I AGR E

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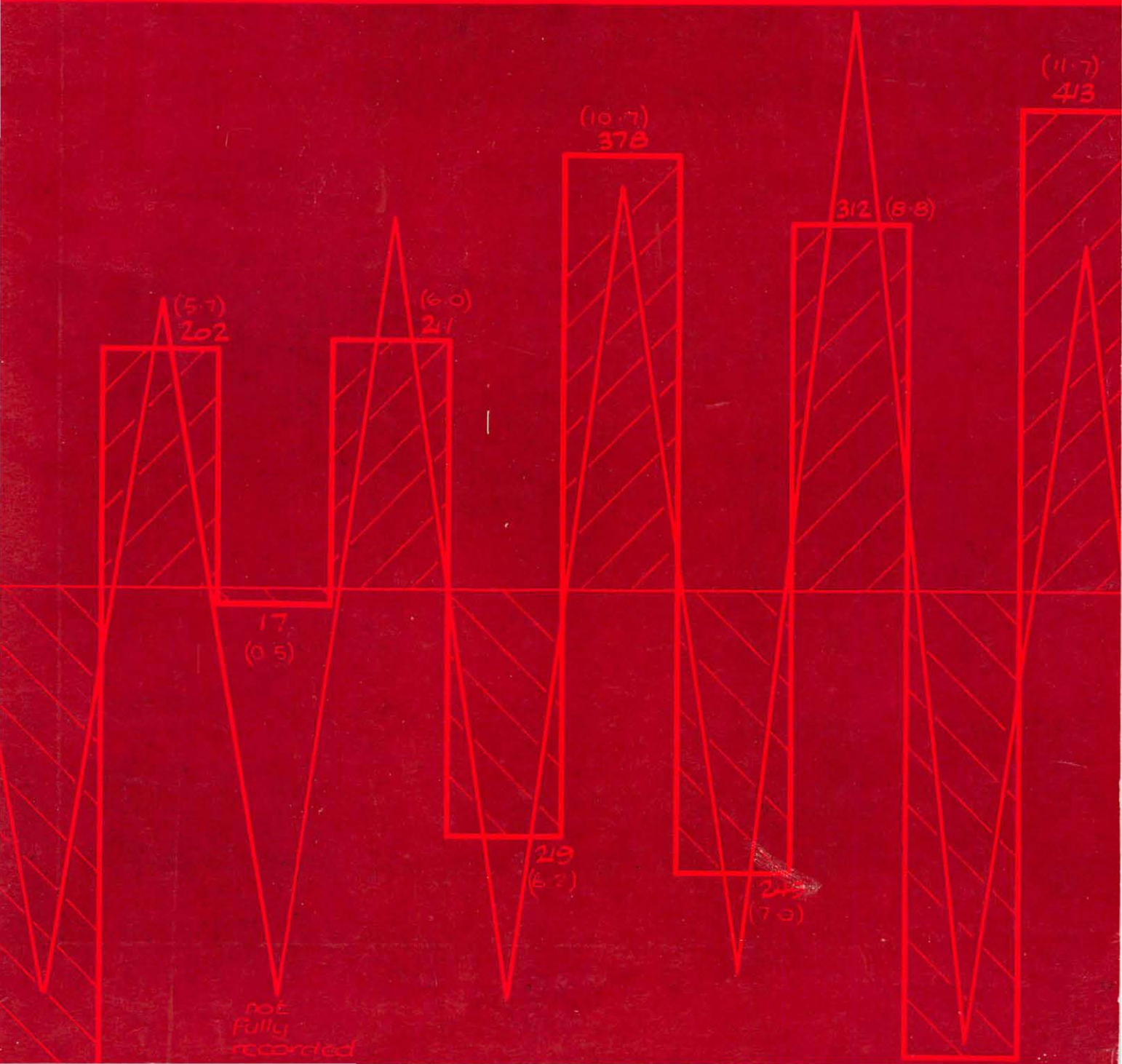
Pressure Equalisation in a Sealed Grain Silo
Long Term Effects of Cultivations
Current Cultivation Techniques
Experiments with Oscillating Tines



JOURNAL

and Proceedings of

THE INSTITUTION of AGRICULTURAL ENGINEERS

WINTER 1970-71 Volume 25 Number 4

The Front Cover illustration is taken from Graph A of the paper by G. Newman

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New Editorial Arrangements

The introduction of new arrangements for editorial work in connection with the *Journal and Proceedings*, the *Yearbook* and other Institution publications, with a view to improving their technical standard, comprehensiveness and interest to members, has been under discussion by Council for some time. As a result, an Editorial Panel has been established, which will have the following tasks:—

1. To select from papers presented at National Conferences and Branch meetings, those appropriate for publication in the *Journal*, in full or in part.
2. To invite the submission of other contributions, or summaries or abstracts of other papers, for consideration as material for the *Journal*.
3. To undertake the compilation and revision of reference material and to arrange for its publication in an appropriate form—not necessarily as a *Yearbook*.

While these points appear quite undramatic, in fact, the first, at least, marks a significant departure from previous practice. No longer will papers given at National conferences necessarily be published in full, to the exclusion of most Branch papers. Instead, all papers received by the Institution Secretary will be assessed by the appropriate member of the Editorial Panel, or if need be by the Panel as a whole, and a decision will be taken as to publication in full, part, summary or abstract form—or not at all. The criteria will be technical excellence and interest to Institution members. The existing service of reprints or photocopies of papers not published in full, will continue to be available to members and (at a more substantial charge) to non-members.

The two criteria mentioned are both incapable of completely rigorous definition. However, technical excellence will be taken to mean high standards of engineering and scientific knowledge, coupled with clear and fluent expression. Interest to Institution members is less easy to define, but it is hoped that the people constituting the Editorial Panel will provide a wider cross-section of opinion than has been available hitherto. What is important is that a new filter has been set up, in some ways more difficult to pass through and yet of greater capacity, capable of dealing with a larger quantity and wider range of material.

The implications for authors, for the Papers Committee and Branch Committees are important. The new arrangements are designed to encourage the submission of more and better papers. This means that Branch Secretaries should encourage authors to prepare papers in a form suitable for publication, since this is now much more a possibility than previously. Clearly, there will continue to be Branch meetings at which the speaker will still use notes on the back of an envelope, or none at all—which may well provide what the Branch wants on a particular subject from a particular speaker. But such a presentation is obviously not suitable for publication in the *Journal*. A revised version of the Institution's *Notes for Authors* is now available.

The kind of paper likely to be published, assuming it meets the criteria mentioned, will perhaps be a review of research or development, or an account of new applications of engineering in agriculture or horticulture. While an original research paper would be welcomed, it may well be that the status of the *Journal of Agricultural Engineering Research* as the officially-recognised vehicle for such papers may often cause it to have prior claim on such contributions. But it is hoped that summaries of research published elsewhere in full, or of unpublished work such as MSc degree theses, may find a place in the *Journal*.

The Institution's *Journal* is of very great importance to all members. For some, it is their main link with Institution activities and other members. Because it reflects the standards of the Institution as a whole, its character and quality, and the impression it makes on the world at large, are of vital interest to all members. The success of the Editorial Panel in improving technical standards and interest to members depends very much on the work of the Papers Committee and Branch Committees in selecting authors and subjects for meetings. Within the Institution there is an enormous reservoir of talent and knowledge. It is hoped that the new arrangements will enable this to be drawn upon in the future to much greater advantage. Since there is an inevitable gestation period in preparation, presentation and editing, all those concerned with the production of papers are urged to make these new possibilities and requirements known to authors as soon as possible. □

The Editorial Panel appointed to supervise the Institution's publications at present consists of:—

Mr J. A. C. Gibb (University of Reading)—Hon Editor and Panel Chairman

Mr J. C. Hawkins (National Institute of Agricultural Engineering)

Mr N. W. Hudson
Mr F. M. Inns
Mr B. A. May
(National College of Agricultural Engineering)

INSTITUTION NOTES

The Technician Associate

From 1 January 1971 the non-corporate class of Associate has been extended to include a new technician grade. This is open to any bona fide agricultural engineer who does not necessarily meet the requirements of corporate membership of the Institution but who possesses a 'technician' academic qualification and has been appropriately trained and employed in an agricultural engineering or mechanisation sector of industry, trade or research for at least three years. Such a person will be able to describe himself as a *Technician Associate* and should be able eventually to apply to the Institution to be registered as a *Technician of CEI* under registration arrangements now being set up under the Charter of the Council of Engineering Institutions (CEI).

This move should go far to silence the criticism that I Agr E has for too long over-concentrated upon degree-level and diploma-level standards, permitting no more than Cinderella status to the agricultural engineering technician.

CEI has given a lead by indicating that it expects a Technician to be academically qualified to a level not lower than that exemplified by an Ordinary National Certificate or a City and Guilds Technician Certificate in approved subjects. It can be deduced from this that existing Associates of I Agr E and those seeking admission can expect to be graded as *Technician Associates* provided they possess a suitable Part I qualification in the Institution's current list of educational requirements and provided also that they have a sufficient amount of the right experience. By this means, a solid career status can at last be conferred upon untold numbers of agricultural engineering technicians throughout industry in the UK and elsewhere. Technician Associateship of I Agr E and subsequent CEI registration will bring a group identity and a goal of achievement to those engaged in what has up to now been a largely anonymous body of technician expertise and accomplishment.

It is well known that the Institution is one of several that have been helping CEI to establish the Engineers Registration Board, and its formation now seems imminent. The importance of this to the agricultural engineering community is such that I Agr E is certain to welcome and attract an acceleration of membership growth at every level in 1971. It is likely to be most marked in the largely untapped technician sector, for which the new grade of Technician Associate should have a powerful appeal. It is important that agricultural engineering technicians should get themselves recognized as such, not only in their own personal interest but for the benefit of the agricultural engineering community and industry as a whole.

The *general* grade of Associate will continue to attract bona fide members of the farming industry or of a profession, industry or trade within or directly ancillary to agricultural engineering or farm mechanization. The new grade of Technician Associate, when introduced, will go hand in hand with it.

The annual subscription for an Associate of either grade is £6·00 and *no entrance fee will be additionally payable by any person who becomes an Associate in 1971.*

On admission, an Associate may display after his name the designatory abbreviation *AI Agr E.* It is thought likely that when the CEI Register is opened, Technician Associates who are accepted on the Register will be able to display the abbreviation *Tech(CEI), AI Agr E.*

Current Membership Standards

As forecast in the previous issue of the *Journal*, a revised edition of the Institution's *Guide to membership* has been prepared and is now available. For the convenience of all members (particularly those who contemplate applying for transfer in grade) the full text of the new *Guide* is being published in the *1971 Yearbook and Membership Directory.*

New booklets entitled *The Part III Review: Notes for the Guidance of Candidates* and *Special Notes for the Guidance of Candidates seeking Entry or Transfer to Fellowship* are also now available and will be supplied on request by the Institution Secretary or any Branch Hon. Secretary, free of charge.

The table on the page opposite shows the current pattern of academic requirements for the grades of Fellow, Member and Technician Associate. It must be emphasized that these qualifications will not *by themselves* suffice to admit candidates; minimum periods of training, experience and responsibility are also required, as described in the *Guide to membership.* However, a young person aged over 21 years who has a Part IIA qualification or any of the first five Part IIB qualifications can normally become a Graduate member straight away. He can apply later on for transfer to corporate membership. Anyone aged over 17 years who has started his studies for a Part I (or higher) qualification can enrol as a Student member with a view to later becoming a Graduate member or a Technician Associate.

It should be noted that the new City and Guilds 465 Syllabus (see *Newsdesk* on page 138) has been approved by the Institution Council and holders of Part I (or an approved equivalent) *and* Part 2 of the 465 Certificate will be deemed to have satisfied the Institution's academic requirement at the level of Part I. City and Guilds are now preparing the 465 Part 3 syllabus which will form the basis of a new-style Full Technological Certificate. It is anticipated that the Institution will permit suitable candidates to satisfy its Part IIA academic requirement by attaining within a given period credits in a minimum number of specified and optional subjects of the 465 Part 3 syllabus.

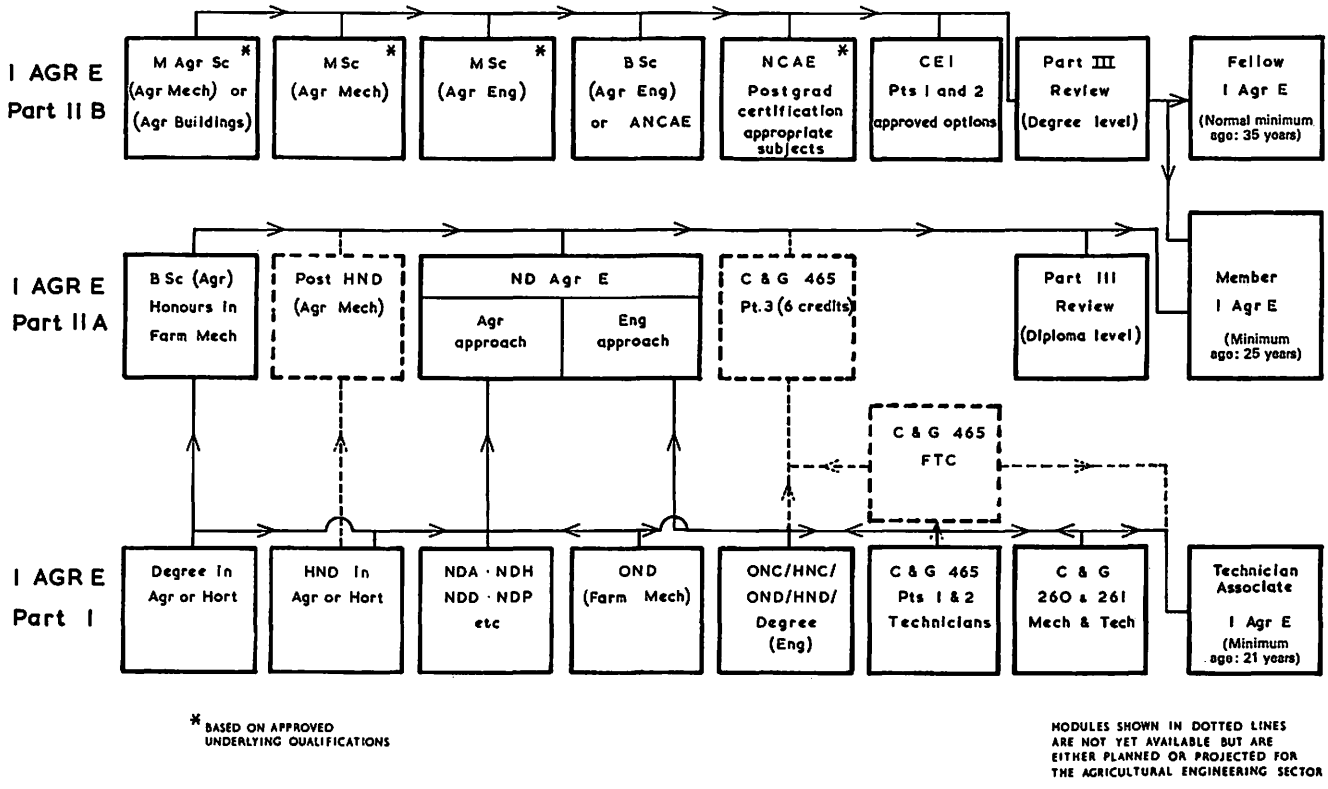
It is still too early to say much about the proposed post-HND course in agricultural mechanization. This is under active consideration by the Joint Committee for National Awards in Agricultural Subjects and it is understood that some progress is being made. The Institution Council sees a strong need for this type of course, in line with today's rapid pace of agricultural mechanization. A soundly-based post-diploma qualification in this sector can be assured of recognition within the Part IIA route to corporate membership; hence its tentative inclusion in the Table opposite.

Associates Old and New

There are close on 600 Associates in the Institution already. Many of them will have read the news about the new Technician Associate grade with its overtones of CEI-linked registration and will doubtless be wondering how they can set about applying to the Institution to be so graded and registered.

THE INSTITUTION OF AGRICULTURAL ENGINEERS

ACADEMIC STANDARDS REQUIRED BY CANDIDATES FOR THE GRADES OF FELLOW, MEMBER AND TECHNICIAN ASSOCIATE BETWEEN 1 JANUARY 1971 AND 31 DECEMBER 1973



A preliminary survey of the Institution's membership index suggests that about one in three of all existing Associates might well find themselves eligible to be graded as Technician Associates, by virtue of possessing an appropriate Part I (or higher) qualification and having been suitably trained and employed in a technician capacity. In the near future, every Associate will receive a letter and brief questionnaire from the Institution Secretary. Those who consider that they might qualify and who desire to be graded as Technician Associates will be encouraged to complete the questionnaire and have their case examined by the Membership Committee.

The Institution's President, George Henniker-Wright, sees the emerging pattern of CEI registration as being of providential significance to the agricultural engineering community. In his latest Presidential statement to all members (see *Viewpoint* on page 179) he points out that these developments, which should give early provision for Members and Technician Associates to be registered by CEI, are of very great importance to the industry and to those engaged in it. 'I want the Institution', he says, 'to seize its opportunity and make 1971 a boom year for membership growth at all levels'.

The President has already thrown a challenge to the Committees of the Institution's Branches in the UK, setting each of them a target recruitment figure for 1971, and laying special emphasis on the importance of the new Technician Associate grade. And as an incentive to all concerned, no person admitted as an Associate (Technician or otherwise) in 1971 will be charged the usual £5 entrance fee.

It is an interesting reflection that if each existing corporate member throughout the world was able to persuade just *one* colleague, employee or acquaintance to apply successfully for membership in any class from Fellow to Student in 1971, the Institution would increase its nominal strength by about 52% in twelve months!

One man who does not consider this an impossible dream is the President. And members everywhere could very easily be determined to prove him right.

Institution Tie

As announced in previous issues of the *Journal*, Institution ties are available, incorporating the design of the Presidential Badge on either dark-blue, dark-green or dark-red grounds. These attractive emblems may be purchased and worn by members only; they are available in any quantity at a cost of £1·00 each, which charge includes packing and postage.

Getting Your Own Back

Members may like to be reminded that the Institution is approved by Inland Revenue for the purpose of allowing members to claim relief of income tax in respect of their annual subscription. Enquiries concerning this useful benefit should be made at one's local Tax Office and not through the Institution.

Although the majority of members have already paid their 1971 subscription there are still some who have not. To avoid the need for individual reminders, it is hoped that this will serve to jog the memory of those to whom it applies. It goes without saying that the Institution is wholly dependent upon income from and prompt payment of membership subscriptions if it is to play its full part in the agricultural engineering industry and profession.

Many hundreds of members prefer to pay their subscription by means of a Bankers' Order. The Institution favours this method and any member who would like to change over to this procedure can use the form enclosed with the 1971 membership diary or obtain a fresh one from the Institution Secretary. □

NEWSDESK

Progress with Metrication

'I am confident that as the country learns more about metrication they will come to see and realize the advantages flowing from it', said Lord Ritchie-Calder at the PERA conference *Progress with Metrification* in November. 'Surveys show that support for metric is proportional to knowledge of it'.

Earlier the conference had heard an industry-wide report on metrication progress—£266 million worth of metric designed construction work now being built, changeover programmes for nearly 70 industrial materials announced, timber already metric and planning far advanced in many other sectors. Lord Ritchie-Calder also quoted major firms in the engineering field such as Alfred Herbert and Staveley Machine Tools, Ford and British Leyland, Joseph Lucas and Guest, Keen and Nettlefold who already had substantial metric production under way. 'This revealed', he said, 'the commitment of the engineering industries, to metrication'.

Lord Ritchie-Calder reminded his audience that except for the United States, every major industrial country had decided to go metric. The Americans had set up a Metric Study Group, he said, which was to report to Congress in 1971. Members of the group had visited London in October and 'left us in no doubt that there is a broad based majority in American industry who believe that metrication is bound to come there too'.

In an address at America's National Metric Conference No. 7 in Washington, Gorden Bowen, Director of Britain's Metrication Board, said, 'One of the truths which our experience in Britain demonstrated is that while there must be adequate time for planning and preparation, once a metrication programme is decided upon, putting the change off and spreading it out does not ease the problems to be resolved, can add to the difficulties and costs, and inevitably it defers the benefits'.

The United States of America Metric Study was set up by the National Bureau of Standards with the backing of Congress in 1968 to study the implications to the US economy of the world-wide swing to metric.

The US Metric Study will report to Congress in mid-1971.

FAO Promises Critical Approach to Land Reform

A new and critical approach to the problems of land reform was promised by the former President of Colombia, Carlos Lleras-Restrepo, speaking as Chairman of a special FAO Committee on Agrarian Reform which met in Rome recently.

The Committee which was meeting at the Headquarters of the Food and Agriculture Organization, includes three cabinet ministers from Poland, Iran and the United Arab Republic, educationalists and members appointed by the United Nations and the International Labour Organization.

'On many aspects, the report asked of us must be different from all previous reports by FAO and other organizations', Mr Lleras-Restrepo said. 'These reports with their information are useful and have contributed to make land reform a big concept. Land reform, however, is no longer just a matter of dividing land, but embraces structural, social and economic changes. The job of the Committee is not merely to give better and more recent information about agrarian reform—though this will be used in the report', the Chairman said. 'What is asked for is a critical study to ascertain what part land reform has played to date and what must be done to enable its success in the future'.

In a welcoming address to the Committee, FAO's Director-General, Addeke H. Boerma, said that he was increasingly impatient and disheartened about the circumstances under which the greater part of humanity lived. 'It is difficult to escape the conclusion that, if these conditions are allowed to persist much longer the world will find itself at the mercy of increasingly widespread violence and chaos', he added. Agrarian and rural structures in many countries—particularly in the developing regions—urgently needed improvement. Existing structures denied access to land, agricultural inputs, credit, markets and employment, to vast numbers of citizens. 'For this reason these people remain second-class citizens', Mr Boerma said. 'Even worse—as happens to many young people leaving rural areas—they are left outside any part of the general social structure, since the new, slowly-growing urban industrial settlements are incapable of absorbing them'.

FAO has arranged for the Committee to visit different countries and regions of the world to gather first-hand information on progress and problems under a wide range of conditions.
'With your prestige and experience, these visits will be an excellent opportunity for you to assist governments in identifying the real obstacles that have hitherto stood in the way of vigorous action and in finding means to overcome them', said Mr Boerma.
FAO is currently helping 15 countries in the field of land reform. Its experts are carrying out research work, while the Organization is offering its technical support to various schemes. About 30 FAO experts act as consultants every year to governments of countries where agrarian reform is under way. FAO is also extending its technical knowledge to specialized agencies such as the Chilian Agrarian Research and Training Institute and two similar institutes which are being created, one in Ceylon and the other in Peru.

The World Food Programme, which is jointly sponsored by FAO and the United Nations, is also participating in land reform programmes through projects such as those it is carrying out in Peru, Equador, Panama, Chile and the Philippines.

City and Guilds announce New Scheme for Agricultural Engineering Technicians

The City and Guilds of London Institute has recently approved a new scheme for agricultural engineering technicians which has been prepared on an 'ab initio' basis so that technician students will no longer be required to undertake previous study at craft level. Craft and technician students will, therefore, follow separate courses of instruction in future, based on either the 260 (Craft) or 465 (Technician) scheme. The preparation of Part 1 and Part 2 of the new scheme has now been completed. A Part 3 of the scheme will be introduced at a later date to provide the opportunity for progression to a higher level of specialized study.

The scheme provides for students who obtain a credit in the Agricultural Mechanic's Certificate (260) and

who are thought suitable for transfer at that stage to the technician course to proceed to Part 2 of the technician scheme providing they have satisfactorily completed suitable 'bridging studies'.

The current Full Technological Certificate in Agricultural Machinery Maintenance and Repair will be replaced by a new FTC in Agricultural Engineering the award of which will be based on the examinations for the new scheme. The first examination for Part 1 will be held in 1972, and for Part 2 in 1973 during the May/June examination series only. Examinations in the old scheme (261) will be discontinued after the December examinations in 1972. The Institution of Agricultural Engineers has said that Parts 1 and 2 of the new 465 scheme will satisfy the academic requirements for its recently introduced membership grade of Technician Associate. The Part 3 syllabus is expected to provide an avenue of advancement to Graduate and corporate membership of I Agr E.

City and Guilds have also recently completed a revision of the examination arrangements for the 260 Agricultural Mechanic's Certificate. This involves the replacement of the current practical and practical/oral examination papers by a scheme of Phased Testing which will be internally assessed. It is intended that courses commencing in Autumn 1970 will include Phased Testing and the first examination incorporating the results will be held subject to alteration each year and the tests for a particular year will apply to both the June and December examination series.

