avoided by the neutron scatter moisture measurements.
- The periodic visits of the observer are an aid to the farmer because in the final recommendation the irrigation application for the following week is given after all the

factors which the programme allows for have been taken into account.

Ian Mathieson d trat l how the *neutron scatter probe operates. It is sensitive* to the quantity of hydrogen molecules in the surrounding soil, and these are predominantly water. It is normally calibrated for each semi-permanent observation point within the *fi and measures the moisture throughout* the profile. These calibrations show up the effects of compacted or stony layers; where there is less space for water retention.

The irrigation operations on the farm are designed to fit in with each other, to get full use of the equipment and of the water. Essentially the cereal crops are irrigated in order to ensure that the fields are all at field capacity by mid June.

Benefit of soil survey

The Soil Survey of England and Wales have a particularly close knowledge both of the soil conditions and of agricultural production. Their Regional Head, Tony Hodge, commented on the considerable variation in soil profile which would occur in the hummocky sandy areas, particularly those previously lying very wet.

Decisions made on the basis of survey knowledge were better than those made without knowledge Mike Jarvis asked about the effect of localised iron pans which the soil survey had shown to be present and which were typical of the area. It was agreed these could have considerable local effect on moisture relationships.

Sproatley, Humberside ADAS Straw Incorporation Trial

The trial at Sproatley is one in a series of many trials carried out by ADAS during the past 3 years to evaluate techniques for straw incorporation. The effect on yield of incorporating straw compared with burnt *treatments* with the *same* cultivation system has been tested to identify or not a unique yield effect due to the presence of crop residues.

The majority of farmers in the main winter cereal area of the North of England adopt the plough as the primary cultivation tool. Hence a straw incorporation system based on the plough will minimise any adjustments required for incorporation of crop residues. The trial was chosen on this heavy site as an example of a difficult soil for straw incorporation where problems may be anticipated. The soil type is a heavy clay loam over clay and good soil structure is difficult to maintain.

Theincorporation treatments were:

Straw burnt – ■ *ploughed* ● *discs plus lines (15cm)*

Straw chopped and spread – ● *ploughed* ■ *discs* plus *fines (10cm) plus ploughed* ● *discs and tines (15cm)*

Superimposed on all of these treatments were combinations of autumn and spring nitrogen to investigate the need for autumn nitrogen where straw is incorporated.

The optimum N requirement for this site was 250kg/haN and total N rates in the trial were aimed at bracketing the optimum.

Autumn N	Late Feb N	Early April N	Total N
0	40	160	200
40	40	160	240
40	80	160	280
80	40	160	280
0	40	200	240
40	40	200	280
0	80	200	280
0	40	240	280
40	40	240	320

Nitrogen *treatments (kg/haN).*

Straw was chopped and spread on the combine which resulted in uneven spread across the width of the cut. Stubble length varied between 7.5-15cm and chopped length between 5-10cm. The combine used has a 6m header and straw was spread in a band only 4m wide. The net result was uneven incorporation and a temporary N immobilisation in the swath on the non-ploughed treatments. This immobilisation of N showed up as yellowing in the crop in bands corresponding with the large concentration of chaff but this did not influence overall yield.

September 1984 was wet, the straw lay damp and a poor burn was achieved on the burnt treatments. Much unburned straw remained on these plots and was incorporated. Immediately after burning all plots were cultivated, in the case of the ploughed treatments with a 5 furrow Dowdeswell mouldboard plough and the non-ploughed treatments twice with a rigid tined cultivator and twice with medium discs. The soil was moist during the cultivations; non-ploughed treatments were compacted and the straw was poorly mixed. Inversion by the plough was good although there were some blockages with straw in the centre of the swath and pre-mixing resulted in more straw on the surface. Secondary cultivations consisted of two passes with a rotary harrow which produced a cloddy seedbed but a good mix of straw and soil.

Autumn N was applied after drilling and the effects could be seen on the non-ploughed treatments until the early spring dressing was apr with the greener crop where N had been applied. Despite the visual N effect in the winter, the autumn N plots did now show a yield benefit over no autumn N on the non-ploughed treatments and the ploughed treatments did not show anv visual differences.

Slug damage was significant on most of the area due to the cloddy conditions, with plant populations reduced by hollowing of seed. Very little leaf grazing was evident.

Non-ploughed treatments were wetter than the ploughed treatments during the late autumn and winter because of poorer surface drainage after numerous passes with implements. Seedbeds on the ploughed plots were better drained and the plants looked healthier and were slightly more advanced than the non-ploughed treatments.

Preliminary results

Yields are apparently lower in the ploughed treatment where straw was chopped and spread than where the straw was burnt. The yield level in general was 8-8.7 t/ha at 85% DM with no yield difference between burning and ploughing down straw after working the surface. The non-ploughed yields were lower than the ploughed due to the cultivation effect and not due to the presence of straw. No statistics are yet available to test the significance of these differences and since there was much variation from plot to plot no firm conclusions can be drawn at this stage. Data from trials nationally indicates that ploughing was the most effectiveway of disposing of straw in 1984 and the subsequent yields exceeded those obtained after straw burning. Tined cultivation to pre-mix the soil with chopped straw prior to ploughing was not beneficialin terms of final yield. Tined minimum tillage to about 10cm also gave satisfactory results on the heavier soils where this type of incorporation method might have relevance in terms of reduced costs and area potential.

This trial and other trials nationally will continue for at least the next 2 years and yield data will be available as soon as the statistical analyses are complete.

Colin Rudd, ADAS Soil Science, *Leeds*

Burnley Hall Farm, Norfolk Farming and Conservation

On June 14th SaWMA held a well a ei led regional field meeting on the Norfolk coast in the area between Martham Broad and the sand dunes.