A one year pilot scheme will be held during the 1969/70 session at a limited number of colleges. The revised arrangements have been introduced to provide a truer reflection of a candidate's ability by testing him on as wide a selection of syllabus as possible and to associate the teacher more closely with the examination of the candidate. In devizing the test an attempt has been made to place a more equal emphasis on the three main syllabus sections.

Professional and Technical Services in the Countryside

The Professional and Technical Services Liaison Committee presented its report at the Third 'Countryside in 1970' Conference in London in October. I Agr E is represented on the Committee, which also includes professions concerned with land use and management, such as architects, civil engineers, land agents, municipal engineers, town planners and many others.

The report recognizes that the professional man concerned with land management works today under the constraints of continued changes in land ownership patterns and management techniques. It becomes increasingly difficult for him to give advice which takes account of long term conservation needs. Nor, once given, is the advice necessarily reflected in the policy decisions which it becomes the professional man's duty to implement. 'If his advice is to carry the fullest weight', states the report, 'it must be seen to take into account the wider aspects of the project, through consultation amongst the relevant professions. Ultimately, it is the community itself, often with more immediate considerations in mind, which decides the issues'.

The report makes five recommendations.

Training and Education

(1) An understanding of conservation should form an intrinsic part of school studies.

(2) The teaching of conservation should form a fundamental part of study courses leading to professional and academic qualifications related to land use.

Co-operation

(3) The professional bodies should be encouraged to review any restrictions that there may be on the freedom of their members to enter into partnerships or working relationships, particularly where conservation is the issue.

Information

(4) This should be assembled and co-ordinated at a central point.

Implementation

(5) An interprofessional committee should be established with adequate means to encourage the inclusion of conservation in professional and academic qualifying courses; to collect, collate and disseminate information, including sources of advice, relevant for the better understanding of conservation by the professions and the public.

In an annexe to the report a survey is made of the regard paid to the principles of conservation in professional and academic qualifying courses now, compared with a similar survey in 1965. While both assessments are non-quantitative and depend largely on self-assessment, it is concluded that the result 'shows a remarkable improvement' reflecting a generally improved understanding of conservation. The report admits however that there is a need for 'more opportunities for graduates and others to work together on inter-disciplinary projects'.

The Wetter the Better at Tittleshall

Farmers in Norfolk had a unique opportunity of comparing the whole range of four-wheel drive tractors on 18 November when that enterprising body, the Norfolk Farm Machinery Club, held a demonstration at Cokesford Farm, Tittleshall, near Fakenham. There were all the British makes such as County, International, Massey-Ferguson, Muir-Hill and Roadless, as well as the imported Belarus, Dutra, Steyr, Universal and Zetor. They were all ploughing with reversible ploughs and it is reported that they all did a good job.

The soil was heavy loam which locally is considered to be crawler land and the date had been chosen in the hope that it would be good and wet. In fact, some *three inches of rain fell in the previous four days and* 0·65 *inches on the eve of the demonstration.* They were happy. A highly successful wallow in glorious mud it truly must have been. On a congratulatory note, our Editorial Unit is happy to commend the pictorial suggestion below as an aid to even better and wetter Club events in the future.

(Reproduced by permission of "Punch") □

Commission Internationale du Génie Rural

CIGR AND THE INSTITUTION

by Claude Culpin, OBE, MA, FI Agr E

Mr Culpin is the UK representative on the CIGR Management Committee. He has been concerned with CIGR activities since they were resumed at the IVth International Congress in Italy in 1951.

1. Introduction

Members of the Institution will at some time have seen mention of a CIGR activity, such as a Conference and Study Tour; but few have any clear idea of what CIGR is, what are its objectives, and what is its relationship to the Institution. This article aims to provide a little basic information on the subject.

2. What is CIGR?

The letters CIGR stand for Commission Internationale du Génie Rural or, literally, International Commission of Agricultural Engineering. The word 'Commission' is, in fact, not a very suitable one, since CIGR is in effect an international association of professional agricultural engineers and is akin to many other international learned societies, such as the International Grassland Society. It was established by a very small group of pioneers who met in Belgium in 1930 under the chairmanship of a Professor Bouckaert, who became the first President. Not much was achieved during the thirties, and the War completely disrupted activity. However, it was revived after the War when it owed much to the efforts of Monsieur Armand Blanc, a leading agricultural engineer in the French Government Service, who became the second President and continued in that office for many years. The first post-war activity of importance was the IVth Congress which was held in Italy in 1951. Subsequently, growth and influence have steadily increased, and outstanding events in the history of the Society have been the Vth Congress at Brussels in 1959, the VIth at Lausanne in 1964, and the most recent VIIth at Baden-Baden in 1969.

Though the Congresses mark the main manifestations of CIGR activities, they are not necessarily more important than the many smaller meetings on specialist subjects which are arranged in the intervals between Congresses.

3. The Basis—An Association of National Institutions

It is an over-simplification to say that CIGR is an international association of professional agricultural engineers. It is, in fact, primarily an international association of national associations of such men. Its aims and standards are similar to those of our Institution, and it provides a set of draft rules for countries which have no existing professional institution and wish to establish one. In fact, many of the countries which are participating members of CIGR set up their national associations according to these draft rules. For example, France had no existing society corresponding to our Institution, and it set up the French National Association of CIGR with a Constitution and Rules according to the CIGR draft. In the United States, Britain and Germany, on the other hand, professional institutions grew up independently; but during recent years their corresponding societies have taken over the responsibilities of the CIGR national association. In the United States it was straightforward. The American Society of Agricultural Engineers embraces all branches of the profession and corresponds exactly to CIGR. So since ASAE made up its mind to participate actively—a decision taken soon after the Brussels Congress of 1959—the only big problem concerning American participation has been the distance separating America from Europe: but even this has failed to prevent American delegates playing an active part in most CIGR events. In the German Federal Republic there was a complex situation because there was more than one existing professional institution with an active interest in agricultural engineering. Nevertheless, these institutions and societies, including the Max-Eyth Society, got together to form a representative unit to act for Germany in CIGR affairs. In Britain there can be no disputing the correctness of the Institution's decision to accept the main responsibility of national representation; but this does bring some problems, which are discussed later.

Today there are 18 national associations which are participating actively in CIGR affairs. In addition there are many countries which have not yet managed to form a national association but which are represented at important events by one or more delegates on an individual member basis.

4. Organization

The organization of CIGR is defined in the 'Statutes', a lengthy document which lays down the conditions of membership and the broad way in which the association shall operate. The Statutes have been amended from time to time to take account of changing needs and circumstances—the last time at the recent Baden-Baden VIIth Congress. The subject matter of agricultural engineering is divided up on the same broad lines as in the American Society of Agricultural Engineers into five Sections as follows:—

1. Soil and Water Engineering.
2. Farm Buildings and Associated Engineering Problems.
3. Power and Machinery.
4. Application of Electricity to Agriculture.
5. Scientific Organization of Agricultural Work.

Each Section has a President who, together with two Vice-Presidents and a Secretary, is responsible to the President of CIGR and the Management Committee for his Section's activities during the period between successive Congresses—generally 5 years. The business of each Section is looked after mainly by the Section President and Secretary, and does not normally pass through the President and Secretary General of CIGR. Each Section reports at least annually on its activities to the Management Committee, which has the duty of harmonizing the work of all Sections.

The Management Committee normally meets once a year in Paris, at the time of the annual SIMA Agricultural Machinery Exhibition. This Committee comprises the President, the five Section Presidents, the Secretary General, and a single representative (who may be one of the Presidents) from each of the constituent national associations. The Committee oversees all CIGR activities including finance.

The chief executive officer of CIGR is the Secretary General. CIGR has been fortunate in that Professor Michel Carlier of France has continued to accept the responsibilities of this post over a long period, and that the University and the French Government has continued to make it possible for him to do this efficiently, while carrying out his main duties as an agricultural engineer particularly concerned with soil and water aspects.

The official languages of CIGR are French, English and German; and at all Congresses and most Section meetings arrangements are made for translation into at least French and English, and sometimes all three languages.

The General Assembly, which meets only at Congresses, elects the President, Secretary General, and the main officers of the Technical Sections. At this meeting each country has at its disposal a number of votes in proportion to the fees which it contributes annually to CIGR.
As a result of the recent Baden-Baden elections, Professor P. C. J. Payne of the National College of Agricultural Engineering, Silsoe, was elected vice-president of Section III, and Professor J. R. O'Callaghan of Newcastle University became Secretary of Section V.

5. Finance

As with other associations of professional men, CIGR has certain expenses which have to be met by direct subscription from its constituent members. Fortunately these expenses are not heavy. The aim with most of the major activities such as Congresses and Section meetings is to make them self-supporting; and much of the secretarial work is spread thinly over a fairly large number of Section Presidents and Secretaries, each of whom is able to secure the approval of his employers for a certain amount of CIGR work to be done without charge. There is a certain amount of work by the Secretary General's office which cannot be 'absorbed' in this way, but these costs are not heavy.

There is, of course, a possibility of heavy expenditure by any host country which runs a Congress or a large Section meeting. Each such country has to work out its finances in the best way that it can, so as to avoid running at a loss, yet aiming to avoid prohibitive subscriptions from the delegates who attend. Naturally, it helps organizers of such events considerably if the government makes a contribution. Associated industries including the farm machinery industry can also sometimes help considerably by providing hospitality.

The current annual budget of CIGR involves an expenditure of the order of 20,000 French Francs or a little under £2,000; and the subscriptions levied are designed to meet this cost. The rate of subscription for national associations is a basic charge of 500 Francs plus 5 Francs per member from 1 to 100, and 2·5 Francs per member from 101 to 700. The maximum charge, covering 700 members, is 2,500 Francs.

The British contribution is at present based on only 20 members, i.e. 600 Francs. This places Britain in a not very worthy position, and it is to be hoped that this situation can be improved in future. Countries which contribute more include USA, Germany, France, Italy, Spain, Japan, Netherlands, Brazil, Israel, Switzerland, Czechoslovakia, Sweden and Portugal.

Where there is no national association, individual members may be approved by the Management Committee, and these pay a subscription of 125 Francs per head.

6. What do we gain?

Some members of the Institution have asked the very natural question "What do we get out of CIGR?" It is not easy to give a convincing answer unless the enquirer is willing to use his imagination a little in order to try to assess the value of several factors which either cannot be measured or are difficult to measure. It is like the question "What do I get out of the Institution?" There are a few material gains such as the published papers which are read at Congresses and at Section meetings; but these are perhaps relatively unimportant, since similar papers are often written either for scientific journals or for the technical press.

CIGR also sponsors the "International Farm Machinery Abstracts", which were initiated after our National Institute of Agricultural Engineering ceased publication of its "Agricultural & Horticultural Engineering Abstracts"; but burden of this service falls mainly on CNEEMA (French National Agricultural Engineering Centre) and to a lesser degree on those of us who contribute abstracts; and there are clear signs that present arrangements will have to be altered. Similarly, though CIGR is accorded a leading place by many other World bodies such as FAO, this is more a question of prestige than a matter of real importance to members of our Institution.

I think that the main advantage is the opportunity to meet and to hear the views of the leading agricultural engineers from other countries. Whether we like it or not, agricultural engineering is an international subject; and as time passes it becomes increasingly important to understand the views and the needs of other countries, as well as the needs of British farmers. For example, with or without British entry into the European Common Market, the development of mechanization in Europe is something which British agricultural engineers cannot afford to ignore. Similarly there are developments in some countries of Eastern Europe which will certainly influence mechanization trends in other parts of the world; while the importance of developments in countries such as North America, Australia and New Zealand need hardly be mentioned here. CIGR brings together agricultural engineers from the whole world in a way that no other body does or is likely to do.

This does not fully answer the question "What do we get out for CIGR?", but with CIGR, as with all associations of professional men, what one gets out of it is directly related to what one puts in. At present, Britain gets little out of CIGR because it contributes little, either in finance or, more important, in participation in CIGR activities. The more British agricultural engineers take part in CIGR activities, the more the value of the association will be appreciated.

Though CIGR is essentially concerned with the pursuit of knowledge, many of its activities inevitably have commercial implications; and when considering what we get out of CIGR, account has to be taken of what British agricultural engineering stands to lose if it is not adequately represented. Though many strictly commercial aspects of trade in agricultural engineering between countries of Western Europe are adequately dealt with by CEMA (The Association of Western European Manufacturers of Farm Machinery), there can be considerable gain to Britain and to individual British firms if their professional staff take part in CIGR activities. It is true that at CIGR functions there sometimes tends to be a preponderence of University and Government officials; but many topics which eventually fall to be dealt with by bodies such as CEMA are influenced in the early stages by the kind of people who attend CIGR Conferences.

7. Institution Problems

The Council of the Institution has a difficult problem in deciding how best to develop participation in CIGR affairs. As regards finance, the Institution has to keep a strict watch on items such as the annual subscription, and though it is clearly desirable to increase this above the £50 or so which the Institution at present contributes, it is also certain that in fairness it should receive some help from those interested in such matters as soil and water engineering, farm buildings, etc., who are not at present members of the Institution. One way in which the Institution could justify an increased annual subscription would be recruitment into

the Institution of all those suitably qualified persons who are not at present members but who are interested in CIGR. This, of course, should be not just a question of recruitment, but also of ensuring that Institution programmes at branch and national level adequately cover these subjects—a trend which is already in progress and which is obviously in the right direction, even if CIGR were not involved.

There are several bodies which could help the Institution to ensure a better and more equitable approach to the question of national representation, and some of these have already begun to help, while others have indicated a willingness to explore ways and means of co-operation. The Electricity Council has been particularly helpful in connection with the work of Section IV. It played a major part in organizing a successful Section IV meeting at the National College of Agricultural Engineering in 1968. Following this, proposals have already been made for half a dozen British delegates to present papers to a Section IV meeting arranged to take place in Italy in 1971. There is no reason why similar active participation should not be developed by those interested in the work of the other technical sections, particularly Section III which deals with subjects of direct concern to so many Institution members. Britain has been asked to consider the possibility of a Section III meeting in 1972 or 1973 on the subject of either root harvesting (potatoes and/or sugar beet) or effective integration of field mechanization systems related to various sizes of tractor. The Institution's Papers Committee will take account of this request in formulating its programmes for 1972 and 1973.

The Institution's Council and the relevant committees are due to study further such questions as how it can more effectively represent and obtain support from non-members, and how the Institution can best associate in CIGR matters with other national bodies such as the Farm Buildings Association.

In the meantime we have taken the useful step of appointing correspondents for the five technical sections of CIGR, and we shall be looking to these to stimulate contacts in their particular fields. Those appointed are as follows:—

1st Section— N. W. Hudson, BSc, AMIRhodE, Mem ASAE, FI Agr E,
Head of Field Engineering Department,
National College of Agricultural Engineering,
Silsoe, Bedford.

2nd Section—S. Baxter, ARICS,
Senior Investigator,
The Scottish Farm Buildings Investigation Unit,
Aberdeen.

3rd Section— J. H. Neville, BSc, MSc, MI Agr E,
Field Engineering Department,
National College of Agricultural Engineering,
Silsoe, Bedford.

4th Section— R. A. Bayetto, FI Agr E,
Agricultural Adviser,
The Electricity Council,
30 Millbank,
London, S.W.1.

5th Section— J. A. C. Gibb, MA, MSc, FR Ag S, FI Agr E, Mem ASAE,
Senior Lecturer in Agricultural Engineering,
The University,
Reading, Berks.

8. Future Programme of CIGR Activities

The following are some of the more important items which have recently taken place or have already been agreed for the future. Some Section meetings as far ahead as 1973 are at the planning stage, but reference to these is omitted for the sake of brevity.

Next *International Congress of Agricultural Engineering* (*VIIIth*) Wageningen, Netherlands, 1974.

Section 1

May–June 1971. Meeting in France at Avignon or Aix.

Section 2

9–12 November 1970. Ghent, Belgium. The Influence of the Environment in Animal Housing.

(*With Section* 4) September 1971. Piacenza, Italy. Fabrication methods; building materials; organization of large-scale livestock enterprises. Some details concerning this meeting are given on the opposite page.

Section 3

19–23 October 1970. Wageningen, Netherlands. Measuring methods and processing of measuring data in farm machinery research.

July 1971. Paris, France. (*With Sections* 2 *and* 4). Mechanization of stock farming. In conjunction with 10th World Congress of Animal Production.

Section 4

See *Section* 2—Piacenza, Italy, September 1971.

Section 5

1972. Conference to be arranged in collaboration with CIOSTA. □

COMMISSION INTERNATIONALE DU GÉNIE RURAL (CIGR)

Farm Buildings and Associated Engineering Problems

Application of Electricity to Agriculture

STUDY DAYS OF THE II AND IV SECTIONS

The Organizing Committee has the honour to invite you to the Study-days of the II and IV Sections of CIGR which will be held at Piacenza (Italy) from September 21st to 25th, 1971.

Monday, 20th

17.00 h: Registration of the participants.

JOINT SECTIONS

Tuesday, 21st

9.00– 9.30 h: Opening and Welcoming Address.

9.30–12.30 h: 1 (II-IV) "Construction problems and electric installations in buildings designed for intensive animal breeding under extreme climatic conditions".

15.00–18.00 h: 2 (II-IV) "Farm storage and ventilation for marketable products".

18.00–19.00 h: Synthesis reports on topics 1 and 2.

SEPARATE SECTIONS

Wednesday, 22nd

9.00–12.00 h: 3 (II)	"Improving rural housing and infrastructures".	9.00–10.30 h: (3) (IV)	"Light and heating for forcing plants in greenhouses and in the field".
		10.30–12.00 h: 4 (IV)	"Electrical distribution in rural areas".
15.00–18.00 h: 4 (II)	"New building materials for farm buildings".	15.00–18.00 h: 5 (IV)	"Development and estimate of electrical energy and labour requirement in specialized farms".
18.00–19.00 h:	Synthesis reports on topics 3 and 4.	18.00–19.00 h:	Synthesis reports on topics 3, 4 and 5.

Thursday, 23rd

9.00 h: Study tour connected with the themes of the II and IV sections.

Friday, 24th

9.00 h: Departure by bus from Piacenza to Florence with visits to farmsteads on the way. The arrival in Florence is foreseen in the first afternoon.

9.00 h (alternative): Study tour connected with the themes of the II section.

Saturday, 25th

9.00 h: Continuation of the journey to Rome. Visits to farmsteads on the way.

P.S.—Excursions will be organised for the ladies accompanying the participants.

Cut Here

Al Comitato Organizzatore delle Giornate di studio della CIGR c/o Camera di Commercio, Industria, Artigianato e Agricoltura di 29100 Piacenza—P.za Cavalli, 35—tel. 22.241.

Preliminary Registration (1)

I wish to attend the "Study-Days" and get further information to the address below:

Christian Name .....

Name .....

Degree and Profession .....

Address .....

.....

I am interested in the study tour of the 23rd September in connection with the themes of the II and IV section YES-NO (2)

I am interested in the study tour of the 24th September in connection with the themes of the II section YES-NO (2)

I am interested in bus trip from Piacenza to Rome via Florence YES-NO (2)

I shall be accompanied by .....

I wish to receive further communications in Italian, French, German, English (2).

I wish to present a report on the theme No..... of the .....section, that is:

.....

.....

.....

(1) The present registration form must be returned to the Organizing Committee immediately.

(2) Underline what you are interested in.

THE INSTITUTION OF AGRICULTURAL ENGINEERS

SPRING NATIONAL MEETING 1971

To be held at
The National College of Agricultural Engineering
SILSOE, BEDFORD
TUESDAY, 30 MARCH 1971

SELECTION AND DEVELOPMENT OF NEW PRODUCTS

The selection of a new product involves management decisions and approaches which are hardly ever discussed.
This is an area in fact where many firms are reticent on how they arrive at a new product and this Meeting will seek to show how the management of some companies with widely varying structures and interests tackle this problem and it is hoped that case histories of certain products will illustrate the process.

Programme Convener and Chairman: T. SHERWEN, C Eng, FI Mech E, FI Agr E, MSAE, Immediate Past President of the Institution

PROGRAMME

10.30 Assemble for Coffee

11.00 Introduction by H. C. G. HENNIKER-WRIGHT, FI Agr E, Mem ASAE, President of the Institution

11.15 Paper 1
Management Control of Design Research and Development by H. E. ASHFIELD, C Eng, FI Mech E, FI Agr E, Technical Director, David Brown Tractors Limited, Meltham, Huddersfield, Yorks.

12.00 Paper 2
Finding and Exploiting New Projects for a Small Company by J. H. W. WILDER, OBE, BA, FI Agr E, Managing Director, John Wilder (Engineering) Limited, Wallingford, Berks.

12.45 Luncheon Interval

14.00 Paper 3
Product Planning and Development in a Specialised Company by J. V. FOX, FI Agr E, Managing Director, Bomford & Evershed Limited, Evesham, Worcs.

14.45 Paper 4
Necessity is Still the Mother of Invention by W. T. A. RUNDLE, FI Agr E, Managing Director, Wright Rain Limited, Ringwood, Hants.

15.30 **Open Forum:**
Questions and Discussion on the four Papers

16.30 Tea and Dispersal

TICKETS

	NON-MEMBERS	MEMBERS (other than Students)	STUDENT MEMBERS
Inclusive of lunch and refreshments	£8·00	£5·00	£3·00

Advance copies of the papers will be forwarded with tickets a few days before the Meeting

Early Application for Tickets is advisable
Applications should be accompanied by remittance payable to 'I Agr E', and addressed to the Institution at Penn Place, Rickmansworth, Hertfordshire, WD3 1RE

NEWS FROM BRANCHES

Stirrings in the South East

E. N. Griffith is made Chairman of Essex/Kent Steering Committee

The prospect of a new Branch of the Institution based on Essex (and possibly Kent) was brought a step nearer as a result of an exploratory meeting of members which took place at Essex Institute of Agriculture, Writtle, in October.

The meeting was chaired by the Institution's Immediate Past President, Theo Sherwen, who had himself been at one time Chairman of the Western Branch. 'A strong network of Branches', said Mr Sherwen, 'is essential to the Institution as a national body, particularly at a time when the Council of Engineering Institutions is looking to us to be the spokesman for agricultural engineering in the new system of registration'. Mr Sherwen gave the meeting a full account of the recent developments and negotiations with CEI. An early outcome was likely to be the registration of Members (MI Agr E) as Technician Engineers of CEI, the minimum academic standard in this sector being exemplified by the ND Agr E. Mr Sherwen felt this was a tribute to Essex Institute of Agriculture who, in company with West of Scotland Agricultural College, had helped to give the ND Agr E its present high reputation and influential standing.

Mr Ben Harvey, Principal of Essex Institute, and a Companion of I Agr E, acclaimed the efforts to start a Branch in Essex and offered the Institute's premises as a venue for a number of pilot meetings. This generous offer was accepted and a small Steering Committee was set up under the leadership of Mr E. N. Griffith, CBE, CI Agr E, a locally-based member of the Institution Council with a keen enthusiasm for the idea of Branch activity in that vicinity.

During the coming months, the Committee will organize a number of lecture meetings of interest to Essex and Kent members, and later in 1971 the possibility of applying to the Council for full Branch status will be examined.

East Anglian Branch

As a result of heavy correspondence and a press release (see *Institution Notes* in the Autumn 1970 *Journal*) help has been given or offered to the Branch Study Group on Operators Instruction Manuals by a large number of organizations and individuals. Notable among these are:—

The British Standards Institution
The National Institute of Agricultural Engineering
The Institution of Technical Authors and Illustrators
The Institute of Technical Publications and Publicity

Branch members have all been sent a questionnaire and, in addition, volunteers are being sought to review operators instruction manuals. Mr R. C. Amsden of Fisons, Chesterford Park Research Station, has joined the Study Group on behalf of the British Crop Protection Council who are interested in crop sprayer manuals.

Talks to the Study Group have been given by Mr M. Pinner of the Publications Department of Ransomes, Sims and Jefferies Ltd and Mr D. L. Hilliam of the Olyslager Organization. Mr Pinner described all the stages on instruction manual work through from the first decision to build a piece of farm machinery to the final product. Mr Hilliam, who is concerned with producing lubrication charts for oil companies, put forward his views on how a tractor manual should be written.

Questionnaries on selected manuals are also being completed by operator members of the East Suffolk and Norfolk Farm Machinery Clubs.

East Midlands Branch

To encourage young people to take a greater interest in agricultural engineering subjects, the Branch has organized an Open Competition in 1971, for which the prize will be an engraved tankard and a cash award to the total value of £10, for the best paper on a topic of Agricultural Engineering or Farm Mechanization.

The Rules of the Competition are as follows:—

1. Entries may be received from competitors under twenty-five years of age who either reside in, or attend college in the East Midlands Branch Area (Lincolnshire, Nottinghamshire, Leicestershire, Rutland, Northamptonshire and Derbyshire).
2. The paper should be the work of the entrant and not exceed 3,000 words in length. Reference to any published work should be indicated and listed.
3. The Competition Committee reserves the right to withhold the prize in any year when there is no entry of the appropriate standard and they may in exceptional circumstances wish to interview a competitor.
4. All papers entered will become the property of the East Midlands Branch. Copies of the winning entry may be circulated to Branch members and may be published in the Institution *Journal*.
5. Papers should be sent to the Competition Secretary, together with completed entry form. Forms are available at Colleges in the Branch area or from:—
   The Competition Secretary:
   D. V. Evans, Esq,
   Ministry of Agriculture, Fisheries and Food,
   Grantham Road, Sleaford, Lincs.
6. Closing date for entries: 1 March 1971.
7. Failure to observe the above rules may cause disqualification.

West Midlands Branch

Tracks instead of wheels on Tractors—machines instead of cows for milk production—even surgical trusses as standard equipment for farm workers, were some of the ways farm people saw the future at a Branch forum held, appropriately, at the Electro-Agriculture Centre, Stoneleigh, on 26 October. The subject under discussion was: 'Is modern machine design right for present day farming?'

Opening the proceedings, Mr Roger Dowdeswell of Lower Radbourne, Warwickshire—the farmer who, for the three-point linkage on a crawler tractor that he designed, won the Burke Trophy at the Royal Show—gave his views. First he 'slated' the big manfacturers for concentrating on the mass markets and not bothering to try out new ideas or work on new designs. "Why didn't the manufacturers come up with a workable linkage design for crawlers a long time ago?" Mr Dowdeswell asked, and he prophesied that now one had been designed there would be a swing to crawlers. He also criticised the manufacturers for "not getting their boots dirty". "Agriculture is a brute force job", he said, "Designers should spend more of their time on the farm".

Next to speak was Mr K. A. Ballard, Managing Director of Shuker and Sons (Shrewsbury) Limited, who gave a dealer's view of machine design. He too criticised the manufacturers. "The inaccessibility of some parts in some machine designs require a surgical truss to be part of every serviceman's tool-kit" he commented. Cab registration also came under attack when Mr Ballard accused the manufacturers of "jumping on the bandwagon". Some manufacturers, he told the meeting, insisted that only their own cabs be fitted on their tractors whereas there were already others building cabs which were just as good but a lot cheaper. He explained why four wheel drive tractors were not as popular as they could be. "Because manufacturers are not building them", he said, "other firms are having to do the modifications and so the manufacturer's warranty is made useless".

"Perfection in machine design is no more possible than in any other walk of life", said Mr John Fox, Managing Director of Bomford and Evershed Limited, giving the manufacturer's point of view. "Although manufacturers often come up with advanced new designs they cannot put them into production because of cost effectiveness—the cost would be too great for them to be economical".
Opening the general discussion of the evening, Mr George Jackson, the Principal of Warwickshire College of Agriculture, attacked both recent cab regulations and the big manufacturers. "Pathetic", was how he described manufacturer's recommendations that ear plugs should be worn in their cabs.

Mr Jackson suggested that with fields being made larger to make way for bigger machinery, the soil was suffering. The top soil was being compacted, organic processes were being prevented from taking place and drainage was spoiled. "We need machines that don't pan or smear the soil", Mr Jackson concluded.

Mr Jackson's comments about cabs and ear-muffs provoked a great deal of argument. Cost effectiveness cropped up again when Mr J. Alcock of Bomford and Evershed Limited said ear-muffs worked out a lot cheaper than complete new design for tractors.

"It takes seven years before a new design can be put on the market", he told the Forum, "because of the difficulties with weather and testing the machine". Chairman of the meeting, Mr Lional Evans, pointed out that even with ear-muffs, which reduced noise to about 80 decibels, deafness could be caused, as sustained medium noise is as damaging as high intensity noise.

Yorkshire Branch

A lecture on "The use of Fluid Power in Ancillary Agricultural Machinery" was given by Mr Ham, deputising for Mr E. G. Morley of the Plessey Company Limited, at the Griffin Hotel, Leeds, on 25 September.

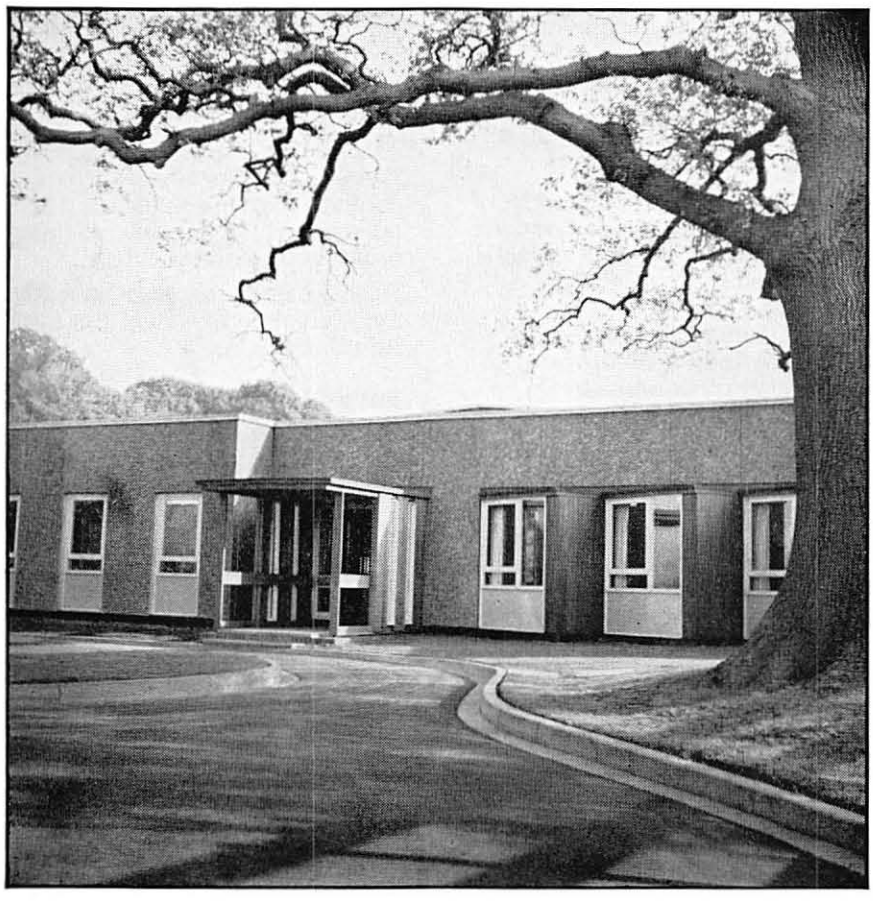
Mr Ham gave a most interesting and profusely illustrated talk on fluid power under four general headings, i.e. General Components in Hydraulic Circuitry; Usage; Complex Circuits; and Unusual Applications of Hydraulics in Agriculture. He dealt at length with the advantages and disadvantages of the various types of pumps and showed how the simple gear pump has kept its place in spite of the ever increasing pressure demands imposed upon it. He indicated how it could still compete with the much more sophisticated and costly axial flow, piston, swashplate and vane types. Mr Ham then went on to discuss valves and showed how modern pressure die-casting techniques could make low cost multiple valve assemblies to very fine limits of clearance and stated that efficient filtration, preferably down to 10 microns, was most desirable for long life. He then dealt with both simple and complex fluid circuitry and went on to show many hydraulic systems employed in agricultural machinery, e.g. tree shakes, electronic potato harvesters, blueberry harvesters, trailers and many others. At the end of his lecture Mr Ham was joined by a colleague and a lively discussion followed.

At a meeting in York on 3 October, Mr D. J. B. Calverley (MAFF) gave a most interesting and spirited lecture on the vexed and controversial subject of "Grass Conservation". He dealt at length with methods of conservation, covering everything from field haymaking, through barn conditioning to large high temperature driers on the dry forage side and from silage in pits or clamps to tower silo and self-feed installations on the moist side.

Several interesting conclusions emerged; for example, that hay making is in general, a wasteful, worrying, over-mechanized and expensive method of making a very low grade feeding stuff and that hay conditioning of some sort has a very large part to play in the future of this crop. Secondly, except for very large commercial installations producing very large quantities of dried grass for compounders, high temperature grass driers have little chance to become extensively used due to very high capital, running and amortization costs.

In general, Mr Calverley gave his blessing to well made pit or clamp silage, suggesting the 'Dorset Wedge' system as having the best method for conserving grass at its most nutritious level with least trouble and least capital cost. He stated that although he liked tower silos and self feed systems, he felt that the very high degree of management organization and experience required for the successful production of high quality feed, as well as the high capital investment required, limited their potential usage. Mr Calverley concluded his lecture with a series of slides showing all the different methods discussed and he convincingly answered many questions from the audience. □

For straight facts about electricity... ask the Electro-Agricultural Centre



The Electro-Agricultural Centre is designed to help you with all aspects of electricity in farming. Here you can get free, accurate and unbiased information about the best equipment for your particular needs. In the main display hall of the Centre you can see examples of the latest systems and equipment for controlled livestock environment, hay drying, potato storage, feed preparation, water heating, refrigeration, frost protection and so on.

Qualified staff backed by a comprehensive library are able to deal with most problems on the spot.

What is more, the Electro-Agricultural Centre is right in the heart of the National Agricultural Centre—where further demonstrations of electrical equipment can easily be seen.

Organised visits (county or local) can be arranged through your Electricity Board. If you cannot come along, write or telephone the Centre and your queries will be promptly dealt with. This service is completely free so why not make full use of it.

The Electro-Agricultural Centre, National Agricultural Centre, Kenilworth, Warwickshire. CV8 2LS Telephone: 0203 27486.

The Electricity Council, England & Wales.

PUBLICATIONS

The following books, papers and data have been received or noted by the Institution.

Air Consumption of Milking Machine Installations and the Required Capacity of the Vacuum Pump—by W. Rossing

This is listed as Research Report 4 1970 from the Institute of Agricultural Engineering and Rationalization, Wageningen, The Netherlands. The author is Head of the Instrumentation Section of the Institute.

Canadian Code for Farm Buildings 1970
—by The National Research Council of Canada

Published by the NRC of Canada Associate Committee on the National Building Code, the Canadian Code for Farm Buildings has been developed as a guide for those interested in the design, construction, remodelling and evaluation of a wide range of non-residential farm buildings.

Enquiries concerning the availability of copies of the Canadian Code should be addressed to the London Office of the Associate Committee on the National Building Code, 64–78 Kingsway, London WC2.

The Chopped Length of Silage (influence on silage quality, and on the feed consumption, the production and health of cows)—by Lars Lindell, Per Lingvall, Johannes Schmekel and Hans Wiktorsson.

This is one of a series of bulletins from the Institute of Agricultural Engineering, Sweden, concerning the rationalization of silage making and silage handling.

Conservation Corps 1959–1969

This illustrated booklet contains a record of the activities and achievements of the Conservation Corps and describes in detail the contribution of volunteers to the conservation of Britain's wildlife over the past eleven years. The booklet is a useful reference for conservationists and for anyone interested in British wildlife. It is available at a cost of 8/6d post free from the Conservation Corps, Zoological Gardens, Regents Park, London NW1.

Control of Algae and Moss in Water Tanks—by E. Crosby Howe and Deon D. Axthelm

This Report (C.C.220) describes a process in six stages involving the use of copper sulphate in low dilution for occasional treatment to help control both moss and algae in livestock water tanks. The Report has been prepared by the Cooperative Extension Service of the University of Nebraska in co-operation with the US Department of Agriculture.

The Control of Seed Borne Vegetable Diseases
—by T. J. Wicks

Published as Extension Bulletin No. 21.70 by the Department of Agriculture, South Australia, its author is a Research Officer in Plant Pathology. He describes simple methods which can be used to control most seed borne diseases in vegetable crops. The equipment used for either hot water or Thiram(R) soak treatment is described.

Enquiries concerning this Bulletin should be addressed to the South Australia Department of Agriculture, Adelaide.

Earthload on Flexible Pipes—by Peder Hove

Report No. 16 of the Agricultural College of Norway publishes the results of investigations into the deformation of flexible plastic pipes installed and loaded in soil.

Enquiries should be addressed to the Library of the Agricultural College of Norway, Vollebekk, Norway.

Environment—a series of filmstrip/slide sets with lecture notes.

This filmstrip/slide set shows some of the main threats to the rural environment, Nature conservation and its relationship to the problems of farming, water resources, environmental pollution and other aspects are discussed.
More details are available from Diana Wyllie Limited, 3 Park Road, Baker Street, London NW1.

Farming and Wildlife—A Study in Compromise

This book is published on behalf of the Farming and Wildlife Advisory Group (FWAG) which organised a conference at Silsoe in July 1969 and on which are represented the principal voluntary and statutory organizations in these fields.

Further details can be obtained from the Society for the Promotion of Nature Reserves, The Manor House, Alford, Lincs.

Fully Slatted Floors for Pigs—by S. H. Baxter

This paper was originally presented at an Agricultural Development Association Course on Pig Production. The author claims that the subject is one which is

today receiving increased attention from the larger pig production units.

Enquiries about the paper should be addressed to the Farm Buildings Department, The North of Scotland College of Agriculture, Craibstone, Bucksburn, Aberdeen AB2 9TQ.

A History of Farm Buildings in England and Wales—by Nigel Harvey

This 280-page book contains a history with examples from AD800 to the present day. Particular sections deal with the agrarian and industrial phases of the agricultural revolution and the last section deals with examples of post-war farmsteads. The author is Farm Buildings Information Officer of the Agricultural Research Council. The book is published by David & Charles, South Devon House, Newton Abbot, Devon.

Housing for Migrant Agricultural Workers—by the Agricultural Research Service, US Department of Agriculture

In the United States of America the housing of migrant or seasonal agricultural workers is of national concern and this has led to the establishment of advisory services and regulations by various agencies of Federal, State and Local Governments. This handbook is intended to assist producers in meeting such regulations and attracting labour through adequate housing.

The Green Book—by Directory Publications Ltd

The famous Green Book of Tractors and Farm Machinery is now in its twentieth year and is henceforth to be published twice annually in two separate volumes. It provides 1200 entries describing and illustrating every known tractor, farm machine and implement available from British sources. The Winter edition concentrates mainly on tractors, primary production machinery and equipment, including a 50-page tractor section giving specifications for over 60 tractors. The Summer edition will concentrate on harvesting, drying, storage, materials handling, farm and equipment maintenance. special machines for overseas use and forestry equipment.

The regular subscription is £5 5s. 0d. for both volumes (Summer and Winter) or £10 10s. 0d. for a pre-paid three years' subscription. Further information and subscription forms can be obtained from The Green Book, Directory Publications Ltd, Saracen's Head Buildings, 36–37 Cock Lane, London EC1A 9BU.

Hydraulic Quality of Drain Pipes—by Peder Hove

Published as Report No. 15 of the Agricultural College of Norway, Institute of Agricultural Hydrotechnics, this paper describes work carried out at the Institute on the measurement of hydraulic resistance in various drain pipes, having regard to the relationship of pipe diameter, slope capacity, run-off co-efficient and drain area.

Enquiries should be addressed to the Library of the Agricultural College of Norway, Vollebekk, Norway.

The Industrial Training Yearbook 1971 and **British Qualifications**—by Kogan Page Ltd

Radically revised and updated each year, the Yearbook provides essential data on the obligations imposed by the Industrial Training Act as well as the facilities and resources available, both from the Industrial Training Boards and other public and private bodies.

The companion volume on British Qualifications is now in its second edition. It gives clear, concise and comprehensive information covering the whole range of qualifications current in the United Kingdom. It should be useful to teachers, careers masters, training officers and anyone who is concerned in any way with education and training.

The Yearbook costs 70/- and British Qualifications 80/-. Further details can be obtained from Kogan Page Limited, 16 Gray's Inn Road, London WC1.

The Influence of a Watercourse Regulation on the State of Groundwater and Crops on Adjacent Cultivated Land—by Einar Myhr

Published as Report No. 17 of the Agricultural College of Norway, Institute of Agricultural Hydrotechnics, this paper gives the results of a number of investigations in connection with the regulation of a watercourse, the aim being to discover whether the water level in the river affected the groundwater table and whether a reduction in the flow of water could lead to crop failure on the low-lying land along the course of the river. Investigations included measurements of precipitation, recordings of the river and groundwater levels, as well as measurements of the moisture of the soil. In addition, harvesting was carried out from fixed experimental plots.

Enquiries about this Report should be addressed to the Library of the Agricultural College of Norway, Vollebekk, Norway.

Minimum Tillage of Corn Production—by G. R. Free

Published as Bulletin 1030 by Cornell University Agricultural Experiment Station, New York State College of Agriculture, this Bulletin presents and discusses results of recent studies of minimum tillage for corn in New York. Emphasis is placed on what is known as 'zero tillage' or 'no tillage'.

Enquiries about this paper should be addressed to New York State College of Agriculture, Cornell University, Ithaca, New York.

Proceedings of the National Agricultural Machinery Workshop—by The University of New South Wales.

The first national agricultural machinery workshop was held in Australia in August 1969. The theme for discussion was 'Seedbed preparation, planting and fertilizing machinery for pasture and crop establishment'. The Workshop was organized to meet an urgent need for improved communication between personnel from various organizations who are engaged in the development and application of agricultural machinery.

The Proceedings are available in book form at a cost of $2.50 (Aust) per copy ($2.00 for students) from The Secretary, The Institute of Rural Technology, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia.

Relationship Between the Tenacity of Beet Seed on the Stalk and the Threshing Ripeness of the Seed—by K. de Koning

The author is Head of the Department of Materials Handling of the Netherlands Institute of Agricultural Engineering and Rationalization. Published as Research Report No. 5 1970 the Report describes researches made into the possibilities of combine harvesting beet seeds. A method was developed to measure accurately any improvement of the threshability of the crop. The tenacity between the seed and the mother plant was measured and reliable differences were found between swathing treatment and defoliation spraying treatment.

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FORTHCOMING EVENTS

Institution Activities

FEBRUARY 1971

MON. 1 at 19.30—WEST MIDLANDS BRANCH
Recent Developments in the Cultivation and Mechanization of Sugar Beet by G. L. Maughan of the British Sugar Corporation Limited, to be held at the Electro-Agricultural Centre, N.A.C. Stoneleigh, Warwickshire.

THURS. 4 at 19.30—EAST MIDLANDS BRANCH
Controlled Environment Stores for Vegetables by T. Laflin, National Vegetable Adviser, to be held at the Kesteven Agricultural College, Caythorpe Court, Nr. Grantham, Lincs.

MON. 8 at 19.30—WREKIN SUB-BRANCH
Recent Developments of Combine Harvesters by a speaker from Manns of Saxmundham to be held at The Sanders Hall, Staffordshire College of Agriculture, Rodbaston, Penkridge, Stafford.

TUES. 9 at 19.00—SCOTTISH BRANCH
Don't Pour Your Milk Profit Down the Drain—(Speakers to be announced) to be held at The Silver Bell Hotel, Lanark.

WED. 10 at 19.00—SCOTTISH BRANCH
Don't Pour Your Milk Profit Down the Drain—(Speakers to be announced) to be held at The North of Scotland College of Agriculture, Craibstone, Bucksburn, Aberdeen.

WED. 10 at 13.30—NORTHERN BRANCH
ANNUAL CONFERENCE to be held at the University of Newcastle upon Tyne.
FARM MECHANIZATION, SELECTION, UTILIZATION AND COSTS
Machinery Selection by C. Culpin.
Machinery Utilization by D. W. Jewett.
Operating Costs by G. Ross.
Operating Costs by R. A. Dudman.

THURS. 11 at 19.30—SOUTH WESTERN BRANCH
The Production and Management of Grass for Drying by J. S. Blatcher, Technical Adviser of Shellstar Ltd., and J. M. Monck of Avon Farm Machines Ltd., to be held at the Training Centre, South Western Electricity Board, Priorswood Road, Taunton.

WED. 17 at 18.30—WESTERN BRANCH
ANNUAL GENERAL MEETING to be held at The Bath Arms Hotel, Warminster.
The Handling and Distribution of Liquid Fertilizers by C. Brown, of J. W. Chafer Limited.

THURS. 18 at 19.30—MERSEYSIDE SUB-BRANCH
Parlour Design and Feeding by A. C. Harrison, Farm Manager, ICI Experimental Farm, Cheshire, to be held at the Lancashire College of Agriculture, Myerscough Hall, Bilsborrow, Preston.

FRI. 19 at 19.00 for 19.30—EAST ANGLIAN BRANCH
DINNER DANCE to be held at the Park Hotel, Diss, Norfolk.

FRI. 26 at 19.30—YORKSHIRE BRANCH
Some Aspects of Farm Waste Disposal by D. P. Evans of the Ministry of Agriculture, Fisheries and Food, to be held at the Askham Bryan College of Agriculture and Horticulture, Askham Bryan, York.

MARCH 1971

MON. 1 at 19.30—WEST MIDLANDS BRANCH
Future Development and Economic Trends in Combine Harvesters by R. E. Arnold of the National Institute of Agricultural Engineering, to be held at Massey-Ferguson Training Centre, Stareton, Nr. Kenilworth.

THURS. 4 at 19.30—EAST MIDLANDS BRANCH
Pea and Bean Harvesting by C. Bridge of Mather & Platt Ltd, to be held at the Lindsey College of Agriculture, Riseholme, Lincoln.

THURS. 4 from 10.00 to 17.00—SCOTTISH BRANCH
ANNUAL CONFERENCE to be held at The Bruce Hotel, East Kilbride.
FARM WASTE DISPOSAL
Legal Requirements by J. Tannahill.
Mechanics of Disposal by J. Reader.
Effluent Purification by V. Dodd
Poisonous Materials (Speaker to be announced).

THURS. 4 at 17.30—SCOTTISH BRANCH
ANNUAL GENERAL MEETING to be held at The Bruce Hotel, East Kilbride.

THURS. 4 at 19.00—SCOTTISH BRANCH
DINNER (Informal) to be held at The Bruce Hotel, East Kilbride.

MON. 8 at 19.30—SOUTH EAST MIDLANDS BRANCH
ANNUAL GENERAL MEETING to be held at the National College of Agricultural Engineering, Silsoe, Bedford.
Engineering Problems in the Field of Dairy Husbandry by A. S. Foot of the National Institute for Research in Dairying, Shinfield, Reading.

MON. 8 at 19.00—WREKIN SUB-BRANCH
ANNUAL GENERAL MEETING to be held at The Harper Adams College, Newport, Salop.
Current Cultivation Techniques by J. K. Grundey of N.A.A.S. Eastern Region.

TUES. 9 at 19.00—NORTHERN BRANCH
Milling and Mixing by R. Thompson of Contractamix (N.E.) Ltd and A. G. S. Reed of E. H. Bentall & Co Ltd, to be held at the Agricultural Department, University of Newcastle upon Tyne.

THURS. 18 at 19.30—MERSEYSIDE SUB-BRANCH
ANNUAL GENERAL MEETING to be held at the Greyhound Motel, Leigh.
Contract Growing (Speaker to be announced).

FRI. 19 at 19.30—EAST ANGLIAN BRANCH
ANNUAL GENERAL MEETING to be held at the King's Head Hotel, Diss, Norfolk, followed by a talk.

TUES. 23 at 19.00—NORTHERN BRANCH
ANNUAL GENERAL MEETING to be held at the Agricultural Department, University of Newcastle upon Tyne.

WED. 24 at 19.45—WESTERN BRANCH
The Use of Computers for the Examination of Systems of Farm Mechanization by G. W. Shepherd, Farm Advisory Service, ICI Limited (Venue to be confirmed).

FRI. 26 at 19.30—YORKSHIRE BRANCH
ANNUAL GENERAL MEETING to be held at the Griffin Hotel, Boar Lane, Leeds.
Plain Bearings in Agricultural Machines by M. G. Davis of The Glacier Metal Co Ltd

TUES. 30 from 10.00 to 16.30—NATIONAL ACTIVITY
SPRING NATIONAL MEETING to be held at The National College of Agricultural Engineering, Silsoe, Bedfordshire. Ticket admission only.
SELECTION AND DEVELOPMENT OF NEW PRODUCTS.

APRIL 1971

THURS. 1 at 19.30—EAST MIDLANDS BRANCH
Tractor Guidance Systems by K. E. Morgan and D. W. I. Brook of Reading University to be held at the Haycock Hotel, Wansford-in-England, Peterborough.