The theme of the visit was to show how managed farming and nature conservation could successfully co-exist. There was a strong turnout from FWAG interests, includiong farmers Dudley Reeves (Beds) and C Johnson (Leics), and Norfolk and Suffolk FWAG and ADAS water service personnel. Speakers included Peter Wright. Nature Conservancy, Stephen Hawes, Land drainage engineer, Dr Ainsley Ede, water resources, and Bob Brewer, farming. It was Bob Brewer who spotted the Marsh Harrier flying over the reed-bed SSSI at the River Thurne.

At the freshwater dune slacks, Peter Wright, Nature Conservancy, (centre of group) explains the requirements of the Natterjack roods, while Bob Brewer gets in wirh them.

The visit showed an aspect of our land and water resources relatively new to SaWMA, but which farming could successfully accommodate and indeed could be moat instrumental in helping.

Straw Incorporation – what about Nitrogen?

A E Johnston & D S Powlson, Soils and Plant Nutrition Dept, Rothamsted Experimental Station, Harpenden

Reviewing the results of recent experiments at Rothamsted, the authors conclude that the increased use of fertilizer nitrogen in current farming systems has probably ensured that there is sufficient ammonium or nitrate nitrogen in soil in autumn to meet the needs of the soil microbial biomass to break down straw which is incorporated in soil. This nitrogen could be a direct residue from that year's fertilizer dressing or from the mineralization of soil organic matter. Nitrate-nitrogen which becomes part of the soil organic matter is not at risk to loss by leaching which may cause pollution of potable waters. Although only a small proportion of the nitrogen immobilized with each input of straw will be released to the following crop, mineralization continues over a number of years. The cumulative effect of nitrogen mineralised from extra organic matter built up from successive straw incorporations may make a significant contribution to the nitrogen requirement of crops.

All plant and animal remains incorporated into soil are processed by the soil microbial biomass, the largely unseen but ever-hungry living organisms in the soil. This active biomass and the simple decomposition products produced are the main source of plant nutrients which are cycled through soil organic matter.

Straw added to soil is a welcome source of food for the biomass but it is an unbalanced diet, being rich in carbon and poor in nitrogen. At harvest, straw contains about 35% carbon hut only 0.35 to 0.7% nitrogen and it has therefore a carbon to nitrogen (C/N) ratio of between 100:1 and 50:1. The cells of the organisms that comprise the hiomass and the soil organic matter or humus they produce are both richer in nitrogen than straw, having C/N ratios of about 6:1 and 10:1 respectively. Although much of the surplus carbon in straw is lost to the atmosphere as carbon dioxide during decomposition, some extra nitrogen is required for the conversion of nitrogen-poor straw to relatively nitrogen-rich soil organic matter. This tie-up f mineral nitrogen t organic forms is known as immobilization.

Any organic material with a C/N ratio greater than about 30:1 causes immobilization of nitrogen when added to soil, whereas materials with a lower C/N ratio release i. This is why FYM, with a C/N ratio of about 13:1, acts a source of nitrogen for crops. The nitrogen required to convert straw to FYM came from dung and urine and nitrogen immobilization occurred in the manure heap.

Straw decomposition – the need for nitrogen

The process of releasing nitrogen from soil organic matter, also done by the biomass, is called mineralization. It proceeds continuously in soil provided the soil is warm enough and wet enough. This explains why soil organic matter levels decline when no new organic materials are added. Thus the amount of organic matter in soil depends on the balance between additions and decomposition.

The amount of nitrogen which will be immobilized when straw is added to soil depends on its nitrogen content and by calculation can be shown to vary between 5 and 10kg N per tonne straw. However, not all of the nitrogen is required in autumn immediately the straw is incorporated. It is difficult to measure the amount of nitrogen actually immobilized under field conditions. One indirect method is to measure the amount of nitrogen which must be added to soil with incorporated straw to achieve the same yield as in the absence of straw. Of course this method ignores any effect of straw on yield caused by factors other than shortage of nitrogen.

In an experiment done at Rothamsted from 1933 to 1958, 53 cwt/acre (6.7 t/ha) of wheat straw was ploughed into the soil in autumn before growing either potatoes, sugar beet or spring barley. On average, adding 22lb or 10kg N per tonne of straw ploughed in was sufficient to overcome yield loss due to nitrogen deficiency.

Similar results were obtained in a series of experiments done between 1951 and 1961 on four MAFF Experimental Husbandry Farms. In these experiments between 5 and 10kg N per tonne of straw was sufficient to overcome the decreases in yield caused by straw incorporation.

In more recent experiments such as that on Rothamsted's light land farm at Woburn, straw was incorporated at 60 cwt/acre (7.5 t/ha) without supplying additional nitrogen. With the exception of spring barley, grown in the first year, yields of all crops have been larger following straw incorporation (Fig.1). These results, which show no requirement for additional N in the presence of incorporated straw, are in agreement with recent ADAS results from straw disposal experiments.

The discrepancy between the earlier and later results requires explanation. One obvious difference between the 1950s and the mid 1970s has been the increase in amounts of fertilizer nitrogen applied to cereals: 1950, 33kg to wheat, 25kg to barley; mid-1910s. 100kg to wheat, 80kg to barley. The apparent recovery of fertilizer nitrogen ir the 1970s was probably about 50% so in this period more nitrogen was unaccounted for than was applied in total in the 1950s. Thus much larger residues of fertilizer nitrogen could have remained in soil in autumn in the latter period but it is unusual to find large quantities of nitrate-nitrogen in soil immediately after harvest. However, increased fertilizer N use increased not only grain yields but also the amounts of stubble and roots which have remained in soil. This will have increased the size of the biomass. In autumn as the soils wet up and whilst they remain warm, much mineralisation of organic matter will take place and, in the absence of a growing crop to compete for the nitrate, there will be a plentiful supply for the organisms breaking down the new input of straw.

Straw incorporation and its effect on the nitrogen economy

One way to get more accurate information on the effects of straw incorporation on the nitrogen balance in the soil is to use the heavy stable isotope of nitrogen, 15_N, as a marker or label. This 15, behaves just like normal nitrogen (14_N) but can be distinguished from it by special analytical techniques. Such techniques, and the 15_N itself, are both very

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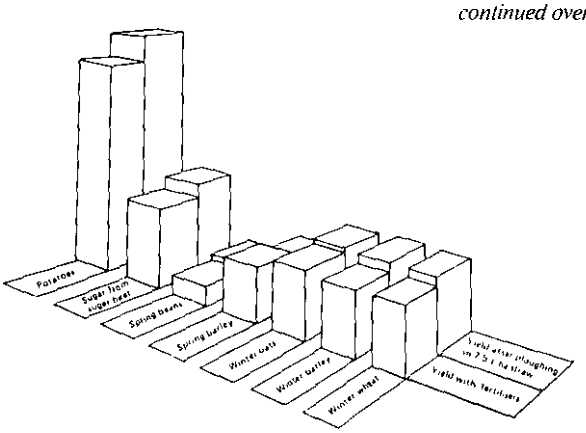

Fig.1 **Yields** of various *crops* following the ploughing-in of *straw,* to which no fertilizer N was applied in autumn, on a sandy loam soil.

expensive, but it is a valuable tool to follow the fate of fertilizer nitrogen in soils and crops.

In a recent experiment at Rothamsted, 48kg N/ha labelled with 15, was applied to plots with or without wheat straw incorporated in autumn. Grain yields of the following winter wheat crop were little affected by the straw, 10.8 and 10.4 t/ha without and with straw respectively. The amounts of nitrogen in the above ground crops at harvest were also virtually identical, about 220kg N/ha. Of the 48kg N/ha applied in autumn there was an extra 3.5kg/ha in the crop and an extra 3.7kg/ha in the soil at harvest where straw had been incorporated. This suggests that even for crops

Fig.2 A specially designedspreader to ensure uniform applicition of fertilizer nitrogen labelled with 15,.

which required, and contained, large amounts of nitrogen there was little competition from decomposing straw for additional autumn-applied fertilizer N. The straw (3 t/ha) was expected to immobilize about 25kg N/ha as it decomposed hut only 3.7kg of this came from the autumn applied fertilizer. Therefore the extra 21kg must have been soil-derived nitrogen. In the absence of the straw this 21kg N would almost certainly have been leached from the soil during winter. This result suggests that the large scale incorporation of straw could significantly decrease the quantity of nitrate leached from arable land and thus decrease the risk of polluting potable waters.

In another experiment wheat straw which had had its nitrogen-containing constituents enriched with 15_N was added to soil in autumn and winter wheat drilled. This crop at harvest contained only about 10% of the labelled nitrogen, 80% was still in the soil in ic f 1 10% had been lost. Thus only a small fraction of the nitrogen in the straw was available to this next crop. However, it is likely that there will continue to be a build-up of organic matter from successive inputs of straw on many soils and the nitrogen mineralized from this increasing quantity of organic matter could make a significant contribution to the nitrogen requirements of a crop in any one year. This is being tested in new long-term straw incorporation experiments recentlv started at Rothamsted and Woburn.

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BOOK REVIEW

Fertilisers in UK Farming

A case study report
by the Centre for Agricultural Strategy

As the author explains, this hook has been written primarily to present a simplified account of the use of fertilisers on UK farms for the enlightenment of interested lay people and of those who influence public thought or take relevant decisions.

The background to the publication of the book is a recognition of the growing concern that some aspects of modern farming, including the application of agrochemicals and fertilisersmay be damaging to valued wildlife. both plant and animal, and their habitats.

The book is an attempt to present the fans, both for and against, so that people can be well informed in the ensuing debate.

The objectives are similar to those of our Association in the presentation of our Conference "Pollution on the Farm" and, although we are addressing a more technically qualified audience, we hope the end result will have equally widespread application and relevance.

"Fertilisers in UK Farming" covers the subject extensively; starting with first principles of plant and animal nutrition it proceeds through manufacture of fertilisers to assessment of fertiliser requirements and the effect of fertilisers on productivity, quality and also the environment and health.

A summary of the concepts described in the book leads the author to outline certain reservations that are held to varying degrees about the use of fertilisers. He dismisses the suggestion that unused unaccompanying ions, such as sulphates, could accumulate in soils t undesirable levels, but he recognises that traces of heavy metals such as cadmium need watching and this is being done.

In so far as the growing-power of fertilisers could now enable less land to he used for food production the author questions what should then be done with any land so released and in any event is it right that in a hungry world we should be seeking to reduce production. And if the alternative to fertilisers were to be greater use of manures, then it is pointed out, more problems of environental pollution are likely to be introduced than solved – there is alreadv an urgent need to devise ways of economically disposing of manure.

Finally, on the question of nitrate leaching into drinking water, or being taken up by vegetables, whilst the author indicates various ways in which leaching might be controlled he also points out that present evidence does not establish that current or conceivable future levels of nitrate ingestion pose any potential medical problem. However, insofar as public anxiety has now been raised on this issue perhaps a government sponsored inquiry may be the answer to establish facts and allay fears.