FRI. 2 at 19.00 for 19.30—SOUTH WESTERN BRANCH
Paper by member of the Devon River Authority on Water Conservation and the problems of pollution (speaker and exact title to be announced). This is a joint meeting with the Exeter Panel of the Institution of Mechanical Engineers to be held at The Royal Clarence Hotel, Exeter.
MON. 5 at 19.30—WEST MIDLANDS BRANCH
The Farm Machines of Tomorrow, or a look Ten Years Ahead by C. J. Sutton to be held at The Mid-Warwickshire College of Further Education, Warwick New Road, Leamington Spa.
TUES. 6 at 19.30—YORKSHIRE BRANCH
Simulated Field Testing of Agricultural Tractors and Components by Rig Testing by H. E. Ashfield of David Brown Tractors Limited to be held at the Huddersfield Technical Training College, Huddersfield. (Joint meeting with the North Eastern Centre of the Automobile Division of the Institution of Mechanical Engineers.)
FRI. 16 at 18.30—WEST MIDLANDS BRANCH
ANNUAL GENERAL MEETING AND DINNER
To be held at Regent Hotel, Leamington Spa, Warwicks.
WED. 21 at 14.00—WESTERN BRANCH
VISIT to the new factory of British Lely Limited, Wootton Bassett, Wiltshire.
THURS. 22 at 19.30—EAST MIDLANDS BRANCH
ANNUAL GENERAL MEETING AND DINNER
(Details and venue to be announced.)

MAY 1971
THURS. 6 from 09.30 to 17.00—NATIONAL ACTIVITY
ANNUAL CONFERENCE to be held at the Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1. Ticket admission only.
ENGINEERING ASPECTS OF GREEN CROP CONSERVATION.
THURS. 6 at 12.00—NATIONAL ACTIVITY
ANNUAL GENERAL MEETING of the Institution of Agricultural Engineers to be held at the Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1.
THURS. 6 at 18.15 for 19.00—NATIONAL ACTIVITY
ANNUAL DINNER to be held at St Ermin's Hotel, Caxton Street, London SW1. Guest speakers to be announced. Ticket admission only.
Further details of all national activities will be released in due course.

Other Activities

FEBRUARY 1971
TUES. 9/THURS. 11—NATIONAL POWER FARMING CONFERENCE 1971
To be held at Scarborough, Yorks. Enquiries to the Administrator, National Power Farming Conference, Room 516, 161 Fleet Street, London EC4.
TUES. 9/THURS. 11—4th ANNUAL CALIFORNIA FARM EQUIPMENT SHOW
To be held at Tulare, Calif. Enquiries to Agri-Action '71, PO Box 1475, Tulare, Calif. 93274, USA.
THURS. 11—FARM AND CONSTRUCTION EQUIPMENT FUELS AND LUBRICANTS FORUM
To be held at Marriott Motor Hotel, Chicago, Illinois. Enquiries to American Petroleum Institute, Division of Marketing API, 1271 Avenue of the Americas, New York, NY 10020, USA.
SUN. 21/FRI. 26—ENGINEERING FOUNDATION RESEARCH CONFERENCE
Environmental Engineering in the Food Industry.
To be held at Asilomar Conference Grounds, Pacific Grove, Calif. Enquiries to Engineering Foundation, 345 E 47th Street, New York, NY 10017, USA.

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IT PAYS TO CHECK

with the organizers whether there has been any change, addition or cancellation to the Institution's published programme. The following officers will gladly keep you informed of sessional activities in their areas.

NATIONAL ACTIVITIES
Asst. Secretary (Publicity):
H. N. WEAVERS
The Institution of Agricultural Engineers
Penn Place, Rickmansworth, Herts.

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EAST MIDLANDS
Branch Hon. Secretary:
R. D. S. BARBER, BSc, ND Agr E, MI Agr E
The Farm Institute, Caythorpe Court
Nr. Grantham, Lincs.

MERSEYSIDE
Sub-Branch Hon. Secretary:
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NORTHERN
Branch Hon. Secretary:
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Sub-Branch Hon. Secretary:
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Staffordshire College of Agriculture
Rodbaston, Penkridge, Stafford.

YORKSHIRE
Branch Hon. Secretary:
J. MAUGHAN, BSc, MSc, MI Agr E
48 The Hollows, Bessacarr
Doncaster, Yorks.

Forthcoming events—*continued*

MARCH 1971

TUES. 9/SUN. 14—42nd SIMA INTERNATIONAL AGRICULTURAL MACHINERY SHOW
To be held in Paris concurrently with the World Market for Farm Implements and the International Leisure Power Cultivation Show. Enquiries to Salon International de la Machine Agricole, 95 Rue Saint-Lazare, Paris-9e, France.

TUES. 30/FRI. 2 APRIL—5th INTERNATIONAL CONFERENCE ON FLUID SEALING
To be held at the University of Warwick, Coventry. Enquiries to H. S. Stephens, 5 FICFS, British Hydromechanics Research Association, Cranfield, Beds.

APRIL 1971

SUN. 11/TUES. 13—ELASTOHYDRODYNAMIC LUBRICATION SYMPOSIUM 1971
To be held at the University of Leeds, Yorks. Enquiries to Conference Publicity Section, The Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1.

SUN. 11/SUN. 18—FIMA/71 INTERNATIONAL AGRICULTURAL MACHINERY TECHNICAL SHOW
To be held in Zaragoza, Spain. Enquiries to FIMA/71, 5 Feria Técnica Internacional de la Maquinaria Agricola, Palacio Ferial, Plaza Emperador Carlos, Zaragoza, Spain.

WED. 14/FRI. 16—4th ANNUAL NATIONAL POLLUTION CONTROL CONFERENCE AND EXPOSITION
To be held at Cobo Hall, Detroit, Michigan. Enquiries to National Pollution Control Conference and Exposition, 1107 S Loop West, Houston, Texas 77021, USA.

MON. 19/FRI. 23—3rd INTERNATIONAL CONGRESS OF THE AGRICULTURAL MUSEUMS
To be held in Budapest, Hungary. Enquiries to Magyar Mezogazdasagi Muzeum, Budapest, XIV, Vajdahunyadvar, Hungary.

TUES. 20/THURS. 22—SYMPOSIUM ON MICRONUTRIENTS IN AGRICULTURE
To be held at the Fertilizer Development Center, TVA, Muscle Shoals, Alabama.
Cosponsored by Tennessee Valley Authority and the Soil Science Society of America. SCSA, 677 S Segoe Road, Madison, Wis 53711.

SAT. 24/SUN. 2 MAY—IGA 1971 SPRING EXHIBITION AND FAIR
To be held at Erfurt, E Germany. Further details to be announced.

MAY 1971

SUN. 23/SAT. 5 JUNE—GRASSLAND RESEARCH
British Council Course 132. To be held at the Grassland Research Institute, Hurley, near Maidenhead, Berks. Vacancies for 20 senior graduates who have had at least five years experience in grassland or closely related research. Applications must be received in London by 1 March. Enquiries to the Director, Courses Department, The British Council, 2/3 Bloomsbury Square, London WC1A 2RL.

The Institution cannot accept responsibility for the accuracy of the foregoing information. Dates and venues may be changed without notice, and readers are advised to obtain confirmation of all details before making travel arrangements. □

Technical Information for Engineers: What They Need and What They Get—by The Institution of Mechanical Engineers
The Proceedings of a conference, the first national meeting in Britain between information workers and engineers, are now available in published form. The conference was arranged by the Council of Engineering Institutions (CEI) and Aslib in 1968. Its concern was time, energy and money for research in engineering later negated by lack of proper information retrieval. Topics covered include, descriptions of inquiries; engineers' needs for information; their information retrieval needs.
The book is available, price £1 5s. 0d., from The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London SW1.

Transporting and Feeding Silage—by Edvard Nilsson
In 1965 the Swedish Institute of Agricultural Engineering started an investigation into the mechanization of silage-handling. This bulletin deals with the transportation of the silage in the livestock building and its distribution into the feed bunk. The bulletin is intended to be of practical assistance to farmers and extension workers in the planning of feed distribution systems and the choice of equipment. It is published at the same time as Special Bulletin No. S 17 'A study of different types of auger feeders'.

Other bulletins in this series are No. 320 'Silage unloading' and No. 329 'Harvesting and filling of forage crops for silage'. A further bulletin in this series is planned which will deal with the choice of methods and the costs of silage making and silage handling.

Enquiries concerning these bulletins should be addressed to the Swedish Institute of Agricultural Engineering, Uppsala, Sweden.

A Trap with Sex Attractant for Monitoring Time of Codling Moth Flights—by L. G. Scheonleber, B. A. Butt and D. O. Hathaway
Published by the Agricultural Research Service of the US Department of Agriculture, this paper describes the design and operation of a trap to capture male codling moths. For the purposes of obtaining effective control of the codling moth with chemical or biological measures, it was necessary to establish the native populations and flight habits, insect traps with attractants being used with limited success as research tools for trapping codling moths. The trap described in this Report was designed to determine the intensity and time of flight and the population trends of the codling moth.

Enquiries concerning this Report should be addressed to the UK Department of Agriculture, Agricultural Research Service, Beltsville, Maryland 20705.

Wiring Regulations: 1970 (Metric) Reprint—by The Institution of Electrical Engineers
The IEE Council have authorized the issue of a 1970 (Metric) reprint of the Wiring Regulations which took effect from 21 August 1970. The reprint is in SI units throughout incorporating the 1969 supplement and 1970 amendments.

The reprint is obtainable from the Secretary of IEE, price 25/-s post free or through booksellers. For the time being the former Imperial version with amendments will also remain available on request price 20/-s post free for users who need this for reference purposes. □

BSI NEWS

The following information has been made available by the British Standards Institution.

Notable Advance in British Standards Methods

The issue of a construction industry publication recently under the general title of 'Drafts for Development' marks an important stage of progress in British Standards Institution's methods—the the Executive Board's decision to publish drafts for development as a form of 'cadet' standard.

This first publication—Accuracy in Building, Parts I and II—was issued under BSI's familiar PD series before the idea was crystallized into policy, but in future the new publications will be issued as a special DD series of saleable publications.

There has been a growing and widely expressed need for a category of BSI publications, which, although not acceptable as formal British Standards, either because of insufficient information or experience or because of lack of unanimity of view, would nevertheless provide a basis from which a British Standard could be developed when a sufficient background of knowledge, experience and practical application had been accumulated. It may well be that the introduction of the Drafts for Development to meet this need will stimulate constructive thinking on a subject when the way ahead is not entirely clear.

BSI's move in this direction is necessarily experimental; policy will need to be developed and the criteria for issuing Drafts for Development will have to be established in the light of consideration of the suitability of drafts suggested for treatment in this way. It is intended that Drafts for Development should be prepared by technical committees or by small working groups and submitted to Industry Standards Committees before publication. They will not normally be issued for general comment although, if there is good reason, comments on the draft may be sought from a limited number of informed sources.

When it has been decided to replace a Draft for Development by a British Standard, official notice of this will be given in *BSI News.* A draft for comment will not normally be issued because, as is shown by the statement below, a Draft for Development is designed inherently to serve as a document for comment as well as for application.

The following statement will be included on an introductory page of every Draft for Development.

1. This publication is not to be regarded as a British Standard.
2. It is being issued in the Draft for Development series of publications and is recommended that it should be applied on this provisional basis, so that information and experience of its practical application may be obtained. Those who use it are urged to write to BSI giving their experience in applying this publication. Constructive proposals for improvement and more precise definition will be welcomed.
3. The intention is to publish a British Standard when sufficient knowledge and experience have accumulated.
4. The British Standards Institution requests that, because of the provisional nature of the publication, its reference number should not be marked on products.

BSI Ends Confusion of Welding Terms

A significant source of confusion in the terminology of fillet welds has been eliminated with the decision by BSI to withdraw "size" as a defined term from the glossary on welding—BS 499 *Welding terms and symbols: Part I: Welding, brazing and thermal cutting glossary* (its obsolescent meaning will be indicated in a footnote). In future, the dimensions of a fillet weld should always be clearly indicated as "leg length" or "throat thickness" as appropriate. The term "size" should not be used.

Alert to the needs of industry, BSI carried out a broad survey of opinion in the welding field to decide whether to retain the term with its contemporary meaning in BS 499, change it to mean "throat thickness", or withdraw it altogether. An excellent response produced a clear majority in favour of withdrawing the term, and this is now being done. It has also been decided by the Welding Industry Standards Committee to establish a preferred range of metric dimensions for fillet welds and the following *leg lengths* have been agreed upon: 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 22, 25 mm.

It is hoped that the change of terminology and the preferred dimensions will be accepted and implemented by everyone concerned, in the interests of rationalization and clarity of expression.

Terminology and Use of Rotary Shaft Lip Seals

The British Standards Institution has published BS 1399: *Rotary shaft lip seals: Part 3:* 1970 *Terminology, and recommendations for handling.*

This is the final part of the revision of this Standard, Parts 1 and 2 of which deal with the dimensions and performance ratings of rotary shaft lip seals.

Part 3 defines and illustrates all the terminology relating to rotary shaft lip seals and also gives recommendations for their storage, handling and preparation for fitting and assembly.

Copies of BS 1399: Part 3: 1970 can be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order 12s (subscribers 10s).

Methods of Test for Hydraulic Pumps and Motors for Power Transmission

The British Standards Institution has published BS 4617: 1970 *Methods for testing hydraulic pumps and motors for hydrostatic power transmission,* which is intended to unify type testing methods, thus enabling a comparison to be made between different types of units.

It is not intended to establish how closely production unit performance complies with specified requirements nor to specify which performance characteristics should be checked during a production.

The Standard specifies the methods to be employed in the determination of the performance and efficiency of hydrostatic power units under steady-state conditions. A hydrostatic power unit is defined as a device for the transmission of energy by means of a pressurized fluid. For the purposes of this specification such units are associated only with continuously rotating shafts.

The unit may be tested as a pump, that is with mechanical energy applied to the shaft and hydraulic

energy obtained at the fluid connections, or as a motor with hydraulic energy supplied to the fluid connections and mechanical energy obtained at the shaft. Transmission units which combine pump and motor in an integral housing may be tested for performance and efficiency relative to the input and output shafts.

Requirements for test installations and procedures, measurement, and presentation of results are given, and an appendix shows a method of determining the energy balance in a hydraulic unit.

SI units are used in the Standard, with imperial units for information.

This Standard follows upon the recent publication of BS 4602 which gives methods for testing oil hydraulic control valves.

Copies of BS 4617: 1970, may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, £1 16s (subscribers £1 12s).

Universal Decimal Classification for Individual Crops, Forestry, Horticulture

The latest section of the English Full Edition of the Universal Decimal Classification (UDC) to be published by BSI is BS 1000 (633/635) *Individual crops. Forestry. Horticulture.* It covers cereals, grain crops, grasses, roots and fibre, stimulant, sugar, starch, perfume, condiment, oil, dye tanning and medicinal plants. Arboriculture, silvicultive, forest engineering, mensuration, management and marketing. Horticulture, vegetable gardening, ornamental gardening.

The UDC is used internationally as an aid to information retrieval and it provides a numerical decimal code for the systematic arrangement by subject matter of material in the form of books, pamphlets, maps, films etc. It is particularly useful for the arrangement of entries representing this material in catalogues and bibliographies. The classification is published in many different languages and this volume is another stage in a programme to provide a full English edition.

Copies of BS 1000 (633/635) may be obtained from the BSI Sales Branch at 101/113 Pentonville Road, London N1 9ND. Price by post 28s (24s to subscribers).

Universal Decimal Classification for Agriculture, Agricultural Machines. Soil Science. Plant Injuries, Diseases and Pests. Plant Protection.

The latest section of the English Full Edition of the Universal Decimal Classification (UDC) to be published by BSI is BS 1000 (631/632) *Agriculture, Agricultural machines. Soil science. Plant injuries, diseases and pests. Plant protection.* It covers general subjects concerning agriculture, the management of agricultural enterprises; farm building and installations; agricultural machines, implements and equipment; soil science and soil research; agricultural operations; rural engineering, land reclamation, drainage and irrigation; fertilizers and manures; plant injuries, diseases and pests; plant protection and pest control in general.

The UDC is used internationally as an aid to information retrieval and it provides a numerical decimal code for the systematic arrangement by subject matter of material in the form of books, pamphlets, maps, films, etc. It is particularly useful for the arrangement of entries representing this material in catalogues and bibliographies. The classification is published in many different languages and this volume is another stage in a programme to provide a Full English Edition.

Copies of BS 1000 (631/632) may be obtained from the BSI Sales Branch at 101/113 Pentonville Road, London N1 9ND. Price by post 28s (24s to subscribers).

Standard Metric General Purpose Rivets

The British Standards Institution has published BS 4620:1970 *Rivets for general engineering purposes*, which is in metric units only. The Standard covers rivets manufactured from mild steel, copper, brass, pure aluminium, aluminium alloys or other suitable metal.

The shapes of heads have been restricted to those in common use in this country and seven types are specified: Hot and cold forged snap heads; hot and cold forged universal heads; cold forged flat heads; cold forged 90° countersunk heads; hot forged 60° countersunk and raised countersunk heads. Diameters from 1 mm to 39 mm are given and these are tentatively associated with lengths in an appendix which will be reviewed in the light of use. The Standard is based on ISO/R 1051 of the International Organization for Standardization.

Copies of BS 4620:1970 can be obtained from the BSI Sales Office, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, 12s (subscribers 10s).

Radio Interference caused by Internal Combustion Engines

The British Standards Institution has revised BS 833 and published it as BS 833:1970 *Radio interference limits and measurements for the electrical ignition systems of internal combustion engines.*

The revised Standard is intended to protect the reception of sound and television signals in a frequency range of 40 to 250 MHz against radio interference and prescribes limits of radiation from the ignition systems of internal combustion engines; it also specifies the methods of measurement to be used for testing for compliance with these limits, and gives a method of measurement for the insertion loss of components used in making up radio interference suppression devices for use in ignition systems.

These limits and methods of measurement are in accordance with the recommendations of the International Special Committee on Radio Interference (CISPR) and with the regulations of the Inland Transport Committee of the United Nations Economic Commission for Europe, and because of this the frequency range covered differs from the 1953 version of the Standard.

The title has been changed to accentuate that the revised Standard applies to spark-ignited internal combustion engines (with the exception of those fitted in aircraft) including all types of road vehicles, including scooters and mopeds, portable prime movers such as generating sets, concrete vibrators and power drills, construction machinery such as cement mixers, winches, hoists etc., *agricultural machinery such as tractors, cultivators, combine harvesters and chain saws* and boats with inboard and outboard motors.

An appendix gives examples of present techniques for suppression arrangements for ignition systems which are also in accordance with CISPR Reports and Recommendations.

Copies of BS 833:1970 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, 17s (subscribers 14s).

Standard Undercuts and Runouts for Metric Threads

The British Standards Institution has published BS 1936 *ISO metric screw threads:* Part 2:1970 *Undercuts and runouts*, which is complementary to BS 1936:1952 which deals with the same subject for Unified, Whitworth, B.A. and Cycle threads.

The standard specifies dimensions for form, width and diameter of undercuts and runouts for ISO metric threads as used in general engineering applications. Undercuts for high-duty applications are dealt with in an appendix, but these do not include those for aerospace applications, which will be the subject of separate British Standards.

In this Part of BS 1936, the width of undercuts has been taken as the distance from the shoulder to the crest of the first full thread, rather than to the chamfer of the first thread, in order to align with current European practice.

Copies of BS 1936: Part 2:1970 can be obtained from the BSI Sales Branch 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order 12s (subscribers 10s).

International Standards Work on Non-Destructive Testing

Fifty delegates from 12 countries attended the first plenary meeting of the new ISO Committee (ISO/TC 135) for non-destructive testing, which was held in London from 21 to 23 September, 1970.

Observers from the International Institute of Welding (IIW), International Electrotechnical Commission (IEC) and from other ISO Committees having an interest in this subject were also present.

The Chairman for this first meeting was Mr. Colin C. Bates, Consultant, who is a prominent member of BSI committees concerned with non-destructive testing and who chairs the U.K. steering committee for this international work.

Bearing in mind that international work on certain aspects of non-destructive testing was already being carried out, the new Technical Committee carefully defined the overall scope of its work to cover non-destructive testing as applied generally to constructional materials, components and assemblies. Technical Committee 135 will not be concerned with quality levels, which are the responsibility of applications committees, nor with developing specific technical applications for particular product forms and components unless so requested by other ISO Committees.

To carry out its planned programme of work, TC 135 set up the following Sub-committees:

Sub-committee 1—Terminology (Secretariat—France)

Sub-committee 2—Surface Methods (Secretariat—United Kingdom)

Sub-committee 3—Acoustical Methods (Secretariat—U.S.A.*)

Sub-committee 4—Electrical and Magnetic Methods (Secretariat—Italy*)

Sub-committee 5—Radiation Methods (Secretariat—Germany)

Sub-committee 6—Leak Detection Methods (Secretariat—France)

For co-ordinating the activities of the above Sub-committees, particularly as regards the presentation and translation of documents, a Working Group was set up with the United Kingdom as its Secretariat.

*Subject to confirmation.

Within their fields of work, the Sub-committees will determine their priorities for preparing documents defining methods of test and specifications relating to the testing equipment required, close liaison being maintained with Sub-committee 1 where terminology is concerned. Particular importance is attached to the development of a glossary for non-destructive testing and also to achieving international agreement concerning the performance of testing equipment and materials. It is also intended to provide guidance on the way in which non-destructive testing requirements should be specified.
The Committee will establish liaison with other ISO Committees and other international organizations having a direct interest in this important and developing field of work.

The Use of Friction Grip Bolts in Steelwork

The British Standards Institution has published BS 4604: *The use of high strength friction grip bolts in structural steelwork: metric series:* Part 2: 1970 *Higher grade (parallel shank)*, which covers the use in structural steelwork of high strength friction grip bolts of the higher grade specified in BS 4395: Part 2; it deals with bolts with parallel shanks.
Part 3 of the standard, now in preparation, will deal with the use of higher grade bolts with waisted shanks.
Copies of BS 4604: Part 2: 1970 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order 12s (subscribers 10s).

Metric Housings for Hydraulic Seals

The British Standards Institution has published BS 1658: 1970 *Housings for hydraulic seals for reciprocating applications*, a new standard which specifies the dimensions for long housings and short housings for hydraulic seals for reciprocating applications. The scope has been restricted to reciprocating applications in order that a more complete standard might be written.
The dimensions of the housings have been specified within the range 6 mm to 500 mm for rods and from 16 mm to 540 mm for cylinders. Other clauses deal with the tolerances and surface texture of dynamic metal parts and the length of the lead-in chamfer.
Manufacturers of hydraulic seals complying with BS 1658: 1970 may apply to BSI to use the Kitemark. This is a registered certification mark used only on licence from BSI and its presence on an item or its package is an independent assurance that it does comply with a British Standard.
Copies of BS 1658: 1970 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, 12s (subscribers 10s).

Flat and Cylindrical Roughness Comparison Specimens

It has now become widespread practice in design offices, workshops and inspection departments to use sets of reference specimens exhibiting the various numerical grades of roughness as produced by different machining processes. These are used to give engineers, draftsmen, machine operators and others a first idea of the feel and appearance of common surfaces with which they are acquainted, and additionally, they are extremely valuable in controlling the production of components on a comparative basis. The operator is given a specimen, or preferably two specimens, one having the target value of the product surface and the other perhaps half of that value and the product is compared with

these specimens by feel and appearance. Normally, the background of surface texture control is by sophisticated instrumentation, but roughness comparison specimens are used in the workshop and elsewhere when it is not always a practical proposition to operate a sensitive instrument.

The British Standard on this subject, BS 2634 *Roughness comparison specimens* Part 1 : 1970 *Specimens representing ground flat and cylindrical surfaces*, has now been revised to bring requirements into line with international agreement aimed at achieving uniformity of texture and accuracy between specimens produced in different parts of the world and thus to facilitate the international exchange of technical information on surface requirements.

Manufacturers of roughness comparison specimens may apply to BSI to use the Kitemark. This is a registered trade mark used only under licence from BSI, and its presence on a specimen would mean an independent assurance that it complies with this British Standard.

Copies of BS 2634 Part 1 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, 12s (subscribers 10s).

Direct Hardening Wrought Alloy Steel

The British Standards Institution have published BS 970 *Wrought steels in the form of blooms, billets, bars and forgings:* Part 2 : 1970 *Direct hardening alloy steels, including alloy steels capable of surface hardening by nitriding.*

Part 2 is the second part to be published of the five parts revision of BS 970. Part 4—Stainless heat resisting and valve steels—was published during February of this year and the three other parts which are still to be published are as follows:

Part 1 : Carbon steels

Part 3 : Case hardening steels

Part 5 : Spring steels

Part 2 is presented in four sections; Section 1 : General requirements, Section 2 : Specific requirements for alloy steels supplied to close limits of chemical composition, Section 3 : Specific requirements for alloy steels supplied to hardenability requirements and Section 4 : Specific requirements for alloy steels supplied with specified mechanical properties.

Two features of the revision are, firstly, that the various steels are identified by the new six digit steel designation system (advanced information of this was given in PD 6431 : 1969) in place of the previously used 'En numbers', and, secondly, the inclusion, for the first time in a British Standard, of the new method for purchasing and releasing steels to hardenability requirements.