In the end, but inevitably with our present state of knowledge, the book leaves us with more questions than answers, but, at least, the reader will then be in a better position to argue from fact what can and should be done on this important subject. CGB

"Fertilisers in UK Forming" by J L Jollans is available at £8.W incl. *postage from* The Centre for Agricultural Strategy, University of Reading, I Earley Gore, Reading RG6 2AT

RESEARCH

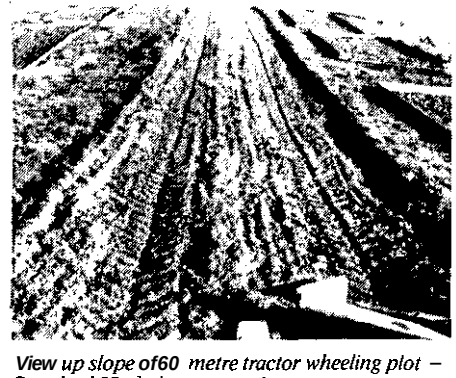
Soil Loss Experiments from Tractor Wheelings

Report from Dr Alan Harrison Reed

Full scale plot studies have been under way since 1975 at Hilton, East Shropshire at Grange Farm where the Polytechnic rents an experimental site. An array of 10 plots 25m² occupy a segment of a sloping field with sloping values ranging between 8 and 15 degrees. The latter slope facet was at the time considered to be near the upper limit of cultivation.

Each plot is rotovated and allowed to settle by natural compaction (rain drop impact and splash) and rainfall run-off is collected in base of plot receivers. Tentative findings indicate annual soil losses ranging from 15-17 tonnes per hectare in 'average' seasons rising to over 40 tonnes per hectare per year in adverse seasons such as 1976 and 1983.

Work has now commenced on a second sequence of plots ranging in length from 20 metres to 60 metres to measure run off and sediment yield from tractor wheelings. Simulated situations on pairs of plots will measure whcclings made in one pass, as well



View up slope of60 metre tractor wheeling plot – Standard 25m² plots at margin.

as secondary and tertiary wheelings (i.e. two and three pases along the same wheel:..gs to simulate tramlines).

Already in a preliminary trial one 60 metre tractor wheeling (single pass) yielded 50kg of sediment after only 9mm of rain which fell over 10 hours. High yields of run-off and sediment are expected from heavier rainfalls.

More information will be provided in a forthcoming paper in Soil and Water.

Dr Harrison Reed is Principal Lecturer in Soil Science, School of Applied Sciences, Wolverhampton Polytechnic

Why the Breakdown of Straw needs Nitrogen

by Dr R Dunn – George A Palmer Ltd, Peterborough

The breakdown (oxidation) of organic matter by soil micro-organisms results in the production of nitrogenous and mineral compounds in a form available to plants, and which are needed by them for growth. The micro-organisms utilise organic carbon to generate energy for the formation of microbial tissue and also require nitrogen and mineral salts for growth.

If the carbon to nitrogen ratio of the organic matter on which the micro-organisms are living is low – as for example, dried blood – more nitrogen will be freed during the breakdown process than the micro-organisms can use in their tissues. This means that nitrogen is made available for plant growth. However, if the carbon to nitrogen ratio of the organic matter is high – as in the case with straw – the large amount of organic carbon will provide the energy for a large increase in microbial growth. Thus the microbial demand for nitrogen and mineral salts is increased. This can result in available nitrogen from the soil practically disappearing. This nitrogen 'starvation' period will persist until the supply of easily oxidisable organic carbon is greatly reduced, at which time the microbial activity will subside, and hence microbial demand for nitrogen will lessen. The duration of the nitrogen starvation period will depend upon the amount of straw added as well as factors such as temperature, aeration and moisture. However, most rapid breakdown and thus greatest nitrogen demand generally occurs during the first 4-6 weeks after incorporation of straw into the soil. In a modern agronomic timetable, 4-6 weeks after primary cultivation coincides approximately with the time of drilling, and more importantly, early croo growth

Thus, when straw-is ploughed into the soil, additional nitrogen is required to prevent possible yield depression, due to some nitrogen being needed to build uo microbial tissue. Applyine additional nitrogen will also prevent nitrogen limiting microbial growth, thus enabling the rate of decomoosition to be considerablv increased and resulting in a larger proportion of the organic matter being converted into microbial tissue This will have the nett effect of increasing theamount of organic nitrogen in the soil, which will eventually be broken down by soil micro-organisms and released in a form available to the crop.

Organic nitrogen application beneficial

The extra nitrogen can be added in any inorganic form, such as Ammonium Sulphate, but organic nitrogen application may be more beneficial for at least two reasons. First, the carbon to nitrogen ratio of soils is usually relatively constant. This is because during the decomposition of organic matter both carbon and nitrogen are lost from the soil. Eventually their percentage loss rates become approximately similar. that is, the percentage of total carbon lost approximates the percentage of the total nitrogen lost. This stabilisation point for arable soils is usually at a carbon to nitrogen ratio of approximately 11:1. Total soil nitrogen is thus the limiting factor and so the amount of organic nitrogen in the soil determines the amount of soil organic carbon. Thus adding organic based nitrogen such as Palmers Nitragro with the straw will enhance the possibility of an accumulation of organic matter in the soil.

Improvement in soil structure

Secondly, there is some evidence to suggest that organic nitrogen sources will not only supply nitrogen, but also lead to an improvement in soil crumb structure, due to a greater development of the fungal population compared to bacteria, resulting in a more mellow and friable soil.

A practical example of the above was furnished by a farmer at SaWMA's Eastern Counties Conference (1982). He stated that, over the last 20 years incorporationg chopped straw into his soil plus pig slurry (organic nitrogen source), resulted in improved soil structure and a 30+ % decrease in nitrogen fertiliser requirement.

Other plant nutrients needed

One final point to consider is that during the breakdown of organic matter, other olant nutrients besides nitrogen – mav at least temporarily – be in short supply. The ash of microbial tissue may contain uo to 25% ohosphate and 37% potassium, so micro-organisms may compete with growing crops for the available supplies of these nutrients if the soil or organic matter is very low in them (as is cereal straw). Furthermore, there is some widence to suggest that increasing the phosphate supply of organic material rich in nitrogen e.g. clover residues, increases the proportion of organic matter that accumulates in the soil.