In addition, the opportunity has been taken to align the compositions of the steels with those demanded in practice, to introduce steels not covered by the previous edition of BS 970 and also to introduce permissible variations on product analysis.

The standard is written in imperial units, it being intended that the metric version of the standard will be published as soon as possible.

Copies of BS 970 : Part 2 : 1970 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, £2 4s. (subscribers £2).

British Standard Handbook on Sampling and Analysis of Steel

A completely new and comprehensive publication on the sampling and analysis of ferrous metals has been published by the British Standards Institution with the aim of grouping together methods primarily intended for reference purposes in the case of disputes involving arbitration, but which are also suitable for the routine checking of materials to specifications.

BS Handbook No. 19 *Methods for the sampling and analysis of iron, steel and other ferrous metals*, includes all the currently approved British Standard methods for the sampling and analysis of ferrous metals, namely those for analysis in BS 1121 (all parts of this standard have now been withdrawn) and new methods not previously published as British Standards, and those for sampling in BS 1837, which will remain available for the convenience of samplers not concerned with analysis.

All the methods have been brought up-to-date on the basis of experience in use and inconsistencies of style, presentation, terminology and nomenclature have been eliminated. One feature of the Handbook is that details of the preparation of all solutions required in all methods are grouped in a separate section and these are not repeated in each method.

The Handbook is in loose leaf form and, at six-monthly intervals, packages of corrections and addenda will be published and supplied to all holders of the Handbook. This will ensure the continuing accuracy of the Handbook and permit the easy addition or withdrawal of methods.

Copies of BS Handbook No. 19 : 1970 can be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, £3 16s (subscribers £3 10s).

The Use of Detergents in the Dairying Industry

The British Standards Institution has published BS 2756 : 1970 *Recommendations for the use of detergents in the dairying industry*, a revised standard which has been considerably enlarged, extending its field of application to equipment used in a number of sectors of the dairying industry not covered by the previous edition. The revision gives very full details of the specific cleaning operations, not only for the dairy farm and the processing dairy, but also for the specialized plant used in the manufacture and packing of butter, natural and processed cheeses, yogurt and ice cream. Recommendations for rotary heaters have been dropped, as these are now considered obsolete.

Methods for the evaluation of detergents were considered, but it was concluded that there is no satisfactory substitute for plant tests of detergent efficiency and general suitability and emphasis has therefore been placed on the correct choice and use of detergents. It is hoped that the information given on dairy detergents will help detergent manufacturers in the formulation of suitable detergents and plant manufacturers in designing equipment.

Reference is made in the standard to combined detergent/sterilizers which are coming into increasing use.

Copies of BS 2756 : 1970 may be obtained from the BSI Sales Branch, 101/113 Pentonville Road, London N1 9ND. Price by post, remittance with order, £1 3s (subscribers £1). □

INVESTIGATION OF A PRESSURE EQUALISING SYSTEM IN A SEALED GRAIN SILO

by G. NEWMAN*

Summary

The volumes of air flowing in and out of a breather bag in a sealed silo were correlated with temperature. The movement of air through a pressure valve, with and without a pressure equalising system incorporated, was recorded. Loss of pressure through the unloading tube when the auger was working, and also when it was static, was demonstrated.

1. Introduction

It has been observed that there is a tendency for moist grain stored in sealed silos to deteriorate, particularly when the grain has been kept until the following Summer. This deterioration is associated with the greater diurnal changes in temperature in Spring, together with an increased proportion of gas as the silo becomes empty. This gas changes in volume with the internal temperature and there is a tendency for the resultant pressure to cause a movement of air in and out of the pressure relief valve, or through the emptying auger tube.

As previous experiments on this subject in the U.K.[1] had not proved conclusive because the silo was not air tight, a series of tests was designed to evaluate the effect of a pressure equalising system using an internal "breather bag".

2. Apparatus

The silo used was a 20 ft (5·9 metre) × 32 ft (9·7 metre) high Harvestore with an internal volume of 9,376 ft³ (265 m³). The silo was about one-third full and contained 65 tons of barley at a moisture content ranging from 21—23%. Unloading was by means of a sealed sweep auger although the sweep arm was not used during the experimental period. The auger transferred the grain into a small hopper from which it was fed into receptacles as required by a second stage auger.

The movement of air was measured by two U.G.I. gas meters working through non-return valves. These valves were made from air-tight glass jars containing oil, with the inlet tube below the surface and the outlet tube in the lid of the jar. The level of the oil was variable and this controlled the back pressure exerted by the valve.[2]

A manometer was connected to the tube between the valves and the silo. This measured the difference in air pressure between the gas in the silo and the external atmosphere. The two valves and meters worked in opposition and one measured the flow into the silo while the other measured the flow out of the silo (see Figure 1).

The internal temperature was measured by a thermocouple which was fitted through a bolt hole in the silo roof and recorded the temperature about 12 in. (300 mm) below the roof. The external temperature was measured in the shade above the silo roof.

The silo was checked for air-tightness before the tests were started.

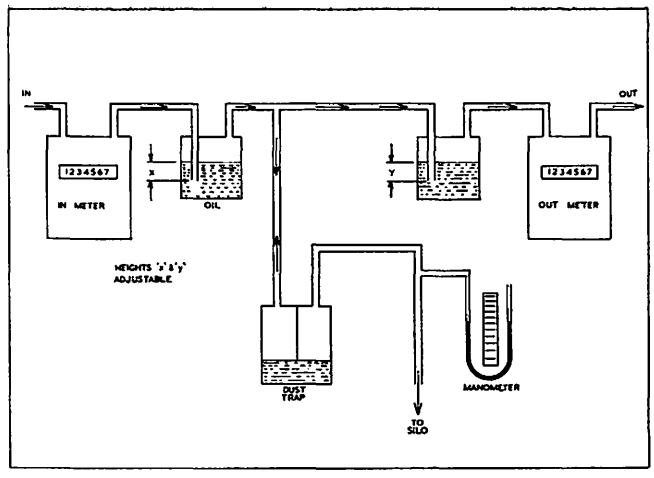

Figure 1.

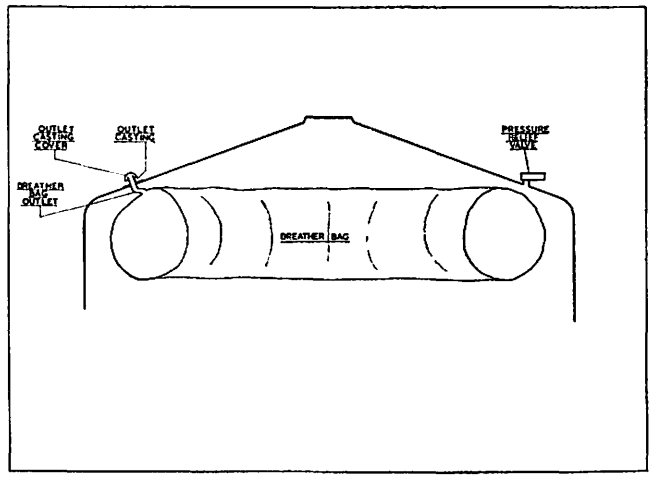

Figure 2.

Test No. 1

Measurement of air movement in breather bags

The breather bag outlet was retained on the outlet casting (see Figure 2) on the silo roof and the cover for this casting was removed. The outlet of this casting was then connected to the gas metering apparatus by means of a hose pipe and adaptor, so that all air movement through the breather bag was measured.

No air could pass to or from the atmosphere above the grain until the pressure exceeded that retained by the pressure valve i.e. + 4 in. (100 mm) water gauge to —2 in. (50 mm) water gauge. This pressure differential could not build up until the breather bag had been filled or emptied to its limit. Air could move freely in and out of the breather bag, apart from the slight back pressure exerted by the valves in the measuring apparatus.
Internal and external temperature, air movement in and out and manometer pressure were noted, together with the weather conditions.

Daily readings were taken for a period of seven days (see graph A) and for the daylight period on 9 May 1970, fifteen minute readings were taken over 15 hours (see graph B). Similar readings were taken for a 24 hour period from noon on 1 June (see graph C).

Discussion

The seven day test shown in graph A indicates that there is a relationship between daily maximum and minimum temperatures and expansion and contraction of silo gas. The difference in air movement between 14 and 15 May shows that a 16°C drop in temperature resulted in a movement of air of over 860 ft³ (24 m³), whilst on the following day a 5°C variation in temperature only resulted

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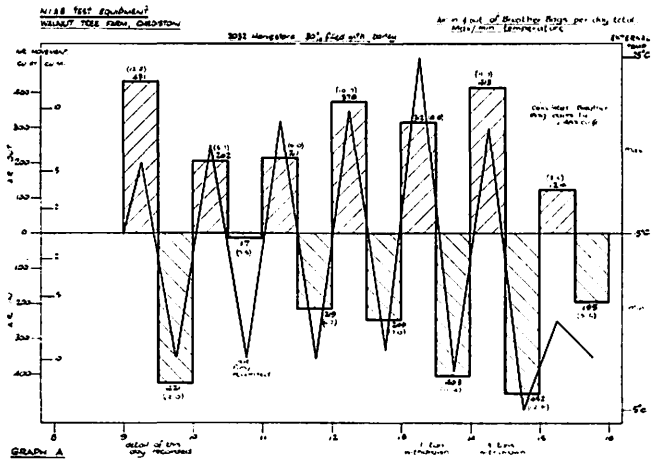
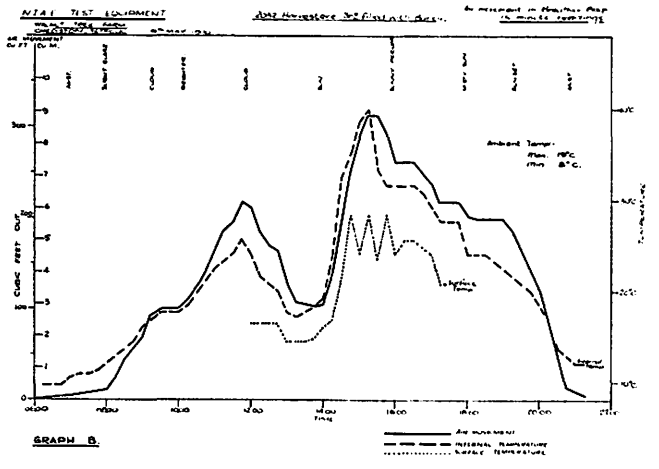
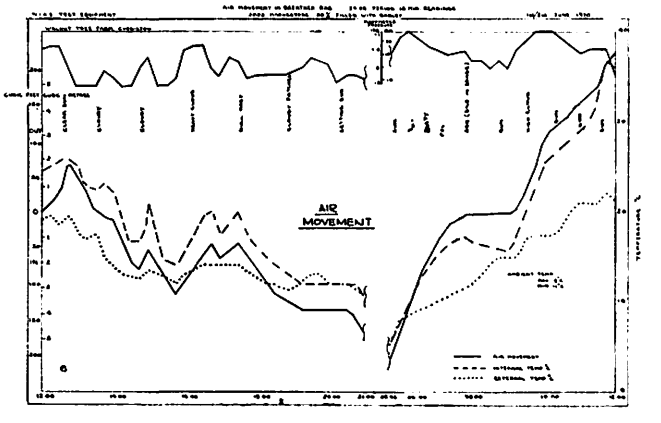


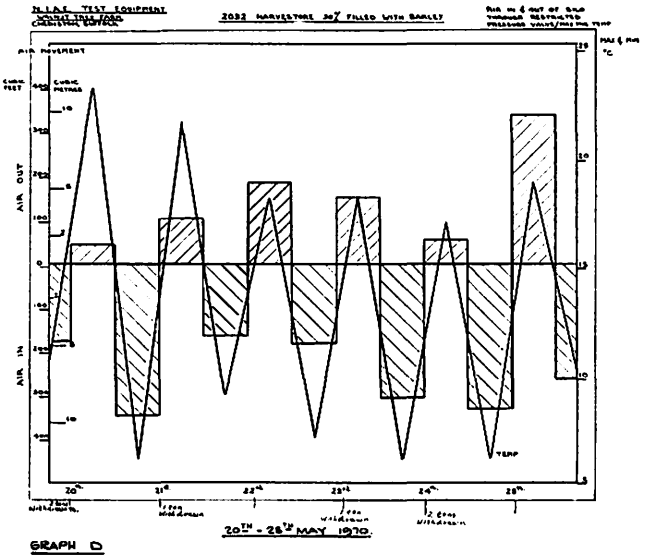
GRAPH A



GRAPH B



GRAPH C



GRAPH D

in just over 300 ft³ (8·5 m³) of air being exchanged through the breather bag.

The reason why the relationship between external temperature and air movement was not closer is illustrated in graph B where the variation of one days' internal temperature and related air movement is shown. This indicates a close correlation between internal silo temperature and movement of air and also illustrates the effect of solar radiation on the internal temperature of the silo.

This close correlation also occurred in graph C at a later date and under rather different weather conditions, On a cloudy day air was going in and out of the breather bags and giving a greater recorded total movement than the maximum/minimum temperature would indicate, whilst in sunny conditions the effects of solar radiation were again apparent. In both types of weather the breather bags succeeded in keeping the pressure within the silo to below ± 1 in. (25 mm) water gauge.

Test No. 2

Measurement of air movement through the pressure valve with breather bags in use

The hose pipe and adaptor were removed from the breather bag outlet casting and reconnected to the pressure valve fitted to the tower (see Figure 2). Air could move freely in and out of the breather bag but was not measured. If the breather bag became completely full or empty then the vacuum or pressure in the silo could build up to + 4 in. (100 mm) water gauge or —2 in. (50 mm) water gauge and any excess would be relieved through the pressure valve and measured daily.

Daily readings were taken of maximum and minimum temperatures over a period of seven days between 26 May and 1 June inclusive. Between a highest recorded maximum of 24·5°C and a lowest minimum of 8·5°C no air movement was recorded through the pressure valve.

Discussion

Although the daily temperatures recorded were similar to those in graph A, there was no movement through the pressure valve and this confirmed that the breather bag was able to cope completely with expansion and contraction within this diurnal variation.

Test No. 3

Measurement of air movement without breather bags

The breather bag outlet sleeve was removed from the outlet casting. The measuring apparatus was reconnected to the outlet casting and the back pressure was adjusted by increasing the oil level to simulate a pressure valve. Air could enter the silo when the vacuum exceeded 1 in. (25 mm) water gauge and out of the silo when pressure exceeded 2·5 in. (64 mm) water gauge.

Daily readings were taken of maximum and minimum temperatures over a period of six days and any air movement recorded (see graph D).

Discussion

Grain was being withdrawn during this period in the late morning and early afternoon. The lower values recorded for air blown out of the structure are the result of a degree of pressure equalisation while unloading took place. Comparatively large quantities of air were drawn into the silo at night in the absence of pressure equalisation.

Test No. 4

Measurement of air movement during unloading

The breather bag remained disconnected and the outlet casting was connected to a small portable pump via an air tight hose with a shut off arrangement. A manometer was

connected to the atmosphere in the silo through a bolt hole in the roof.

The silo was inflated by the air pump to a pressure above the "blow off" value of the pressure valve and the filler hose was shut off. The air pressure on the manometer was noted every half minute and the air escaped through the pressure valve until it closed and a steady pressure was reached. The auger unloading cap was removed and the auger operated under high and low pressure conditions. The tests were carried out in early morning under constant temperature conditions

Discussion

The results on graph E show that when the silo is pressurised and the cap removed from the unloading auger, gas is driven through the grain and out of the silo through the auger outlet. The rate of discharge at high pressure was not appreciably affected by the auger working. At the lower pressure the gas moved out through the auger faster when it was working and the results are summarized in the following table:

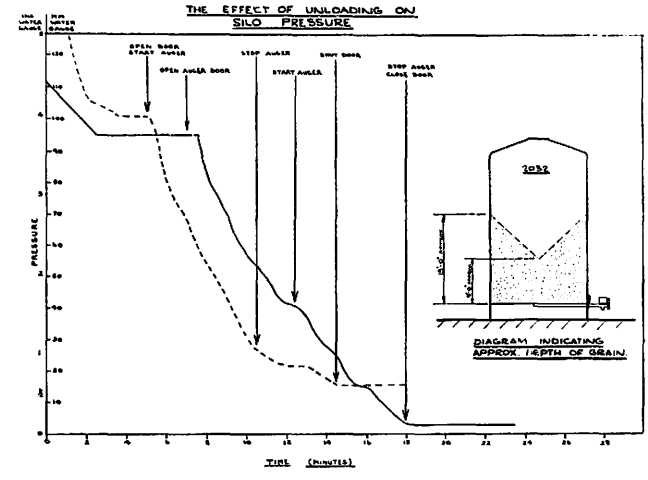
Rate of fall of pressure	Auger working in./min	Auger working mm/min	Auger static in./min	Auger static mm/min	Increase caused by auger working
High pressure	0·53	(13·5)	0·40	(10·0)	30%
Low pressure	0·32	(8·2)	0·09	(2·4)	240%

It is reasonable to assume that a similar movement of air into the silo through the auger tube takes place when there is a vacuum in the silo, and this has been confirmed.[3]

3. Conclusions

Under the conditions prevailing during this series of tests:

1. There was a close correlation between internal silo temperature and the movement of air through the pressure equalising system.
2. The capacity of the breather bag was adequate for a 20°C variation in diurnal temperature.
3. In the absence of a pressure equalising system, up to 350 ft³ (9·9 m³) of air entered the silo at night.



GRAPH E.

4. An internal pressure of 4 in. water gauge (100 mm) was equalised through the unloading auger within a period of ten minutes.
5. The entry of air in the absence of the breather bag caused a rise in grain temperature. Other work has shown that when air is introduced into a silo, the oxygen content of the gas increases at all levels due to thermal convection and diffusion.[2]

4. Acknowledgements

The encouragement and loan of equipment from the Farm Buildings Department of the National Institute of Agricultural Engineering is gratefully acknowledged, together with the co-operation of Downing Farms Ltd., Chediston, Halesworth, Suffolk.

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LONG-TERM EFFECTS OF CULTIVATIONS

by J. R. MOFFATT, AI AGR E*

Presented at the Annual Conference of the Institution in London on 12 May 1970

Summary

An experiment is being done at Rothamsted to compare ploughing, rotavating and deep-tine cultivation for crops in a four-course rotation (beans, wheat, potatoes, barley). A similar experiment was done on light land at Woburn on a two-course rotation (potatoes and barley). The effect of hormone herbicides is measured on the yield of cereals, and the immediate and long-term effect of residual herbicides is measured in beans and potatoes.

Different cultivations had little effect on crop yield even when continued on the same plot every year, but weeds were fewer where a plough was used. Crop yields have been maintained over nine years without apparent loss of soil structure.

Hormone weedkillers, though controlling weeds in cereals, did not give any more yield. Residual herbicides controlled most weeds in beans and potatoes; simazine tended to lower bean yields but potato yields were unaffected by a linuron/paraquat spray. None of the herbicides appreciably affected the crop in the year after application.

Long-term Effects of Cultivations

Until about thirty years ago soil cultivation was a traditional art; sequences of operations were dictated by what had been done by fathers and grandfathers, and not because the value of the operations was really understood.

Over a period of years improvements were made in implement design and materials used, but the number and type of operations remained largely unchanged. If any operation improved the appearance of the soil it was natural to believe that the crop must benefit, so many operations were done and those given to a crop in particular areas became almost standardised. However, these traditional operations depended upon an adequate supply of cheap labour, which gradually became more expensive and in short supply. As mechanisation and the cost of each operation increased it was important to measure what loss of yield, if any, occurred when some operations were omitted. Cultivation experiments have been done at Rothamsted since 1926 to measure the effects of different cultivation treatments on crop yield; when they were started herbicides were unknown. The main results of the early experiments done at Rothamsted and elsewhere were given by Dr. (now Professor) E. W. Russell in a paper read before this Institution in 1945. They were quite consistent but unexpected in that yield did not depend on the number of cultivations done, and that any more than necessary to control weeds did no good and often decreased yield. In fact most crops seemed quite insensitive to the cultivations given.

Russell discussed the results of a six-year rotation experiment and said "the results obtained were striking in their simplicity; the crop yields were surprisingly independent of the cultivation treatment if the land was clean . . . but they were depressed by any treatment which gave a weedy seedbed". This meant, in effect, that the plough, by inverting the furrow slice and burying the weeds produced a seedbed with few weeds; other methods of seedbed preparation that did not bury weeds were only of limited use. In the discussion which followed, Professor, now Sir Harold, Sanders said the results of experiments like those of Dr. Russell were not conclusive, as they were done for relatively short periods. To settle the matter it was necessary, he felt, for experiments to be conducted on the same piece of land year after year.

With the introduction into farming of chemicals to control weeds in most crops the time seemed ripe to start more long-term rotation experiments. In 1961 an experiment on a four-course rotation (wheat, potatoes, barley, beans) was started on clay loam at Rothamsted, and a two-course one (potatoes, barley) on sandy soil at Woburn.

The main objects were:

(1) To measure the long-term effects of different primary cultivation treatments on crop yields, and on the physical condition of the soil.

(2) To see how far weed control by herbicides can simplify or replace field cultivations.

(3) To measure the long-term effects of herbicides on crop yields.

The three primary cultivations tested on each crop in each year are:

P The land is mouldboard ploughed followed by operations to produce a seedbed.

R The land is rotary cultivated once or twice, but is not mouldboard ploughed.

T The land is worked with a deep-tined cultivator two or three times before seedbed-producing operations; it is not mouldboard ploughed or rotary cultivated.

In combination with these are three systems of post-planting weed control in beans and potatoes:

M Mechanical cultivations.

Sx Residual herbicides. Simazine to beans. Prometryne/paraquat or linuron/paraquat to potatoes.

Sy Residual herbicides, differing from Sx in composition. time of application or subsequent cultivations.

The M plots get only mechanical operations appropriate to the crop; the Sx plots have no mechanical operations after planting; the Sy plots in 1966–69 on the potato area are ridged when the M plots are ridged.

In addition, there is a test of hormone herbicide (H) v. none (O) on wheat and barley, and (since 1967) a stubble cleaning test (G) v. none (–) on the stubbles of wheat, barley and beans. All treatments are cumulative.

The experimental area is divided into four series, one for each phase of the rotation. Each series consist of two randomised blocks of 12 whole plots, nine plots carrying the nine combinations of primary cultivations and weed control systems. The remaining three plots were "reserve" plots and had the PM treatments, but they have all now been allocated other treatments.

The effect of the primary cultivation treatments and the continued application of herbicides on soil conditions is being watched. The growing plants are considered the best indicators of physical soil conditions, and detailed studies will be undertaken should differences in yield eventually appear between the primary cultivations. The soils will be compared to see whether spraying develops a micro-flora adapted to decompose residual herbicides. Soil samples (0–8 in.) taken in 1965 show that the percentage of organic carbon differs between main cultivation treatments and more analyses will be done in 1970.

The experiment at Rothamsted began on a field ploughed in December 1960. In the first year treatment R for spring wheat, spring barley and spring beans was one rotary cultivation; the P and T plots were disc harrowed. Since then, all cultivations for winter-sown crops have been done shortly before drilling. For spring-sown crops treatment P is always done in autumn, and R and T are done some in autumn and some in spring. Treatment T usually consists of two or three passes with a heavy cultivator, each at a different angle. Treatment P is about 8 in. deep, the T about 6–7 in. deep and treatment R produces 8–10 in. of tilth for potatoes and 5–6 in. for cereals and beans.

The plots are 50 ft long by 28 ft wide, with a 7-ft discard between them and a 7-ft sideland on each side, making

*Farm Manager, Rothamsted Experimental Station

21 ft for turning implements when working across the plots. They are split for the test of hormone herbicides on cereals, and these sub-plots are harvested separately for all crops. Cereal rows are 7 in. apart, and sixteen rows are combine-harvested on each sub-plot. Potato rows are 28 in. apart, and the four centre rows of each sub-plot are taken for yield. Spraying is done on a rounded surface left by a ridge roll. Beans are drilled at 21-in. spacing, five rows per sub-plot being combine-harvested.

Each year weeds on sample areas of the potato and bean plots are identified and counted, and observations are made on the weediness of the cereal blocks. Couch grass (*Agropyron repens*) has been present since the start of the experiment, and most years some areas have been sprayed with dalapon or TCA to control it.

A report on the results in the first five years was published in the Rothamsted Report for 1965. The results of the last four years are examined in this paper and compared with the earlier results. The most striking feature is the similarity between the two periods, both in yield and in the effects of primary cultivation treatments.

TABLE 1

Long-period crop yields

Spring beans

Grain at 85% DM cwt/acre

		P	R	T	Mean
Mean 1961, 62, 64	(±0·71)	25·0	25·7	24·5	25·1
Mean 1966–69	(±0·78)	28·0	25·9	26·3	26·7
Mean 1961, 62, 64 66–69	(±0·54)	26·7	25·8	25·6	26·0

Wheat

Grain at 85% DM cwt/acre

		P	R	T	Mean
Winter 1964, 65, 68, 69	(±0·53)	46·2	46·7	46·4	46·4
Spring 1962, 63, 66, 67	(±0·79)	35·6	36·5	35·5	35·9

Potatoes

Total tubers tons/acre

		P	R	T	Mean
1961–65	(±0·197)	13·79	14·01	14·02	13·94
1966–69	(±0·296)	15·47	14·17	14·29	14·64
Mean	(±0·171)	14·63	14·09	14·15	14·29

Barley

Grain at 85% DM cwt/acre

		P	R	T	Mean
1962–65	(±0·45)	43·6	42·5	42·5	42·9
1966–69	(±0·36)	42·2	42·1	42·6	42·3
Mean	(±0·29)	42·9	42·3	42·5	42·6

The different primary cultivations—ploughing, rotavating and chisel ploughing—produced similar yields of wheat or barley, even when continued for nine years, and the yields were maintained over this period. The yield of beans and potatoes has also been maintained but in the last four years ploughing has apparently given bigger yields than rotavating or tine cultivating.

Beans

Winter beans were grown in 1963 and 1965. The Sx plots were sprayed with simazine all in autumn but on the Sy plots half was given in autumn and half in spring.

TABLE 2

Winter beans 1963, 1965

Grain at 85% DM cwt/acre

			P	R	T	Mean
Mean 1963, 65	M	(±1·62)	33.8	28·4	28·1	30·1 (±0·94)
	Sx	(±1·62)	28.6	28·1	27·0	27·9 (±0·94)
	Sy	(±1·62)	27.2	27·4	31·7	28·8 (±0·94)
	Mean	(±0·94)	29.8	28·0	28·9	28·9

Non-gramineous weed numbers per yd²

		P	R	T	Mean
Mean 1963, 65	M	115·5 (175·0)	84·0 (129·5)	123·0 (163·0)	107·5 (155·8)
	Sx	58·0	103·0	127·0	96·0
	Sy	5·5	11·0	17·0	11·2
	Mean	59·7	66·0	89·0	71·6

M = Inter-row cultivations
Sx = simazine in autumn
Sy = simazine ½ in autumn, ½ in spring
( ) = weeds in rows

Simazine seemed to decrease yield (Table 2). The autumn simazine spray decreased the weeds only on the P plots, but the divided application greatly decreased their numbers with all cultivation treatments.

Spring beans were grown in 1961, 62, 64, and 66–69, and simazine was applied at 1 lb/acre a.i. (Table 3).

TABLE 3

Spring beans 1961, 1962, 1964

Grain at 85% DM cwt/acre

		P	R	T	Mean
M	(±1·23)	24·9	26·3	25·2	25·5 (±0·71)
S	(±0·87)	25·1	25·1	24·1	24·8 (±0·50)
Mean	(±0·71)	25·0	25·7	24·7	25·1

Non-gramineous weed numbers per yd²

M	14·0 (20·0)	26·0 (42·0)	31.3 (50.7)	23·8 (37·6)
S	4·3	5·0	7.7	5·7
Mean	9·2	15·5	19.5	14·8

Spring beans 1966–1969

Grain at 85% DM cwt/acre

		P	R	T	Mean
M	(±1·35)	29·1	26·0	26·9	27·3 (±0·78)
S	(±0·96)	27·4	25·9	26·0	26·4 (±0·55)
Mean	(±0·78)	28·2	25·9	26·4	26·8

Non-gramineous weed numbers per yd²

M	16·0 (62·3)	26·3 (90·3)	33·8 (98·0)	25·4 (83·6)
S	15·0	34·5	41·0	30·2
Mean	15·5	30·4	37·4	27·8

M = inter-row cultivations
S = simazine
( ) = weeds in rows

Yields varied from less than 19 cwt/acre to over 30 cwt/acre, the seven-year mean being 26 cwt. There was no difference between the three primary cultivation treatments in the first three years but in three or the four years 1966–69 the ploughed plots yielded more than the R and T plots, and in one year equalled them. Simazine slightly but fairly consistently decreased yield by ½–1 cwt/acre.

In the first 3 years 1961, 1962 and 1964 there were fewer weeds on sprayed plots than on mechanically cleaned plots, but in the four years 1966–69 weed numbers on them were very similar. This suggests that the simazine spray can control weeds between rows at least as well as mechanical operations, and the slight decrease in yield by simazine is a direct effect, and not the result of differences in weed numbers. On the P plots, whether sprayed or mechanically cleaned, there were fewer weeds than on the R and T plots and this may partly explain the larger yield, but in three of the four years 1966–69 the ploughed plots yielded more than the R and T plots.

Wheat

Four winter-sown and four spring-sown wheat crops have been grown in which the residual effects of the simazine to the preceding bean crop and the effect of hormone herbicide sprayed on the crop were measured, in addition to those of the main cultivation treatments.

TABLE 4

Residual effects of treatments to beans
Winter wheat 1964, 1965, 1968, 1969

Grain at 85% DM cwt/acre

		P	R	T	Mean
M	(±0·89)	46·5	45·8	47·2	46·5 (±0·51)
S	(±0·65)	45·8	46·7	45·5	46·0 (±0·38)
Mean	(±0·51)	46·1	46·2	46·6	46·3

Spring wheat 1962, 1963, 1966

Grain at 85% DM cwt/acre

		P	R	T	Mean
M	(±1·08)	35·8	34·1	34·8	34·9 (±0·62)
S	(±0·76)	34·9	34·9	33·2	34·3 (±0·44)
Mean	(±0·62)	35·4	34·5	34·0	34·6

M = no sprays
S = residual sprays

The effects of the primary cultivations differed slightly from year to year but they were similar for both types of wheat. Residual effects of simazine applied to the preceding bean crop were generally small but fairly consistent on both winter and spring wheats. The rotavated plots benefited slightly from simazine in each of the eight years, averaging 1½ cwt/acre more, but on the tined plots yield was decreased in each of the eight years by more than 1 cwt/acre The results on the ploughed plots were variable, and on average the yield was unaffected.

TABLE 5

Wheat—mean response to herbicides. Hormone—no spray

Grain at 85% DM cwt/acre
Winter wheat

		P	R	T	Mean
1964	(±1·24)	−3·2	0·2	−0·3	−1·1 (±0·72)
1965	(±0·82)	−3·5	−5·2	−3·9	−4·2 (±0·47)
1968	(±0·95)	0·7	−0·9	−1·8	−0·6 (±0·55)
1969	(±0·36)	−1·7	−1·3	0·1	−0·9 (±0·21)
Mean	(±0·45)	−1·9	−1·8	−1·5	−1·7 (±0·27)

Herbicides used 1964–65 Mecoprop/2, 4-D
1968–69 Mecoprop/2, 4-D

TABLE 5 (continued)

Spring wheat

		P	R	T	Mean
1961	(±0·90)	−2·2	−1·9	−1·8	−2·0 (±0·52)
1962	(±0·74)	−2·7	0·1	−2·9	−1·8 (±0·42)
1963	(±1·15)	−2·3	0·8	0·3	−0·4 (±0·67)
1966	(±1·87)	−2·4	3·0	1·6	0·7 (±1·08)
Mean	(±0·62)	−2·4	0·5	−0·7	−0·9 (±0·36)

Herbicides used 1961 Mecoprop
1962–63 MBA/MCPA
1966 Mecoprop/2, 4-D

Yields of both winter and spring wheat were generally decreased by the hormone herbicide, especially on the ploughed plots, but were increased a little on the rotavated plots of spring wheat.

Weeds in the wheat were not counted, so it is not known whether these effects on yield were related to weed numbers.

Potatoes

In this crop, different herbicides or mixtures of herbicides with some timing differences, were compared with mechanical cleaning operations (Table 6). Simazine was used in 1961 but proved unsatisfactory, and the results are not included in the table. A prometryne/paraquat mixture was used in the three years 1963–65, and was compared with a linuron/paraquat mixture in 1964 and 65.

TABLE 6

Potatoes 1963–1965—mean yield of cultivated and sprayed plots

Total tubers tons/acre

		P	R	T	Mean
M	(±0·341)	14·74	14·10	13·97	14·27 (±0·197)
S	(±0·241)	14·55	14·52	15·17	14·75 (±0·139)
Mean	(±0·197)	14·64	14·31	14·57	14·51

Mean non-gramineous weed numbers per yd²

M	14·7	32·7	28·7	25·3
S	4·0	12·8	5·8	7·5
Mean	9·4	22·8	17·3	16·4

In the three years 1963–65 the sprayed plots yielded a little more than the mechanically treated plots (Table 6), and the P, R and T yields were very similar. There were no treatment differences in percentage ware in any year.

Weeds, counted each year after the final ridging of the potatoes, were fewer on sprayed plots than on mechanically cultivated plots, and fewer on the ploughed plots than on the rotavated or tined plots.

TABLE 7

Potatoes 1966–1969

Total tubers tons/acre

		P	R	T	Mean
M	(±0·512)	14·16	12·63	12·21	13·00 (±0·296)
Sx	(±0·512)	15·83	14·50	15·50	15·28 (±0·296)
Sy	(±0·512)	16·42	15·40	15·18	15·67 (±0·296)
Mean	(±0·296)	15·47	14·17	14·29	14·65

TABLE 7 (continued)

Non-gramineous weed numbers per yd²

M	41·8	96·8	88·0	75·5
Sx	8·5	21·5	15·0	15·0
Sy	5·8	15·0	9·8	10·2
Mean	18·7	44·4	37·6	33·6

M = mechanical cultivations
Sx = sprayed linuron and paraquat
Sy = sprayed linuron/paraquat and rotoridged

In the four years 1966–69 a linuron/paraquat mixture was used on the Sx and Sy plots, and the Sy plots were moulded up with a rotoridger in June (Table 7). The yield of ploughed plots was more than 1 ton/acre greater than of the R or T plots, and the sprayed plots consistently produced about 2 tons/acre more than those mechanically cultivated; rotoridging in addition to spraying increased yield on the P and R plots but decreased it on the T plots in three of the four years. The mean yield of the last four years (1966–69) was slightly greater than the first three years (1963–65). The manuring was altered slightly in 1967 to give an extra 10 units of nitrogen and phosphate but 16 units less of potash, and the variety was changed in 1966 from Majestic to Pentland Dell.

Weed numbers in the second period were about double those in the first, but treatment effects on weeds were similar in both periods. With all primary cultivation treatments spraying decreased the number of weeds more than mechanically cleaning, and rotoridging caused a further decrease. On the ploughed plots the numbers were about half those on the rotavated or tined plots.

Barley

Nine barley crops were grown and the results (Table 8) are grouped into two periods 1962–65 and 1966–69. In addition to the effects of the main cultivation treatments, the residual effect of the sprays to the preceding potatoes, and the effect of hormone herbicides sprayed on the crop were measured.

TABLE 8

Barley—residual effects of treatments to potatoes 1962–1965 and 1966–1969

Grain at 85% DM cwt/acre

			P	R	T	Mean
Mean	M	(±0·77)	43·0	42·6	42·7	42·8 (±0·44)
1962–65	S	(±0·55)	44·2	42·4	42·3	42·9 (±0·32)
	Mean	(±0·44)	43·6	42·5	42·5	42·9
Mean	M	(±0·63)	42·2	41·9	42·5	42·2 (±0·36)
1966–69	S	(±0·44)	42·2	42·3	42·6	42·4 (±0·26)
	Mean	(±0·36)	42·2	42·1	42·6	42·3
Mean	M	(±0·50)	42·6	42·3	42·6	42·5 (±0·29)
1962–69	S	(±0·35)	43·2	42·3	42·5	42·7 (±0·20)
	Mean	(±0·29)	42·9	42·3	42·6	42·6

M = no spray
S = residual sprays

In neither period was there any difference in yield between the three prime cultivation treatments, and the mean yields in the second four-year period were as large as those in the first period. The residual effects of the herbicides applied to the preceding potatoes on barley yield were small in the first period but positive each year on the P plots; the R and T treatments gave similar yields and had no residual effects. In the second period no treatments had any residual effects.

TABLE 9

Barley—mean response to herbicides. Hormone—no spray

Grain at 85% DM cwt/acre

		P	R	T	Mean
1961	(±1·03)	−0·9	−0·8	0·2	−0·5 (±0·59)
1962	(±0·92)	−2·0	−2·3	−0·9	−1·7 (±0·53)
1963	(±1·89)	0·2	−1·9	3·4	0·6 (±1·09)
1964	(±1·43)	0·8	1·0	5·9	2·5 (±0·83)
1965	(±0·57)	−0·6	−1·3	−1·8	−1·2 (±0·33)
1966	(±1·61)	0·6	−0·1	−1·6	−0·3 (±0·93)
1967	No treatment				
1968	(±1·66)	2·1	3·7	5·1	3·6 (±0·96)
1969	(±0·71)	0·0	1·7	−0·6	0·3 (±0·41)
Mean	(±0·46)	0·0	0·0	1·2	0·4 (±0·27)

Herbicides used 1961 Mecoprop
1962–1963 MBA/MCPA
1964–1969 Mecoprop/2, 4-D

Hormone herbicide had more variable effect on barley than on wheat. The nine-year means show no difference in yield between P and R plots but T plots produced 1·2 cwt/acre more. In the wet summer of 1968 hormone herbicides gave big increases with all three prime cultivation treatments.
An experiment started at Woburn in 1961 included a comparison of primary cultivation treatments similar to those in the Rothamsted experiment (P, R and T), and similar spray treatments were given to potatoes, but the site was so weedy that all the barley plots were sprayed each year.

The small area of the site imposed a two-course rotation, which until 1963 was potatoes and barley, and both crops were grown each year. Because of the presence of potato cyst nematode (*Heterodera rostochiensis*), sugar beet without herbicides replaced potatoes in 1964 and 1965. The Woburn soil is a light sandy loam.

The plot size was the same as at Rothamsted but there was no discard area between the plots. Methods of cultivation, drilling and harvesting were the same.

Potatoes

In 1961 and 1962 simazine and prometryne were the herbicides used, and these results are not discussed as both proved unsatisfactory. In 1963 a prometryne/paraquat mixture was used, and in 1966 and 1967 the mixture was linuron/paraquat (Table 10).

TABLE 10

Potatoes 1963, 1966, 1967

Total tubers ton/acre

		P	R	T	Mean
M	(±0·807)	11·02	11·09	10·56	10·89 (±0·466)
S	(±0·570)	12·34	11·51	11·73	11·86 (±0·329)
Mean	(±0·466)	11·90	11·37	11·34	11·54

The primary cultivation treatments gave similar yields but the sprayed plots fairly consistently yielded more than the mechanically cleaned plots with all prime cultivation treatments; the increase was biggest on the ploughed plots.

Sugar beet

In 1964 and 1965 sugar beet replaced potatoes, and no sprays were used (Table 11).

TABLE 11

Sugar beet—mean yield 1964, 1965

Total sugar cwt/acre

	P	R	T	Mean
1964 (±1·79)	53·2	55·1	53·0	53·7
1965 (±2·88)	72·5	72·0	71·7	72·1
Mean (±1·70)	62·8	63·6	62·4	62·9

There were no differences between the P, R or T treatments in yield of roots, tops or total sugar, in either year.

Barley

As all the barley plots were sprayed with hormone herbicide each year, the only effects measured were the differences between the prime cultivation treatments, and the residual effect of herbicides applied to the preceding potato crop. Yields were small in 1961–64 when little nitrogen was given (64 units N 1961, 56 units N 1962, 1963, 1964). Starting in 1965, a wet year, there were three rates of N (60, 85 and 110 units), and the yields since 1965 are the mean of the three rates.

TABLE 12

Barley—mean response 1961–1967

Grain at 85% DM cwt/acre

	P	R	T	Mean
1961 (±0·72)	21·8	22·4	20·6	21·6
1962 (±1·28)	19·3	21·1	19·8	20·1
1963 (±0·67)	24·6	24·3	23·7	24·2
1964 (±1·70)	16·4	14·7	16·9	16·0
1965 (±0·57)	42·6	42·5	40·8	41·9
1966 (±1·34)	27·8	27·5	30·2	28·5
1967 (±0·71)	28·4	29·9	28·4	28·9
Mean (±0·41)	25·8	26·1	25·8	25·9

Amounts of nitrogen to barley:
1961 0·46 cwt N/ac.
1962–64 0·56 cwt N/ac.
1965–67 0·60 cwt N/ac. N1
0·85 cwt/ac. N2
1·10 cwt/ac. N3

The prime cultivation treatments gave similar yields (Table 12).

TABLE 13

Barley—residual effects of treatments to potatoes 1963, 64 (S-M)

Grain at 85% DM cwt/acre

	Previous treatment	P	R	T	Mean
1963 (±1·41)	Prometryne	0·3	−0·2	0·1	0·1 (±0·81)
1964 (±3·61)	Prometryne and paraquat	−1·1	−8·0	0·7	−2·8 (±2·08)
Mean (±1·94)		−0·4	−4·1	0·4	−1·4 (±1·12)

Prometryne had no residual effect in 1963, but in 1964 residues of promotryne/paraquat decreased the yield of barley on the rotavated plots (Table 13).

Conclusions

These experiments, in which no organic manures have been given, have continued long enough to justify the following conclusions:

1. The three prime cultivations, continued on the same plots every year, gave similar yields of all crops, but weeds were fewer where a mouldboard plough was used.
2. Residual herbicides controlled most weeds (other than gramineous ones) in beans and potatoes without decreasing the yield appreciably.
3. Residual herbicides did not affect the yield of the crop in the year after they were applied, and there is no suggestion that they accumulate in the soil.
4. Hormone herbicides usually decreased the yield of wheat at Rothamsted, although they controlled weeds. Their effects on yield of barley were variable, but on average negligible.
5. The yield of the four crops grown in rotation with adequate amounts of inorganic fertilisers has been maintained over nine years without any apparent loss of soil structure. □

CURRENT CULTIVATION TECHNIQUES

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Abstract

Factors contributing to problems of cultivating soil and to farmers' greater interest in practical solutions to these problems are mentioned.

Methods of cultivation found on farms are discussed as also are the variety of ways in which cultivating machinery may be used. Mention is made of the use of ploughs, tined implements, rotary cultivators, power harrows, and other recently introduced seed bed preparation equipment is described.

The apparent tendency of farmers to plough too deeply and to overwork soil when preparing seed beds is noted. The benefits of large horsepower wheeled tractors are acknowledged as also are the potential dangers to soil structure when these heavy machines are used under wet soil conditions.

Introduction

It is generally agreed that the farming community is today much more aware of the problems of good cultivation and interested in practical solutions. The predominance of straw crops in many rotations at the expense of grass with its remedial effects on soil structure; the steady loss of labour from farms and the need to make positive efforts to increase profit margins, all contribute to this greater interest.

Not unexpectedly in this situation, the trend has been to resort to more powerful tractors. A decade ago the maid of all work on an arable farm was most likely a tractor of around 40 hp. whereas today 28% of all wheeled tractors are of 50 hp. or more and the 65-75 hp. class is very popular. Farming has never had so much power at its elbow and whilst this can bring great benefits there are also problems.

It is common practice to water-ballast rear tyres and to add both front and rear wheel weights to ploughing tractors in the search for maximum wheel grip. Although the engineer or adviser might expect additional ballast to be removed when not required, life on the farm is such that wheel weights are seldom taken off although the tractor may move on to lighter work. Moreover, where heavy powerful tractors are in use and expected to cover large acreages it is almost inevitable that they must sometimes be at work when soil conditions are too wet. This happens even on the best managed farms. Possibly no other sight can so bring home to a farmer the potential danger to the structure of his soil as that of a tractor rear wheel smearing and puddling the bottom of a furrow. No-one will deny the benefits of powerful tractors but if they are misused they can create serious compaction problems.

Unfortunately, the subject of cultivations is almost as much a matter of personal opinion as religion or politics. There is little in the way of scientific fact to assist judgment and when generalising it is easy to be wrong or give offence. Soil types vary enormously, not only from farm to farm but even across a single field. Farmers themselves vary too; their knowledge, skill, sense of timing and not least their patience, all help determine how well they can manage their soils.

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Tradition

Skill in cultivations is certainly more of an art than a science and, although general principles are easily enunciated, the decision of "what next" in the field is a very subjective one. This and the variability both of soil and of weather doubtless accounts for the vast range of cultivating machinery on the market. To try and distil distinct techniques of cultivation from the many ways in which implements can be used is fraught with difficulties, if not impossible.

The traditional stance that the only "proper" basis to any cultivation programme is good, deep, mould-board ploughing still predominates; but it is being eroded by the wider acceptance of herbicides in farming. There appears to be a tendency for ploughing to be carried out more often and certainly more deeply than is necessary. This is understandable because there is something intangibly satisfying in watching the brown shiny ribbons unfolding behind the plough and it is easy to feel that this must be right.

Alternatives to the Plough

An alternative to the plough and increasingly accepted is the use of a tined implement. Used after deep rooted arable crops like potatoes, early lifted suger beet and to some extent after peas, a satisfactory seed bed can be obtained and generally quicker than by ploughing. The chisel plough is becoming widely used in stubble cleaning operations and successfully so in all but very wet seasons.

There is a good deal of confusion over the terminology applied to tined implements. The dividing line between a chisel plough is not clear, nor is there any fundamental division between chisel ploughs and sub-soilers. Suffice to say that the chisel plough has been rapidly accepted on the farm and in a few notable cases has almost completely replaced the normal plough. One of the attractions of tined cultivation is to retain in the surface layers, the soil richest in organic matter content which the mould-board normally inverts and buries out of reach of young plants. This is particularly important on poorly structured soils where impressive results have been obtained by intelligent application of the chisel plough. However, this should not be taken as implying that the days of the mould-board plough are numbered, for it is too entrenched, too good at its job and too forgiving of misuse to be in danger for some time to come.

Seed Bed Preparation

Conventional cultivation, after ploughing and weathering, is to stir the top surface of the soil with tined implements. Probably the most popular implement for this is the spring tined cultivator-harrow. This tool must produce more seed beds than any other implement, yet equally it must be the most abused. With tractors lacking cage wheels too often the driver, seeing the wheel marks left by the tractor, increases working depth excessively. Because of their shape[1], the tines begin to bring up raw unweathered soil from below. Frequently, as much of their useful work in breaking down soil is achieved by the rubbing of the main framework on the soil as is contributed by the spring action of the tines. When correctly set the rear of the implement should run a little deeper than the front. Levelling boards and crumbler rollers are now offered to improve performance in clod breaking and to leave a firm seed bed. Other implements freely used include rolls and a variety of harrows.

Excessive Cultivation

Many seed beds are greatly overworked and with the idea of 'making a good job' there is often a struggle to get a deeper tilth than required. One of the most frequent causes of poor establishment in corn is drilling too deeply, yet it is common to find 4 in. or more tilth being prepared for the drill which has great difficulty in sowing shallow enough when presented with an excessive depth of fluffy tilth.

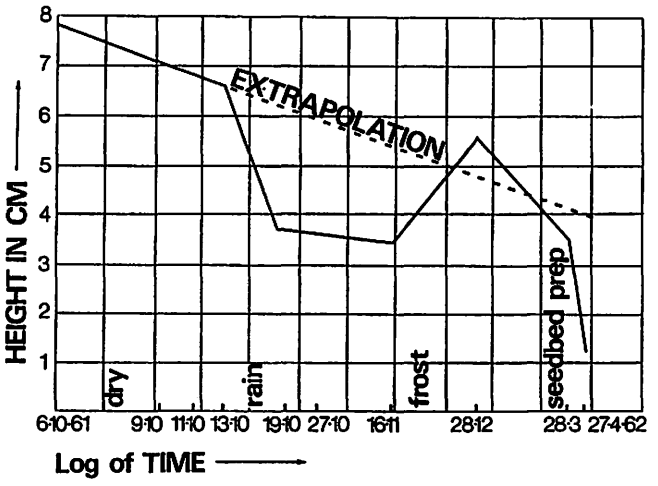

Fig. 1. Mean height of the soil surface in relation to log of time after ploughing a river clay soil. (Kuipers and Van Ouwerkerkc)

To curb this tendency to overwork soils is difficult. However, thoughtful discussion invariably results when farmer audiences are shown the curve derived by Kuipers and Van Ouwerkerkc.[2] Figure 1, shows the loss of air space in soil between ploughing and sowing especially during final seed bed preparation.

The advantage of retaining at the surface valuable frost mould or even simply weathered soil, is widely accepted by farmers, yet it is common for cultivators to be set too deeply and many poor seed beds result. Somehow sight is lost of the basic essentials. Perhaps it is an over-simplification, but seed will germinate and flourish if sown in sufficient tilth which overlies soil in 'suitable mechanical condition' for the penetration of roots, ie, no pans either natural or mechanical are present. Clearly this presumes moisture, air and fertiliser are available too. This type of 'two tier' approach on the farm does appear to help in a better understanding of basic requirements. The advantages of straight tined implements for seed bed preparation become more obvious.