Dr R Dunn

Pesticide regulations

Under the Food and Environment Protection Act, 1985 it is planned to introduce regulations concerning the use and handling of pesticides.

A Consultation Paper is due to have been issued by the end of October and will be available through appropriate channels to all those with an interest in the subject.

After allowing time for submission of views on the proposals, the Government's intention is then to prepare a final draft for presentation to Parliament so that the regulations can be brought into effect by early summer, 1986.

Let's Cool It!

Putting the subject of agricultural pollution into its proper perspective

Murray Sandeman, Press Adviser to the Fertiliser Manufacturers Association and formerly ICI's Agricultural Manager

For some years 1 have been acutely aware that 'pollution' or 'pollution of the environment' has become an 'in' subject to study, to research and to express opinions about in newspaper articles, books, conferences and television programmes. Ever since Rachel Carson put pen to paper in the 1960s to voice her opinions about the destruction of the countryside, the agricultural industry in general, and farmers in particular, have been subjected to attack after attack from a wide assortment of what are popularly known as environmentalists.

Agriculture argues that the environment and the countryside is not being spoilt. Others say it is. The war of words has become so vicious and so polarised that the two 'sides' do not trust each other any more.

Well meaning people, who have tried to fill the middle ground of opinion, have tried to analyse why this 'war' has come about in an effort to end it.

One of the more popular reasons put forward is that since World War II the agricultural industry has been so intent on increasing production, using all the latest technical resources, that it never stopped to consider whether it would be a good idea if it explained to the general public what it was doing. After all, it is the public who have to eat the stuff produced by the industry.

A cool look at the facts reveals that the truth is far removed from both these images.

Regrettably those who label farmers as polluters of the environment today are not usually aware of how agriculture has been developed. Nor, incidentally, do many of them have much idea of the safetv standards demanded bv Government authorities and others in the application and use of modern agrochemicals and fertilisers.

Before discussing some of these issues and presenting them factually and, I trust, unemotionally, let me offer a word of warning.

Environmental regulations made in this country are not simply an issue of scientific facts and it is a delusion to imagine that decisions, even in an ideal world. could ever be based on complete impartiality and objectivity. Before you rise to disagree, let me make it clear that these words wereuttered, not by me, but in a report by the Royal Commission on Environmental Pollution.

The effect of political considerations entering the debate on agricultural pollution is emphasised bv another part of the reoort:

"Public opinion, where it can be reliably gauged, is another important factor to be taken into account. In forming its opinions the public is heavily influenced by what it learns from the media and'other sources and by the ways in which the issues are presented. We have noticed a tendency in some areas for relatively small risks to become magnified and for the public to see major hazards where there is little evidence of potential damage. This does not mean that the strength of public opinion in these circumstances is not a valid reason for governments to take action, since that is a matter for political judgement",

Which is all another way of saying that if public opinion is strong enough, it can persuade governments to take action on environmental issues which are, scientifically speaking, not a problem. The scientific purists in the agricultural industry would do well to remember that!

The public's concerns

High on the list of the public's pollution 'concerns' are the effect of straw burning and pesticide, herbicide and fertiliser use.

Aware of the build-up of public feeling on straw burning and, as part of their general need to help farmers avoid unnecessary side effects of modern farming practice, the NFU produced a Code of Practice on straw burning which has been reviewed annually since 1978. It has become progressively stricter, especially in the wake of public outcry in 1983. The tighter controls highlighted in the NFU's Code were drawn up on consultation with Government departments and conservation interests. In England and Wales the Code also forms the basis of byelaws recommended by the Home Office and adopted by local authorities in most straw growing areas.

A mammoth publicity campaign mounted in 1984 has undoubtedly contributed to a vastly improved situation this year, although the soggy weather has obviously played its part.

If these attempts to minimise the nuisance caused by straw burning do not have the desired effect, a ban on this highly critical husbandry technique seems inevitable.

The so-called 'pollution by pesticides' can be divided into two areas of concern – residues in our food and their effect on the countryside.

Space does not permit a thorough investigation of the subject here, but it is worth recording that Rachel Carson's book, referred to earlier, did much to awaken public interest – and anxiety.

As far as residues in food are concerned, there is no amount of misunderstanding. Television programme presenters will give an impression that you could almost scrape the chemicals off an apple because it has been treated so many times, yet the reality is far removed from that picture.

It is true that minute pesticide residues may be left in the harvested crop, though they do not necessarily remain after processing or cooking. The amounts are usually so small that it is hard to comprehend their significance.Government standards are among the highest in the world on this subject and minimum residue levels are in accordance with standards advocated by the World Health Organisation.

continued overleaf

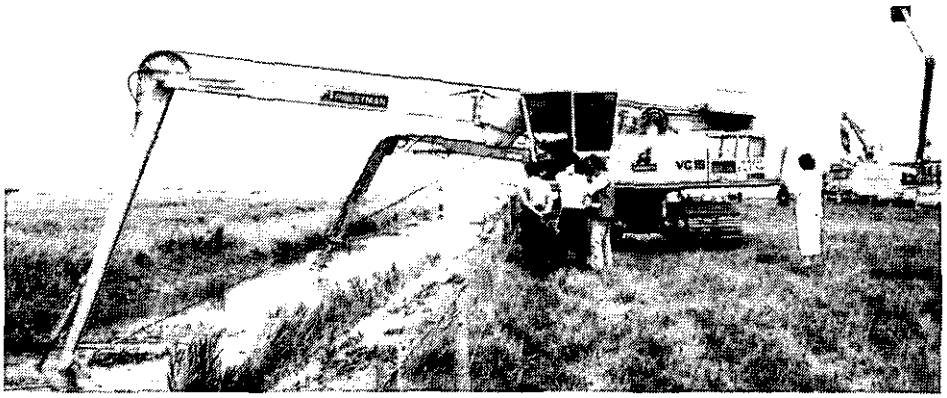
Drainage authorities demonstrate the way ahead