It is perhaps no accident in this context that the reciprocating power harrow has been rapidly accepted especially by potato growers. Similarly, the Dutch or levelling harrow is enjoying a rebirth of interest. Originally considered mainly for use on precision seed beds for root crops it is now used much more widely. A variant of the idea now imported from Scandinavia, has levelling or scrubbing planks in metal and is fitted with long straight spring tines. This has been adapted to sow corn by simply attaching a seed box. One of the attractions of these simple 'machines' is that their action often improves with speed—a considerable attribute at a busy time of the year.

Other ground driven machines which have created interest include the rotary tiller harrow and the orbital harrow. The former resembles a disc cultivator where each disc has been cut away until it resembles four knives attached to the axle. The orbital harrow comprises circular frames approximately 2 ft. 6 in. diameter, free to revolve and set at an angle so that contact with the ground causes the frames to rotate. There may be several frames on the implement according to width and each carries short duckfoot tines. This tool breaks down clods mainly by by impact as does the rotary tiller harrow but this latter also has an element of cutting to its action. Both operate best at fairly high forward speeds of 4·5 mile/h or more. As with many ground driven implements, forward speed tends to be limited by driver comfort.

Rotary Cultivation

One of the most efficient ways of applying power to cultivation is via the rotary cultivator. It is used with great success for jobs ranging from reclaiming hill land to preparing potato seed beds and is an effective antidote to perennial weeds as well. This machine has become firmly established in a wide range of agricultural conditions all over the world and has earned much foreign currency for Great Britain. The use of rotary cultivation seems certain to extend especially with the advent of very large tractors because of the effectiveness with which these large power units can be utilised.

Used when conditions are too wet, however, compaction or smearing problems can be generated at or just below the depth of work. As a preventive rigid tines set to reach 4 in. or more below the rotor working depth may now be fitted.

The General Scene

Looking broadly at the class of machines and methods of use in what might be termed the more conventional approach to cultivations the only real conclusion which can be drawn is that almost anything goes. For most types of soil it has to be reported that different machines used by different farmers under different conditions in different ways can still produce good—and bad—seed beds. There is no one 'best' machine.

Perhaps the reason may be that when a soil has weathered sufficiently to fail along its natural cleavage planes it will do so with little regard to the intricacies of the machine used upon it. Hence timeliness is the most important factor for success in cultivation. The light land farmer might use only a roll after ploughing to prepare a seed bed whereas the man on clay knows that an October ploughing and amnesia until February or March serves him best.

It should not be concluded however that all farmers meekly accept the sanctity of conventional ways. Fortunately for the cause of development, there are those who question, probe and experiment. For example, one farmer cultivated to 3 in. deep his heavy clay land with one or, at most, two passes of a disc cultivator. After an interval the land was ploughed 6-7 in. deep. Another interval and a pass with a straight spring tined cultivator gave a most acceptable winter seed bed. His aim was roughly to shallow stubble clean and at the same time reduce the amount of work for the plough to do. This then turned only 3-4 in. of new soil to be broken down to give a good tilth.

On studying a case like this, many will react by thinking of how many circumstances in which the method would fail. However under that man's conditions some effective cleaning and a wonderful take of corn were achieved in a most economical way. This is a good example of constructive thinking about an old problem in particular circumstances and coupled with a willingness to try something different.

Minimum Cultivation

No discussion of cultivations would be complete nowadays without mention of the term 'minimum cultivation'. This is generally accepted as describing techniques involving the use of herbicides with a limited amount of soil cultivation. In its more extreme forms the only equipment required is a sprayer and some sort of drill to plant the new crop. There is available a rather expensive multi-disc drill of heavyweight construction to aid penetration. An alternative is the rather cheaper modification of the ubiquitous rotary cultivator fitted with a special slot-tine rotor and seed box. Each drill drops seed into narrow slots which it has made in the field surface.

Such techniques were first aimed primarily at corn growing but failure to control grass weeds, slug damage or unsuitable soil conditions resulted in several crop failures. This rather slowed down its acceptance as a normal arable farming practice. At present it offers an effective short cut in certain circumstances or where normal methods of cultivation are not possible. The technique has proved

valuable for kale direct drilled into old pasture. Retention of the old turf mat as a platform for the grazing animal usefully extends the grazing season or, indeed, may make grazing possible in conditions where it would otherwise be quite impracticable. The technique is also useful in the reclamation of hill land where the decrease in power requirement, draft especially, is of great benefit. On light land there are advantages too in that direct drilling allows retention of organic matter in the surface layers. This favours crop establishment because of better soil moisture availability and less risk of blowing.

These techniques are at their best when the underlying earth is in good condition and well drained. Where crops are subjected to much harvesting traffic, regular use of the sub-soiler becomes a worth-while investment to preserve soil condition.

Conclusion

Larger tractors are becoming much more popular. To utilise this extra power the tractors themselves are heavier. When used with draft implements maintaining satisfactory wheel grip at all times is difficult, and under wet soil conditions compaction can be caused. In the field the farmer can guard against this by the use of cage wheels and removal of any unnecessary ballast. The track laying tractor has advantages over its wheeled counterpart in the realms of ground adhesion and compaction problems. The concentration of crawler tractors on the heavier land is strong evidence that farmers appreciate these advantages. It is unlikely however that the numbers of track laying tractors will markedly increase because, although useful for ploughing, their ground speeds are rather restricted when when used on lighter work. Further, there are the problems of field to field transport. Whilst the crawler may usefully function as the main ploughing tractor, it will be outnumbered by lighter wheeled versions for other cultivations. Before leaving the question of tracks it is interesting to note the development of quickly detachable half track conversions for wheeled tractors which have been offered on the market recently. At present these are perhaps over-priced, costing almost £400 for a set and it is to be hoped that further development might cheapen this cost and hence enlarge the potential market.

To minimise the problems of soil compaction it is clear that seed beds should be prepared with the minimum number of passages across the field. At present relatively few farmers use implements in tandem where conditions are suitable and more use like this is to be recommended. Further development of combined machines, eg, cultivator/drills and further development of power drives would be a help in this respect. Finally, it does seem that there is a growing awareness of the damage to soil structure which can be caused by root harvesting operations late in the year when soil conditions are generally unsuitable.

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Cultivations

DISCUSSION (Second Session and Forum)

Chairman: J. G. JENKINS*

Conducted during the Annual Conference of the Institution in London on 12 May 1970

MR G. SPOOR (National College of Agricultural Engineering) said he would like to comment particularly on certain aspects which had arisen from Dr. Soane's paper, although the topics themselves were perhaps relevant to all the speakers. He had always considered that the provision of adequate drainage and timeliness of cultivations were the first steps in minimising the effects of compaction and that greater attention would have to be paid to these in the very near future. The sooner we could bring, or the closer we could keep our soils to field capacity the sooner they would dry out to moisture contents at which compaction damage would be minimal and the greater the time that would be available for non-damaging cultivations.

Dr. Soane's conclusion in his discussion on the effect of moisture content on compaction conflicted very strongly with this view; this was very worrying and offered almost no hope for the future. Dr. Soane had pointed out that the optimum moisture content for compaction was slightly below the lower plastic limit at moisture stresses between one third and fifteen atmospheres, i.e. in the normal growing range of moisture contents. Dr Soane, in his paper, had concluded:—"In general it has been found that in this climate there is little hope of avoiding compaction by waiting for more favourable moisture conditions since many operations have to take place when soils are readily compacted." Was there, asked Mr Spoor, really no hope at all? Dr Soane's statement was very true so far as dry unit weight and tractor tests were concerned but was it relevant in agriculture? One had to differentiate between two types of compaction or rather damage. The first was a form of particle and aggregate rearrangement with some destruction which tended to occur when the soil was friable and the other was a destruction of structure when the soil was in a plastic condition. The transition between the two lay somewhere about the lower plastic limit and obviously there was quite a lot of overlap between both.

Mr Spoor said he believed compaction by rearrangement with some breakage was much less serious from the plant point of view and might even improve the moisture status as mentioned by Mr Brown, whereas the smearing effect and pan forming type of compaction which occurred in the plastic type of moisture content could be very damaging. There was therefore a great deal to be gained by waiting for more favourable conditions, when the soil was friable. This state would be reached earlier if good drainage existed throughout the profile.

Mr Spoor said he would also like to ask Mr Grundey if it was feasible and reasonable to expect farmers to wait and so carry out more timely cultivations or had we just to forget about this completely? Moreover, could Dr Soane comment further on the suitability of a density measurement alone in compaction studies related to crop production, particularly in the light of work which he had cited which showed the relationship and interactions between mechanical impedence, oxygen status, moisture stress and so on? The Newcastle studies had shown the effect of soil stresses either due to density itself or surchange or internal stresses due to cohesion themselves, on root elongation and there were many other non-conclusive and conflicting results which had come from density experiments. To be fairly blunt, did Dr Soane in fact believe that this problem could be solved on a basis of density measurement or did he in fact agree that the only real solution to the problem would

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be found by following an approach similar to that suggested by Mr Brown?

DR B. D. SOANE (Author of Paper II) said he appreciated these comments. Sometimes after one had written a paper one became aware that one had put a slant on certain factors which one in fact would subsequently like to change. The comment about the moisture was an interesting one, said Dr Soane, and he thought his own comments on this tended possibly to be influenced by the fact that he came from a northern part of the country where Autumn ploughing took place usually under rather difficult conditions as far as timing was concerned. The situation in the south might be very different and might allow the possibility of a longer period after the harvest in which to choose when one did operations. This was certainly not the case in the north where harvesting could continue well into October in many conditions and occasionally even later. Ploughing following these conditions was a matter almost of desperation, to get the job done before the winter set in, so that might colour his own feelings on this question.

Dr Soane said that if the question was how the compaction pattern was going to be influenced by the moisture content, then he would agree it would be influenced. The interesting thing about the point raised was the matter of there being essentially two kinds of soil damage. It must be realised that there were regions within the soil underneath the wheel or the track in which totally different kinds of action or reaction were taking place. The zone, which he had termed Zone A and which was essentially the compactive zone, might be more important in some conditions and relatively less important under others. Under very wet conditions Zone A tended to be less important and the smearing, puddling and general destruction of structure under a plastic condition in Zone C, tended to become much more dominant. It was this sort of action that very largely influenced the creation of plough pans with the very smeared conditions where the tractor wheel had been running along moist sub-soil. Dr Soane said the question was whether there was any hope for influencing compactive effects by some measure of control over the moisture content with respect to the time at which it was done, either by waiting until moisture conditions were more favourable or by changing the general hydrological balance of our soil by such an action as subsoiling. He thought that in some areas subsoiling had in fact done this for us, bearing in mind some of the subsoiling done in Cumberland, where quite remarkable changes in the hydrology of the soil had been produced; the soils were draining very much more quickly. They were changing the way in which the balance was achieved between moisture and time during the season quite remarkably and in such a way that one could lengthen the period during which one could choose when to carry out a particular operation. But if one considered simply compaction then civil engineering tests like the Proctor test could be used to test the optimum moisture content, which generally was found to correspond approximately to the conditions under which soils were in fact ploughed in the north of the country. This might not be the case in the drier areas. If Mr Spoor had been thinking of the damaging action of such effects as smearing and puddling due to high wheel slip then it was true that they tended to happen more when the soils were wet and one would largely avoid them when soils were drier. Certainly the strength of surface soils could be considerably increased during a dry spell. It was perhaps not always recognised that one often got a very sharp change of moisture content with depth so that if one could run the wheels on the hard firm surface soil and not in the furrow bottom, one took advantage of using the strength of the dry surface soil to support some of this load instead of putting the load of the tractor right into the root zone, which was exactly where it should not be.

Dr Soane summarised by saying he had possibly been a little too pessimistic, because there were ways in which one could modify the moisture regime. Certainly by working under drier conditions, one could reduce the amount of puddling and smearing which was very damaging, although straight compaction would generally not of itself be greatly influenced. In other words, one did not necessarily get worse compaction as such by working under wet conditions because when soils were in a porridge-like condition and machinery was put over it, the result was more a stirring and mixing action than compaction.

Regarding the usefulness of density measurement, Dr Soane recalled that he had introduced his paper by stating his awareness that plant physiologists were not particularly hopeful that bulk density measurements were going to be a useful indication of plant response. There was plenty of evidence to support this, stemming largely from the literature where tremendously conflicting results had been obtained concerning the response of plant growth, root growth and yield to changes in soil density. This proved that soil density as such was not a particularly useful criterion for plant studies and interpretation of root growth. Nevertheless, for short term effects, for instance, when measuring the distribution of soil changes as a result of wheeled traffic or the passage of a plough the density changes were very instructive. They were also of value in the field of soil mechanics in which dry bulk density had special significance. Dr Soane said he did not think there was any one criterion of the soil to which one had to confine attention. He drew attention to his paper, in which he had quoted not only patterns of soil density but also patterns of air-filled porosity, because the latter was a useful criterion of aeration status. He added that he could have equally well quoted patterns of soil strength which might be better related to root penetration, and therefore he would agree that this was only one of several approaches; if one wanted to cover the whole range one had to have criteria of density change, criteria for aeration and of mechanical impedance. These were probably the most critical types of measurements one could make.

MR J. K. GRUNDEY (Author of Paper IV) said Mr Spoor had raised this question of timeliness and had asked if it was ever going to be feasible or did we just abandon hope? The odd thing was that although farmers were an average sort of group in society, one found that when a farmer was really interested in what he was doing, he could achieve a great deal. He might be working in areas where the soil was notoriously difficult, and yet one would find the odd fellow who could really manage it well. He would be the sort who, by some people's standards, might be somewhat over capitalised in machinery, so that when the time was right he moved fast, because he knew he must. Hence timeliness was the most important factor for success in cultivation. The light land farmer might only use a roll after ploughing, whereas the man on clay would know that an October ploughing, followed by no further action until February or March, served him best, and this was about the most succinct way of putting it.

THE CHAIRMAN commented that, in the opinion of some, one bought big machines today to get timeliness of operation. But it was a matter of economics really as to how one could and should afford to keep off the land until conditions were right. He believed that farmers broadly accepted the disciplines of patience allied to timeliness but in many cases impatience crept in. The Chairman said he tended to the optimistic view that management in this field should get better rather than worse.

MR D. J. B. CALVERLEY (National Agricultural Advisory Service) said he thought the position of moisture and soils, and timeliness, needed to be put into perspective. He would like to bolster up Dr Soane and not let him be persuaded against his better judgement by his friends from down south. The paper which Mr Moffatt had given was

incontrovertible in its facts and this was traditional Rothamsted work on cultivations. The interpretation however required very careful consideration, because problems were not solved by buying big tractors in order to carry out cultivations while soil conditions were right, and selecting any one of the galaxy of machines that Mr Grundey had shown to us. One was faced in the north with a very low evapo-transpiration rate and in consequence a relatively high soil moisture content. Farmers were continually faced with a late Spring, often with wet soils, and late harvests and were too often forced to work on wet soils. It was difficult to give a precise geographical location but these conditions were typical of areas northward from the Yorkshire Wolds. The problem in the north was how to deal with these high moisture conditions; and to consider what kind of cultivations had to be done. Mr Calverley said he believed Mr Moffatt's experiments at Rothamsted were of no value in those circumstances because they were done under timely conditions when the soil was of sufficient strength to carry the weight of tractor and the kind of machine he was using. Nobody had considered having to do cultivations when the soil was wet, when as Dr Soane had shown, the soil moisture conditions on the surface and the bearing capacity of the soil were inadequate to support tractors and machines. This question of timeliness really must be put into perspective. It was not a question of bad management, but a question of the kind of soil and the geographical situation of the farmer.

MR J. R. MOFFATT (Author of Paper III) replied that he agreed with Mr Calverley that the cultivations done on the cultivation weedkiller experiment had been done under suitable soil and climatic conditions. It was no use going on the land which was unfit to carry a tractor. However, a point which he would consider and might possibly take up was that at the end or towards the end of this experiment perhaps on some plots still held in reserve, some cultivations could be done when soil conditions were unsuitable. One could then see what lessening of yield there was as a result of operations done at the wrong time as distinct from operations done at the right time. That could be an extremely useful test.

MR N. J. BROWN (Author of Paper I) said that in the south, cereal growing did not often present much trouble, but on heavy clay soils where the drainage was poor trouble was encountered when one had to lift sugar beet, potatoes and the like during the wetter part of the year. This was a situation where a lot of damage occurred on some of the arable land in the south. Mr Calverley had said, and rightly, that in the northern climes the harvest for cereals was very much later. One wondered if the situation was that, because cereal growing was profitable, arable farming was being carried on in areas which perhaps were not absolutely suited to it.

MR H. G. PRYOR (Farmer, Essex) said he was disappointed that no one had delved very deeply into the subject of ground speed and its effect on compaction. Would the panel agree that if one doubled the ground speed of a tractor this would have the same operational effect as doubling the tyre size of the tractor? Had there been any research done at all into this effect of extra speed to provide flotation? His own observations seemed to indicate that up to three miles per hour there was not very much difference in effect, but once one exceeded three miles per hour it did seem that there was much less compaction from the same operation.

Dr Soane said this was a very relevant question in view of the fact that we were all urging farmers to go over their land quicker, providing them with tractors which had the ability to go faster. In fact, to his own knowledge, very little work had been done on this and it was interesting to hear the observation that had just been made. The only paper he knew of was by Vomocil, the late Rex Fountain and Reginato describing work in California where they had specifically set out to test this point. Dr Soane said he believed the general conclusion had been that there was not a very marked effect. There was little, if any, evidence of a tendency for it to decrease with extra speed but certainly a lot more work had still to be done before one could be confident of this under a range of soil conditions.

MR F. COLEMAN (Pembrokeshire) said that one could utilise the power of a large tractor in two ways—either by travelling slowly at high draft, probably leading to high compaction—or by travelling fast at low draft.

Dr Soane said the conclusion one came to after Mr Moffatt's paper was that if ploughing, which we knew to be an expensive operation, produced no effect in yield then why were we still ploughing? It seemed that there was very little support for the mouldboard plough on the basis of Mr Moffatt's statements and it would be interesting to study the economics of the alternative systems. Was there, in the chisel plough for instance, an economic alternative to ploughing, bearing in mind that one might have to chisel plough two or three times and perhaps do one or two other operations as well? If Mr Moffatt and possibly others in the country could produce no increase in yield by ploughing what was the economic conclusion from this in terms of practical farming?

Mr Moffatt replied that one advantage of the chisel plough over the ordinary plough was speed of working. Dr Soane had said that to get the same effect one might have to go over the ground two or three times. With this he agreed, but one could go over a big acreage once to disturb the weeds and volunteer corn, and then go back and do a second cultivation later after having done a considerable acreage. There was no need to do two or three cultivations at the same time.

Another point which nobody had made was that the load of autumn work could be spread by spraying with a paraquat as a holding operation until ploughing could be done. Grassy weeds and twitches of various sorts grew extremely vigorously in the autumn after the removal of the cover crop, and one needed to be able to control them. Spraying with paraquat kept the weeds under control until ploughing or chisel ploughing could be done, and these operations could be spread over a far longer period. This eliminated the need to do these operations under unsatisfactory soil conditions before the weeds got too big. Mr Moffatt said it was his impression that the chisel plough enabled one to cover the ground initially and, coupled with the use of paraquat, it greatly facilitated autumn work.

The Chairman said he thought Mr Moffatt had not actually answered Dr Soane's question as to whether specific figures were available on the economics of the chisel plough.

Mr Moffatt replied that they at Tothamsted seldom looked into the question of economics because it was so difficult. Results were obtained and then it was up to the people who wished to use them to interpret the results in the light of their own conditions. It was no good quoting costs, if these would only apply to the particular spot at Rothamsted. It was far better to produce the facts and figures, and then for farmers themselves or their advisers to work out and interpret the figures in the light of the conditions appertaining to each individual area.

Mr Brown gave a word of warning that the soil at Rothamsted was extremely well drained. Secondly, he said he could recall experimental evidence from the past in Professor Russell's papers where one would find that ploughing gave better drainage than tine cultivators. Although he was not sure whether they were the same types of tine cultivator that had been mentioned today, it should be borne in mind that scientific evidence did exist on this point.

MR R. B. EVANS (Oppenheimer Intercontinental Corporation) said it seemed to him that one of the predominant questions today had been that of timeliness of operation of the cultivation. It led him to ask whether it was becoming more difficult to prepare land in a way which was satisfactory for either the winter or for the following seed bed. If it was the case, why was it so?' Was it that we had changed our farming practices to such an extent that we were causing the land to become sick? Was there increased incidence of disease, or was it something else that we had not yet put our fingers on? Mr Evans also enquired of Dr Soane whether he had any idea of the rate of application of artificial fertilizers and the crop rotation methods in Eastern Europe where he had quoted that they were in fact having to compact their soils to an extent one would have thought to be in excess of that which we found necessary for grass seeds.

Dr Soane said he would venture to give an answer only to the last part. He had no idea what fertilizer applications were being used, but he thought the reason why they were much more concerned about adequate soil/seed contact in eastern Europe was that their Springs tended to be a lot drier than ours. The season started earlier, the hot dry winds dried up the top three or four inches to an extent which was not usual in this country and consequently they were working in a more arid climate.

Mr Moffatt referring to Mr Evans' suggestion that we might be finding it more difficult to prepare seed beds now than we used to, said he disagreed entirely. He had found during his work at Rothamsted that it was very much more easy to prepare seed beds with modern equipment. Ten years ago one used to plough, Spring tine cultivate twice, drill, and harrow in. That was the sort of normal sequence of events for most crops. Now one ploughed or one used a chisel tine. Mr Moffatt said he was a great believer in the power harrow. One stroke with a power harrow produced a really excellent seed bed. One could adjust its action by adjusting the forward speed and it produced a seed bed in one operation very successfully. Then one used the combine drill so that there was no additional operation to apply fertilizer with mounted harrows on the back of the drill. There would be just the initial ploughing, the power harrowing and the drilling. This required three passes of the tractor and that was all. Ten years ago one used to do five or six.

MR R. V. FALKINGHAM (National Agricultural Advisory Service) asked if the speakers would comment a little more on ploughing and the time when ploughing ought to be done. A percentage of the tilth was from frost mould and as a percentage of it was obtained mechanically, one would therefore plough in the winter to try and get a frost mould. Unfortunately, in the West country winter ploughing was sometimes followed by heavy rains all through the winter which caused the ground to be beaten down again, resulting in a kind of 'livery' substance to be dealt with in the Spring. One then wondered whether to plough it again and get more clods coming up which, in turn, dried out and one then had to consider how to deal with them. These were some of the problems.

Mr Falkingham sought guidance on the use of narrow mould boards. He said that if one was trying to get frost mould, narrow furrows pointed and crested like the old horse plough furrows and about the same depth, presumably one would get a better frost mould from them than from larger, wider furrows. These might get a frost mould on the outside of the furrow but still left a big clod remaining in the centre.

Mr Moffatt agreed that the first ploughing was all important. He said he would never do a second ploughing, especially late in the season. He had done it a few times at Rothamsted on soil which was not particularly heavy and unless one was lucky with late frosts there was the greatest difficulty in working a seedbed. Nowadays, if reploughing was needed because of weed growth, one answer was to use paraquat and avoid the necessity for ploughing. If the ground was beaten down he would not replough but would leave it until it was dry enough and then rotavate for potatoes. Mr Moffatt said he would cross swords with Dr Soane who, in his paper, said that the current widespread use of rotary cultivation prior to potato planting, seemed to be an expense which could be wholly charged to the compaction account, and if soils had been left in an uncompacted state after the previous crop, it was unlikely that this rotary cultivation would be required. Mr Moffatt said he disagreed with that. At Rothamsted they grew quite an area of potatoes, and he would not attempt to grow them unless the ground was rotary cultivated. This, in his view, was an essential part of potato cultivation. Ploughing in autumn followed by rotavating in Spring gave a fine relatively clod free tilth very suitable for potatoes.

The Chairman commented that it seemed to him entirely dependent on different soil conditions. In Cambridgeshire, the heavy boulder clay which for seventy years had been in arable crops, was today producing as good seed beds and crops as it had done seventy years ago. On the other hand, the different type of soil in Lincolnshire, which had been adapted to the same arable rotation as a result of economic pressures over the past ten or twenty years was clearly not standing up to this situation as well. It appeared one had to adapt the treatments to soil conditions so much.

PROFESSOR P. C. J. PAYNE (National College of Agricultural Engineering) said he would like to congratulate Dr Soane on a quite brilliant piece of work and then comment by saying that we were not very much further on. Professor Payne said it appeared to him that nobody seemed to have studied the effect of the area that was treated by wheels or whatever. To take the two extremes, if one put a few very high pressure point loads over a field nobody worried at all; equally, if one put a low pressure over the whole field the chances were that this would not cause worry either. Would it not be possible for Dr Soane to investigate the climate occurring in the soil under various patterns of treatment with wheels, since this seemed to be the key to the practical situation, and in particular to study the concentrations of oxygen and CO_2, etc. under different patterns.