Report by Mike Darbishire on the 1985 ADA Demonstration

'In balance for the way ahead' would have been an apt theme for the 5th Demonstration by the Association of Drainage Authorities held at Cross Gun Meadows, Thorney, Cambridgeshire recently. The comprehensive content of the went clearly indicated the depth of responsibility, under the lack lustre titles, of Drainage Authorities and Internal Drainage Boards. Considerable powers are invested in these, though their objectives are frequently misunderstood by the public

Whilst the benefits to agriculture of their work is acknowledged, it should be remembered that the interests of the urban population are of equal importance and protected. This was evident in the various displays showing the care and consideration given to maintaining the 'conservation balance' to ensure habitats for wild life and plants. The complex tools of modern day waterway management, equipment and services were available for assessment.

The enthusiasm and interest of visitors and exhibitors was expressed in the close attention to detail shown by H R H The Duke of Gloucester to each sector on display. The extensive static and working sites hosted some 72 exhibitors with commendable presentations of a varied range of equipment, materials, and services. Visitors largely represented membership of the Association, which includes Regional and Local Land Drainage Committees of Water Authorities and the 250 Internal Drainage Boards across the country. A good attendance was reported from all over the British Isles, with foreign guests from Holland, Italy, Germany, Eire, and the USA.



The Sanderson *Forklifts* Ltd, Priestman *VC15* excavator

Along the waterways and ditches neighbouring the static area were the working demonstrations, comprising of some seven sites. Of the long-reach tracked excavators, the Ackerman, the Poclain and new JCB 814 could be compared with the wheeled Leibherr. However, the Sanderson Forklifts Ltd., Priestman VC 15 attracted much attention, and seen for the first time at an A.D.A. Demonstration. It is the forerunner of a projected range which combines the best features of a dragline and tracked excavator.

The VC 15 counter-weight design offers increased bucket payloadwith long-reach and high stability, whilst retaining excavator versatility. Roy Sanderson, the Chairman of Sandersons, who have acquired Priestmans was obviously pleased with this latest addition to their product range, and keen enquiry was expressed.

Three models of weed-cutting boats showed their paces in a limited area, some being fitted with ancillary attachments to clear debris on to the banks, such as a buckrake. Various flail mowers, both tractor mounted and self-propelled such as the high speed Mulag RM 50 from Bradshaws, commanded attention. The Berkenheger 'Spider', now marketed by Interdrain, and in use with the South Holland I.D.B. proved a major attraction. It was supported nearby by the Tractor Bicycle with mounted cutter (or flail) and rake. ➤

continued from previous page

'The persistence of organochlorine insecticides in the 1950s and *1960s* is a striking exampleof undesirable levels of a product persisting for a long time in the environment. Residues of the insecticide DDT were found in Antarctic seals and penguins while dramatic effects were seen in birds of prey. On the plus side. DDT saved millions of people from dying of malaria, a fact whichwent largely unnoticed by the headline writers of the day.

Organochlorines have largely been withdrawn from use in the UK and the more recently developed organophosphates, carbonates and pyrethroids are much less persistent and are often used at very low rates. The whole agrochemical scene has, in fact, cleaned up its product range in terms of environmental effect, but it still has a long way to go in satisfying the demand of some sceptics.

Provided that the world population increases at its present rate. and there are no signs of that changing, pesticides will become an even more vital tool in the business of food production. Every reasonable precaution must be taken in testing and using them, and their effects must be continually monitored to make sure they are environmentally acceptable. The proposed Food and Environment Protection Act will help that to happen

Nitrates

A more recent area of concern has been on the fertiliser front and it concerns the increasing level of nitrates found in our waterways.

Many critics simplify the subject by stating that nitrate levels are caused by unwanted or excessive fertiliser running off our farmland. Ii fact the subject is vastly more complex.

Rising nitrate levels are the result of increasing levels of production which began in earnest after World War 11. It is simply not possible to produce the nation's food in the quantities needed without nitrate leakage. Most of the leakage fhat does occur comes, not from the fertiliser as some people suppose, but from the soil's own organic matter. the amount of which is determined by the level of intensity of the crop: ping. (Even a comnlete change to organic farming and the use of liberal quantities of **FYM** would not prevent nitrate leaching.)

On the health side, the Department of the Environment and the Department of Health & Social Security have made it clear on a number of occasions fhat the extensive epidemiological evidence gives no support to the suggestion that nitrate is a cause of cancer of the stomach or any other organ.

The DHSS confirmed that, on blue baby disease, it knows of no suspected or confirmed cases in the last decade which can be attributed to high nitrate levels in drinking water.

Although the evidence that nitrates do not pose a threat is quite clear, tougher water quality standards arecontinually being made and have to be met. Clearly it is in no-one's interest that nitrate should be leached into water courses and the future must lie in sensible use of fertiliser, more tailor-made to the needs of the crop than hitherto. At the same time we should be adopting agronomic practices which minimise the likelihood of nitrates reaching our waterways.

Invest in research and development

If our systems of agriculture are to be accepted by the public in future, and it is crucial that they are, the only sensible way ahead is to invest in research and development to identify suitable farming practices which ensure our national heritage is passed on to our successors.

The ADAS/LAWS demonstration of tiles and headwall outlets lent weight to the importance of 'Drainage Aftercare', which was backed up with jetting of land drains. There were plots of various treatments using chemicals to control aquatic weeds in watercourses, which had much to commend them.

Thory Plant Hire of Whittlesey, Cambs., demonstrated the modified Hymac 580C, which had had the track width increased from 8'0" to 12'0". The conventional bucket had been replaced by a 'V' bucket especially designed for trenching providing either a 1:1 or 1:1½ batter. The excavator straddles the ditch area and the operator can control grade using Laserplane equipment. Buckets were quoted by Mr Thory to be priced at from £1,100 to £1,250 for the range of 2'0" to 5'0". Conversions of most excavators could be entertained at a cost of about £4,500 each. Thory, Mastenbroek, and Bradshaw were offering cutting buckets for excavators.

High technology was not omitted, and Essex Telecommunications Ltd., and the Oundle Division of Anglian Water Authority both showed the computer application within this sector of the industry. The former have been responsible in developing 'AFCOPS' system now in use at the North Level I.D.B.. and claims to be the first in the world using microprocessors for the monitoring and remote control of pumping stations. The Oundle Division showed their weather Radar system which offers immense potential in pin-pointing areas of severe storms. Interconnected by land line to weather stations, the progress of severe weather appears on the screen, colour coded to identify in mm. the quantity of rain actually falling. Using a zoom facility local storm centres can be narrowed to within less than two miles. I.D.B's, Fire Stations, local authorities and Farmers will applaud this service when it becomes fully operational.

The objectives of a comprehensive approach to maintain an efficient and balanced policy for water management throughout the country by ADA must be commended.

RESEARCH

Macaulay Institute for Soil Research – 1984 Annual Report

New evidence on nature of soil organic matter

Despite many years of research by soil scientists much is yet unknown about the nature and identity of the organic matter in soil. With the development of pyrolysis – mass spectrometry (Py-MS) methods in the Department of Mineral Soils, however, it is now possible to assess the organic matter status in whole soils rapidly and semi-quantatively. The effect of particular soil processes, such as gleying and podolization on organic matter composition is another feature distinguished by Py-MS. This work is now at the stage where Py-MS can be used to correlate organic matter status with soil history, physical structural condition and soil fertility.

Widespread sulphur deficiency now acknowledged

In former years sulphur was added inadvertently to soils in the form of superphosphate fertiliser and in basic slag, but the modern practice of using triple phosphate and the clean up of the atmospheric inputs of sulphur dioxide have changed the situation markedly.

Apart from increasing the yield of many crops, sulphur fertilisation also increases the quality of crops by maximising the production of essential amino acids and proteins. An experiment was set up to compare the effectiveness of sulphur applied as ammonium sulphate to the soil and as elemental sulphur in a foliar spray. Results on grassland showed a substantial yield response irrespective of the sulphur form used.

	oven-dried yield t/ha				
Kg S/ha	*Cut 1*	*Cut 2*	*Cut 3*	*Cut 4*	*Total*
Nil S	5.6	1.0	0.9	0.6	8.1
10kg S applied as foliar treatment before first, second and third cuts	5.8	1.7	3.1	2.6	13.2
20kg S m ammonium sulphate to soil	5.8	2.1	3.0	2.4	13.3

Effect of sulphur on yield of ryegrass

Tree Nutrition: Nurse species decrease need for fertilisers

The high cost of nitrogen fertilisers can pose economic restrictions on the afforestation of poor peatland and upland heaths. There are also worries about the run-off of fertilisers into waterways that may feed urban water supplies. The Institute is investigating the "nurse species" phenomenon whereby mixed growth of Sitka spruce with pine or larch can reduce or even remove the need for nitrogen fertiliser. The work is funded in part by an EEC contract and should lead to an understanding of the wav in which nitrogen and other nutrients cycle more rapidly in mixed stands and to the development of low input management systems.

New technology permits study of undisturbed roots

The availability of new technology has greatly facilitated the direct, undisturbed, in-situ examination of root behaviour. Work in the Deoartment of Soil Organic Chemistry employs an extended red–range Newvicon camera sensitive to non-visible light >800nm in conjunction with infra-red emitting diodes to observe the behaviour of roots under conditions of total "plant darkness". This offers a uniquely useful way of observing the response of roots to many chemical and physical stimuli and their behaviour under conditions of varying restraint.

This work links up with the seed bed studies and with previous work on seedling growth.

Land Restoration in the USSR

by N V Simakov, V E Zibarov, V N Popov, M B Estaev – *Ministry of Non-ferrous metals.*

Following the interest shown in the three articles on UK land restoration practice published in our July issue, we are pleased now to include an article on methods and practices overseas.

We are indebted to the United Nations Environment Programme for permission to . duce the following tract from the article which appeared in the Spring quarter issue of their journal Industry and Environment (Volume 8 No 1 1985).

The conservation of land in the Soviet Union is written into the Constitution of the USSR, according to wh land is state property, the common possession of the entire Soviet people, to be used in the interests of societv. In 1968 the Supreme Soviet of the USSR adopted the "Fundamentals of Legislation for Land of the USSR, and of the Union Republics': to establish legal standards and prescribe a scientifically sound, rational use and conservation of land.

That Act gives priority to agricultural use over all other types of land-use to comply with the needs of the national economy. Consequently, all branches of the mining industry are required to take the necessáry measures to conserve the land resources of the country and to provide for the recultivation of disturbed lands.

An analysis of the terriotorial distribution and nature of the disturbances of lands during the mining of minerals shows that the overwhelming part of disturbed land belongs to the most highly developed industrial regions with high population density and to the regions with the best agricultural conditions.

The diversion of lands to mining operations in the most fertile zone of the European part of USSR without their recultivation would lead to annual costs of several thousant roubles per hectare.

Research into methods

In the USSR work on the theory and practice of land rehabilitiation has been widely developed, and research is being focused on technical, engineering and ecological measures for the recultivation of lands disturbed by the activity of mining enterprises.

Between 1971 and 1975 some 168,000 hectares were recultivated and returned for use; between 1976 and 1980 this had risen to 545,000 hectares, 338,000 of which went back to agricultural production including 151,400 hectares of arable land. The trend towards an increase in the scale of recultivation is also being maintained in the current five-year period.

The method most often used is that basic mining equipment of the quarries is borrowed for reclamation, and special equipment is used in addition. The use in modern quarries of powerful mining and transportation equipment enables reclamation operations to be an integral part of a single technological process. This substantially reduces costs and shortens the time reauired to restore the land for agricultural production.

The removal and deposit of the fertile soil layer

In accordance with the asic provisions for land rehabilitation, the mining enterprise is obliged to remove and transport to the place of stacking (or temporary storage) the fertile soil layer as well as to deposit it on the rehabilitation lands or the low-yield areas.

Before the removal of the fertile soil layer, the suitability of the soils and rocks for subsequent recultivation is determined. Its suitability is ascertained on the basis of the agrochemical and physical properties of the rocks. The main indicators include: acidity, the content of elements of mineral nutrition, and salinity. The majority of extracted rocks are characterized by a low content of nutritional minerals in a form available to plants. Such shortage is made up by applying appropriate mineral and organic fertilizers. Establishing the suitability of the rocks is of great importance in planning the technology of working stripped rocks and their stockpiling in dumps.

Before the removal of the fertile layer, the site is cleared of refuse and stones. The thickness of the layer to be removed is established according to data provided by agrochemical analyses. It varies within a range of from 0.3 to 0.5m. After the removal of the soil layer, rocks are extracted to a depth of up to 1.5m and stored separately as potentially fertile rocks.

In planning the removal of the fertile layer from sites allotted to quarries, dumps, tailings dumps, slurry reservoirs, roads and other installations, the sequence of operations for the removal is drawn up, taking account of the effect of specific types of disturbances on the timetable for the removal of the fertile layer.

Usually, the period of storage of the fertile layer in dumps is not limited, since provided proper conditions of storage are ensured, the content and quality of humus in it are not lowered. With a view to conserving the agrochemical and biological properties of the fertile soil layer, dumps should not be higher than 10m. In order to ensure stability against erosion, their surface is sown with perennial grasses.

The technique used to remove the fertile soil layer from disturbed lands should be chosen so as to make efficient use of the available equipment fo excavating.

Filling the gaps in knowledge

Both under natural and man-made conditions the processes of self-regulation of the terrain are maintained. A newly created terrain (a quarry, dump etc) achieves its own dynamic equilibrium, as expressed by the complete stabilization of the phenomena of settling, erosion, oxidation of rocks and other factors.

On the basis of observations and experiments in the reclamation of dump rocks, the following factors have been determined: the maximum time required for the settling of the rocks in the dump; the time required to carry out the final (post-shrinkage) levelling of the surface and slopes of the dump; the time required to set up an insulating screen ensuring the protection of the rehabilitated site against the effects of toxic waste rocks and the time needed to install sub-soil water drainage.

To a large extent the time required depends on the age of the dumps. If the dumps were established a long time ago, the rocks will probably have settled however. in such dumps because of bulk dumping in the past, and the possible phyto-toxicity of the rocks and because of the non-conformity of the surface, a relevelling of the surface and slopes of the dumps may have to be carried out, as well as the screening-off of any toxic rocks before reclamation is complete. Under circumstances in which the dump has to be reworked, a plan has been devised which combines technological and reclamation operations, as well as selective dumping.

Levelling operations

The surfaces of man-made dumps tend to be uneven, depending on the technology used in dumping, with thk result that they cannot be readily used for forestry and agriculture. Therefore the operations for levelling the surface of the terrain are planned with a view to its subsequent development, hence the degree to which the surface of the dump is evened out is determined according to the recultivation required and the type of subsequent development of the rehabilitated lands. Topography and the exposure of the slopes are the main factors determining microclimate. The levelling of the surface leads to an increase in the density of the rocks, decreasing the rate of infiltration, and impairs the adaptability and growth of brushwood plants.

Continuous levelling to create a zone-like surface is used in rehabilitating disturbed lands for ploughing, and to some extent for tree-planting. The most common practice is to carry out partial and terraced levelling, with the shearing off of crests and the flattening out of slopes.

The choice of levelling is, as a rule, determined by the nature of the man-made terrain, the composition of the rocks and the mechanized means available Levelling is carried out in two stages, the time between the rough and the final levelling, and their extent being determined by the plan.

Conclusion

The experience of recultivation in the non-ferrous metallurgy of the USSR shows that the main condition for enhancing the effectiveness of recultivation operations is the selective formation of dumps, carried out by the basic mining equipment. In the USSR, different dumping methods have been successfully employed in rehabilitating land after non-ferrous mining.

V13-2.

DIARY

NOVEMBER 1985

12* "Pollution on the **Farm**"– SaWMA, MAFF/ADAS – E. of E. Ag. Soc. One-day Conference – Silsoe College, Silsoe, Beds. 10.30 – 4.30.

19 The Future Role for Drainage – One Day Conference – **RASE/ADAS** National Agricultural Centre, Kenilworth, Warwick

M **Better** Soil Management for Cereals and Rape – One Day Conference – RASE, **ADAS** National Agricultural Centre – Kenilworth, Warwick

DECEMBER **1985**

2-5 Royal **Smithfield** Show – Earls Court, London

4 Grassland **Manuring** – British Grassland Society – Winter meeting, **Purcell** Room (adjacent to Royal Festival Hall), London

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

JANUARY **1986**

6-9* Soil Management – Short Course, **Silsoe** College

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

FEBRUARY **1986**

25 Better Use of Nitrogen – The Prospect for Grassland – One-day Conference – **RASE/ADAS/AGRI** National Agricultural Centre, Kenilworth, Warwick

APRIL **1986**

7-11 Irrigation; Short Course, **Silsoe** College

* denotes events at which **SaWMA** is participating

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