Dr Soane agreed that this question of the area distribution was very important. He was planning to do the things that Professor Payne had pointed out should be done. There were one or two other people involved in this sort of work and one should mention them. As it happened they were not in this country but work was being done at Uppsala by Professor Heinonen and Dr Håkansson who had studied compaction under many conditions. They had literally compacted whole plots to different densities and under controlled moisture conditions. They had put tents over their plots so that they could simulate dry, wet and intermediate seasons all in the same year. This was quite in advance of where we were at the moment. Work had been done in Australia by Arndt who had conducted studies in relation to the wheel track pattern. There were certain crops where wheel tracking could be restricted conveniently to certain lines and it pointed to the fact that perhaps we should be working towards this in ordinary arable cropping. If traffic produced a damaging effect it would be better to restrict these effects to certain limited areas, keeping the wheels always going in the same direction; in fact, superimposing our wheels rather than trying to scatter them. This was interesting, and it had already been put into practice in some tropical areas where spraying of cotton was recognised as being a soil damaging operation, particularly under irrigation. In some such cases, repetitive spraying had been done in exactly the same soil tracks, for two reasons. First, the damage from

subsequent traffic was much less than from the first tracking, so if all the tracking was confined to the same lines, the net total damage was much less than distributing it over the area indiscriminately. Secondly, by doing it in this way narrow "roadways" of high strength were provided for the wheels, giving much less wheel slip. Given the situation where the spraying of insecticide for insect control might have to be repeated five or six times during the life of a crop, it was a practical proposition to confine the wheels to the same bands exactly, using wide booms to keep the area involved to a minimum. Dr Soane thought there were situations in our own field crops where this sort of thing might very well develop, but there was obviously scope for looking more at this question of whether one should concentrate the compaction to narrower bands or whether one should distribute it widely, and what effect it all had anyway.

Dr Soane said the question about effects on the gas phase was interesting. He had quoted figures for air-filled porosity which was a beginning in this direction. However, he would not wish to concentrate on the gas phase entirely because mechanical impedance could influence plant response in compacted zones. If one looked at the pattern of root penetration into clods, which was always an interesting exercise, it was generally found that the roots tended to go round the clods rather than into them, an indication that they were not happy in regions of high density.

PROFESSOR J. R. O'CALLAGHAN (University of Newcastle upon Tyne) said it seemed to him that the problem in cultivation work was now to define the climate for the seedling or the plant. It was doubtful whether measuring one quantity such as consolidation or moisture or anything like that was really going to get us anywhere in this type of work. Climate was made up of moisture, the availability of it, the amount of oxygen present, the amount of CO_2 and possibly the mechanical strength of the soil. This would obviously vary, so it became more critical at the planting of the seedling and seedling emergence, and less important possibly later on. Moreover, because the plant was adaptive, it would obviously be able to compensate for many of these changes. This possibly explained why, despite all the various kinds of cultivation which had been talked about, including the problems in the northern area, the yield in the end was not sensitive to wide variations. Professor O'Callaghan said this caused him to be critical of the Rothamsted work which, having gone on for the best part of fifty years or more, was irrelevant to a lot of the problems we were facing. For instance, with regard to those three cultivations of ploughing, rotavating and the tine cultivator, what one really wanted to know was the minimum one could get away with. Mr Brown had hinted that there was some work going on at Rothamsted where there was no cultivation at all, and this possibly would get into the things that really mattered.

Mr Moffatt said he would like to comment on the criticism of some of the experiments at Rothamsted. Recently they had been comparing three different main cultivation treatments, but there were some reserve plots in this cultivation/weedkiller experiment, and about two years ago minimum cultivation treatment had been assigned to them so that one could compare the minimum with the optimum that was given at the moment. It was found however that unless one tooled up with special equipment for minimal cultivation treatments, such as special drills which would slit the seed into the ground or break up narrow bands of soil for the seed, the cultivations needed to get a suitable seedbed had to be much the same as on the plots receiving the optimum cultivations. Because of the compaction which took place during harvest operations in most years, minimal cultivation did not produce a seedbed suitable for conventional drills. It could be done with special drills designed for minimum cultivations, but with ordinary equipment one had to do a reasonable amount of cultivations and not much more was done on the plots receiving the optimum cultivations.

MR J. V. FOX (Bomford & Evershed Ltd) suggested that with regard to combination equipment where, for example a machine did several jobs at once with the object of reducing compaction, it appeared that there was a very distinct difficulty in getting a good result from more than one operation at any one time. This seemed to be largely due to moisture in the soil. Could anybody comment on that?

Dr Soane said he felt that Mr Manby or Mr Patterson of Wrest Park might be very well fitted to answer this one because they had been working in this field of single trip combine tillage operations and had acquired some experience of this in practice over several years.

MR T. C. D. MANBY (National Institute of Agricultural Engineering) said he thought a number of points had been made on which he could perhaps usefully comment. First of all, he did not think Mr Pryor's question about the effect of speed had really been dealt with completely. The point, which Dr Soane had not fully brought out, was the question of influence of the rate of loading soils. Was there a critical rate, i.e. a threshhold rate below which a soil would not readily consolidate, simply because it did not have time to consolidate?

Second, the facts of life appeared to be that we were going to have more powerful tractors but they would not necessarily be very much heavier. If one had to provide horsepower to make up for diminishing labour then it was very much cheaper to do it this way. It followed that implements were probably not going to become wider. They would certainly have to travel faster and therefore travel over the field a greater number of times, as had already been pointed out. In the higher speed range chisel ploughs at the present time could be hauled faster for the same pull than would most ploughs, but this was not a fundamental fact of life. One could design ploughs which would have the same sort of pull characteristic at high speeds as chisel ploughs. However, as it seemed likely that implements were going to have to travel faster and would have more power available to them, it seemed logical to provide the power through a power take-off shaft rather than try and transmit it through the tractor wheels. It seemed logical under some conditions to combine the number of operations so that one had to go across fields as few times as possible. To achieve this it appeared that the most economical way of applying the power to the land was by combining a rotary cultivation, or at least a cultivation by power transmitted by a shaft, to produce a tilth only to the top surface where the seed was going to be in contact in the soil, together with tines to break up the soil at the lower depths. This was one of the things that Patterson had proposed and was doing at NIAE. Work was also proceeding along the lines Professor Payne had suggested. Mr Manby said that being engineers rather than agronomists they had had no real respect for soils and so had done some pretty dreadful cultivations. Plant establishment had been as low as 8 to 9 plants per square foot and everybody had been horrified but the yields were still reasonably satisfactory. Experimentation was now in its second year so it was too early to say much about it.

'Permanent ways' had been mentioned by Dr Soane and this was a very interesting question. Mr Manby believed that in the USA this was one of the aspects that they were very keen to study. His own experience was that in most of their experiments the effects of compaction had been produced by ludicrously intensive means. When they had tried to do compaction experiments to prove that compaction affected yield they had carried out the compacting in a way that no farmer would have done.

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A SUMMARY OF PUBLISHED EXPERIMENTS WITH OSCILLATING TINES

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1. Introduction

The introduction of the farm tractor has not greatly influenced the design of basic tillage implements. The plough and cultivator remain enlarged versions of the animal drawn tools and few successful attempts at applying the available tractor power directly to the implements have been made, the most successful being the rotary cultivator. The conversion of engine power to draught is usually an inefficient process which depends on tractor wheel adhesion, a function of tractor weight. Using tractor engine power for soil tillage without an intermediate conversion to draught could lead to a lighter tractor construction and less potential damage to soil structure by compaction. One possible method of using tractor engine power directly for soil working is to use it to oscillate the tool.

2. Attempts at producing a theory

Eggenmüller[1] lists four patents for oscillating soil working tools taken out in Germany before 1900. All are from addresses in Britain, the earliest being that of Thomas Churchman of Derby, Essex, in 1878.

Dubrovskii[2] refers to work published by Krylov in 1938 in the Bulletin of The Lenin Agricultural Academy, though the first of the number of recent publications on the subject in English was by Gunn and Tramontini[3]. Work on oscillating cutting tools for metal working had previously been reported by Redko[4].

Gunn and Tramontini[3] postulated for a rigid tool a linear draught/speed relation $D = mV_t + b$, where D = draught, V_t = speed, and m and b are respectively slope and intercept of the curve. Assuming that simple harmonic motion is then applied to the tool, four dimensionless quantities are suggested, viz:—

$K = V_t/\omega r$ where V_t = forward speed, ω = angular velocity of shaft and r = crank eccentricity (1)

$L = m\,\omega r/b$ (2)

$\bar{P}_o$ = average oscillating power/b ωr (3)

$\bar{P}$ = average total power/b ωr (4)

K is the ratio of forward speed to the maximum speed reached by the oscillating unit. Clearly the effect of oscillation in reducing draught will be greatest if K is less than 1. L depends on the characteristics of the combination of soil and implement (m and b) and will probably be small compared to 1. If K is less than 1 and L is small compared to 1 the power expression can be simplified to

$\bar{P} = K$ (5)

For a given forward speed, K can be reduced either by increasing the crank throw or its angular velocity. K is decreased in direct proportion to either, but because the inertia forces are proportional to the square of the angular velocity, the power required will increase more rapidly when the crank speed is increased than when the stroke is increased. For K = 0·25 a draught reduction of 66% was reported, but with little decrease in the overall power requirement.

Dubrovskii[5] used an oscillating triangular wedge in moist sand and reported that oscillation reduced draught in some cases and increased it in others. He suggested the concept of the wavelength of oscillation λ, such that

$\lambda = \frac{V_t}{n}$ where V_t = forward speed (m/s) (6)

n = no. of forced oscillations per s

i.e. λ = the distance moved forward by the tool carriage during one cycle. K and λ are related such that $\lambda = K\frac{(r)}{2\pi}$

Points of equal wavelength of oscillation were plotted on axes of draught against forward speed and showed that as the curves approached the draught/speed curve for a rigid tine they merged with it. From this it was concluded that the action of a nominally rigid tine was actually a special case of vibratory movement.

Increasing forward speed also increased the length of soil opened in front of the tool (1) and from this it was concluded that an oscillation whose wavelength is smaller than the length of this cleavage section will reduce draught.

In a later paper Dubrovskii[2] refers to work carried out in 1938 when the draught of a mole plough was reduced 10–20% by vibration.

Work with a ditching machine and a mole plough showed draught reductions of 57% and 50% respectively. The ditching machine was vibrated at 600–800 cycles/min. (10–13·3 Hz) at an amplitude of 3–5 mm and a forward speed of 0·3–0·5 m/s, and, allowing for the power required for oscillation, gave a net power reduction of 35%, some 3·4 hp. The mole plough was vibrated at 1 800 cycles/min (30 Hz), the forward speed being 0·2–0·3 m/s, but on increasing this 1·0–1·2 m/s the effect of vibration was lost. It is claimed that the length of cleavage, l, is directly related to λ and increases with forward speed. Higher frequencies give more pulverisation and reduce l. Greater amplitudes also give more pulverisation. Vibration is effective if

$\lambda < C_2 l$ (7)

(where C_2 is a dimensionless empirical constant) whereas it is of no particular value if

$\lambda = C_2 l$ (8)

and actually unfavourable if

$\lambda > C_2 l$ (9)

The following equation is suggested as a first approximation:—

$P = qL + ML + fL$ (10)

where P = draught, M = generalized mass, L = generalized displacement, f = generalized coefficient of friction and q = generalized coefficient of elasticity. In ploughing with the aid of vibration qL includes the force required for slice deformation, fL the force necessary to overcome internal and external friction and ML the force necessary for soil displacement.

Dubrovskii then suggests the relationship

$l^2 = C_1 \frac{abV_t}{\gamma}$ (11)

(requiring $C_1 = \frac{\gamma}{(C_2)^2}\,\frac{(V_t)}{abn^2}$ (where C_1 is a constant, ab = cross section of slice, V_t = forward speed and γ = an index of ground hardness) and substituting equation (11) in equations (6) and (7) gives $\frac{V_t}{\omega^2} < \text{const}\,\frac{ab}{\gamma}$ (for $n = 2\pi\omega$) (12)

This indicates that the optimum conditions for the effective use of vibration are a slow forward speed, a high frequency of vibration, a large area of slice and hard ground. This was confirmed by experiment.

Shkurenko[6] introduced the term "effect of oscillation" which is defined as :—

$\delta = \frac{P_{ab} - P_{pr}}{P_{ab}}$ (13)

where P_{ab} and P_{pr} are the draught in the absence and presence of oscillation.

*Scottish Station, National Institute of Agricultural Engineering.

Two directions of oscillation, up-and-down and front-to-rear were examined for two blade positions, vertical, and perpendicular to the direction of travel inclined at 45° to the horizontal. Oscillation was obtained by the use of rotating out-of-balance weights i.e. the blades were not constrained to take a particular amplitude. Shkurenko showed that linear vibration theory can be used to predict the parameters of this type of vibration. The curves obtained show that for a given frequency, increasing amplitude of oscillation gives an increasing effect, δ. A value of $\delta = 0{\cdot}2$ was obtained with an amplitude of 0·2 cm, and $\delta = 0{\cdot}6$ for an amplitude of 0·8 cm, the frequency being 33·4 Hz in both cases. Oscillation in the direction of cutting has an effect 1·5–1·6 times greater than in a vertical direction, though this is at variance with the findings of Panajotopoulos[7] who, working with a bulldozer blade, found the effect of vibration smallest when the blade was vibrated horizontally. When the tool was towed faster it was noticed that a six-fold increase in speed (0·3 m/s to 1·8 m/s) reduced the effect of oscillation by about 25% with the frequency kept constant at 33·4 Hz. This reduction was attributed to loss of amplitude at the higher speeds. Shkurenko concluded that in order to achieve a reduction of 50–60% in draught, fairly high speeds of oscillation, of the order of 130–170 cm/s are required.

Some considerations of basic vibration theory applied to soil working tools were described by Eggenmüller[8]. He examined the effect of the angle between the direction of oscillation and the soil surface, concluding that the minimum demands of draught and oscillating power were achieved when this angle was slightly less than 30°. If the angle of oscillation is too steep, friction between the underside of the tool and the soil is excessive. At the higher amplitudes examined (9 and 12 mm) and a low forward speed (0·4 m/s) a frequency of 20 Hz reduced the draught to 30% of that of a rigid tine at an oscillation angle of 30°, and to about 50% at an oscillation angle of 0°. Increasing the frequency did not further reduce draught, and, indeed, seemed to increase it slightly at an amplitude of 12 mm. The effect of amplitude increased with increasing forward speed. At a constant amplitude draught was progressively reduced by increasing frequency. At constant frequency, amplitudes of 6 mm had achieved practically the maximum draught reduction at a forward speed of 0·4 m/s. At 0·8 m/s draught was further reduced at an amplitude of 12 mm. With low amplitudes the draught increased rapidly with increasing forward speed. At higher amplitudes and a steep oscillation direction this was less marked, and this was observed at all frequencies. The power required increased rapidly with frequency, in proportion to the square of the increase in acceleration. Power increased roughly linearly with amplitude. The power required merely to move the tool and the transmission elements, and to overcome bearing friction was high and only slightly more power was needed to drive the tool through the soil. Better soil working by the oscillating tool than the rigid one was observed in all tests; the higher the frequency, the better the degree of soil working. Plotting the reduction in draught against a factor z, the ratio of oscillating length to height, showed a curve of decreasing draught with decreasing z. At a value of $z = 2$ this curve began to flatten at a reduction in draught of about 75% and a further decrease in z did not greatly further decrease draught.

Gill and Vanden Berg[9] compare the action of an oscillating tool with a rotating one, but state that there is little information available to explain why and how an oscillating tool is more effective than a rigid tool, and until the reasons are established the design of such tools must be largely inventive.

Experience with vibrating pile driving described by Fawcett[10] strongly suggests that maximum rate of penetration (i.e. presumably, minimum force required for driving) is achieved when the pile is in resonance with the vibration or, if more convenient, at a harmonic. Fawcett considers that the mechanism of operation is fluidisation of the soil at the pile tip.

Ogorodnikov[11] suggested that external and internal soil friction is reduced by the action of a vibrating tool. The reduction in friction allows the tool to penetrate the soil more easily, and facilitates soil breakup and movement.

Work with a subsoiler oscillated at frequencies of up to 2 800 vibration/min at amplitudes in the range 0·5–5 mm provided a maximum reduction in draught of 64% at 1 500 vibrations/min (25 Hz) and an amplitude of 4 mm. This reduction in draught fell as the forward speed was increased or frequency of vibration reduced.

Perlei[12] discussing the reduction in soil friction through vibration, concluded that the coefficients of external and internal friction in dry soil were much reduced by vibrating the tool (a reduction of five times was quoted). A small increase in moisture reduced the friction force markedly.

Gumenskii and Komarov[13], however, point out that under certain circumstances increasing the moisture content of a soil can increase its coefficients of friction, though further addition of water may then bring them back through their original values. The writers argue convincingly that the action of vibration in clay soils is to induce thixotropy, temporarily releasing both free water and physically bound water in the vicinity of the vibrating tool and softening the soil sufficiently for easy penetration. The writers suggest that 2% of clay is enough to make a soil thixotropic in the presence of vibration. Organic colloids also increase thixotropy. The mechanism of the reduction in draught through vibration in cohesive soils may be different from that in frictional soils.

Senator[14], characterising soil resistance by modified Coulomb friction, showed that the performance of a rigid penetrator, and of a "flexible" penetrator could be predicted. The flexible penetrator, comprising two portions connected by a spring and damper was shown to have considerable advantages over the rigid type.

Boyd and Nalezny[15], using a soil tank to obtain data on the effect of vibration on draught, also developed a method of predicting the draught force of a simple tool when vibrated. Soil cutting was characterised as a spring with Coulomb damping, and the predicted results were in close agreement with the experimental results. It was shown that the average cutting force can be reduced by increasing the system stiffness as well as by increasing frequency of vibration.

3. Papers largely concerned with descriptions of experimental machinery

Eggenmüller[16] described work with a plough, applying oscillation to both share and mouldboard. The share was oscillated in a direction inclined at 30° to the furrow, in side view, and at 15–30° to the direction of travel, viewed in plan. Balancing was achieved through the selection of the angle between the cranks of the oscillating tools, and by weights fitted to the driving shaft.

When landside and slade were replaced by an angled, rubber tyred wheel the draught of the oscillating body was reduced to about 50% of that of a rigid body, at an amplitude of 5 mm, a forward speed of 0·3 m/s and a frequency of 20 Hz. The reduction was much less at higher forward speeds. Increasing the amplitude to 9 mm reduced draught by as much as 60%, but, again, the reduction fell at higher forward speeds, though the reduction was not so great as with the smaller amplitude under similar conditions.

With a fixed landside and slade, an amplitude of 5 mm and a frequency of 20 Hz, draught of the oscillating body was reduced by 40–65% compared with the rigid body, at a forward speed of 0·3 m/s. At a frequency of 10 Hz the reduction was 10–30%. Increasing the amplitude to 9 mm gave a draught reduction of about 70% at a frequency of 20 Hz and 20–40% at 10 Hz.

The oscillating parts were driven by an electric motor and the power supplied to this was measured by a watt-meter. At an amplitude of 5 mm and a frequency of 10 Hz, 1 hp was sufficient to drive the plough over the range of speeds examined (0·3–0·9 m/s). At 20 Hz, 2 hp were required.

At an amplitude of 9 mm, up to 2 hp was needed for a frequency of 10 Hz and 3·4–4·0 hp for 20 Hz. The power required rose rapidly with increase in frequency, particularly at the larger amplitudes. The total power required by the oscillating body was always more than that required by the rigid body, but the difference fell as forward speed increased. In the worst case (5 mm amplitude, 20 Hz, forward speed 0·3 m/s) the total power required by the oscillating body was about 190% of that of the rigid body: in the best case (9 mm amplitude, 10 Hz, 0·6 m/s) it was about 115%.

A factor $z^1 = \frac{\text{forward speed of implement}}{\text{amplitude} \times \text{frequency}}$ was introduced, and the results indicated that where $z^1 = 1{\cdot}5\text{–}2{\cdot}5$ the draught of the oscillating body is reduced to 20–50% of that of the rigid body, and at lower values of z^1 this might be improved still further. Limitations of the equipment used did not enable this to be examined experimentally.

A further paper by Eggenmüller[17] examined an oscillating ridging plough. A rigidly mounted ridging plough of the small type popular on the Continent was compared with two types of oscillating body, one of which was a slightly modified form of the other, enabling the unit to make a satisfactory ridge when not oscillated. The oscillating bodies were composed of flat plates since it was considered that this enabled the tool to produce a better tilth than the shaped body of the rigid tool. The two plates were placed one behind the other, inclined at an angle of 30° to the soil surface. The two plates taken together formed an isosceles triangle when viewed in plan. Each was oscillated so as to obtain the maximum degree of balance. The front portion was installed at an angle of 25° to the soil surface and oscillated in a direction inclined at 30° to the surface; the rear portion at an angle of 30° to the soil surface oscillated in a direction inclined at 45° to the soil surface.

Measurements of the draught of the tools oscillated at various frequencies were made. At 14 Hz and 0·4 m/s forward speed oscillation reduced the draught by 50–70% of that of the rigid tine. Increasing the frequency to 30 Hz decreased the draught by a further 5–10%. At a forward speed of 0·6 m/s the reduction was smaller at the lower frequency but comparable when the frequency was increased to 30 Hz. The total power requirement of the oscillating bodies was always greater than that of the rigid body increasing rapidly with frequency at lower forward speeds and less rapidly, but to the same maximum at a higher forward speed. At 0·4 m/s and 14 Hz, the total power required was about 110% of that required for a rigid tine and at 30 Hz this rose to 120–200%. At 0·6 m/s and 14 Hz the total power supplied to the oscillating share was about 150% of that supplied to the rigid share, and rose to 170–200% at 30 Hz.

Ridge information was satisfactory with the oscillating ridgers though the shape of the first pattern oscillating ridger required oscillation at 30 Hz to form good ridges and furrows. The second pattern, a modified form of the first, ridged well at 14 Hz.

Puddling of the clay on the sides of the ridges was noted following use of the rigid body, but was not present when the oscillating body was used. Measurements of soil compaction by the velocity of air passing into the soil from a standard instrument showed an increase of 2 to 10 times in the porosity of furrows made by the oscillating tools over those made by the rigid tool.

Eggenmüller[1] also examined a cultivator with oscillating tines after examining the Ransomes "Vibro-hoe"[18]. The amplitude of the motion of the blades of the "Vibro-hoe" was 2·7 mm and the frequency was related to forward speed, 10 Hz at 1·6 km/h and 18 Hz at 2·9 km/h, giving a wavelength of 4·4 cm. Eggenmüller[1] considered the amplitude and range of frequency satisfactory as his previous experiments had shown this region to be the optimum one. However, the direction of oscillation, straight ahead, and horizontal, was not the optimum; if oscillation were directed at an angle of 30° to the horizontal viewed from the side, better tilth would be obtained and draught would be reduced further beyond the 40–50% of that of a rigid tine, which might be expected with horizontal oscillation.

Eggenmüller built an eight tined duck-foot cultivator, the tops of the tines oscillating with an amplitude of 25 mm in a direction inclined at 30° to the horizontal. The order of oscillation was 1, 6, 4, 2, 7, 5, 3, 8, to give the best balance in the longitudinal and vertical axes. Draught in the absence of oscillation was 700–1 300 kg; at a frequency of 20 Hz the draught at slow speeds was reduced to 200–400 kg, but increased at higher forward speeds. Blockages caused by a heavy top dressing of farmyard manure were troublesome when the cultivator was used with the tines rigid, but was not a problem when the tines were oscillated.

At a forward speed of 0·4 m/s and with the oscillation characteristics described, draught was reduced 60–70%. At a forward speed of 0·8 m/s the reduction was about 40%. For the oscillation characteristics described a forward speed of not more than 0·6 m/s is required for a reduction in draught of 50%.

The total power required was high. Merely running empty required 10 hp; working at a depth of 9 cm required 20–25 hp and at a depth of 14 cm required 25–30 hp. Power requirement increased with speed. The tilth produced particularly at low speeds resembled that after rotary cultivation.

In a paper concerned with the performance of a unit of four duck-foot cultivators, Eggenmüller[19] again showed the inter-relationship between forward speed, frequency of oscillation, amplitude and draught reduction. The relation between the total vertical movement of the tine (h) to the total horizontal movement during one cycle (l_h) was again defined as $z = \frac{l_h}{h}$. By plotting the draught reduction against z it was shown that for all forward speeds and amplitudes examined and for three angles of inclination of the direction of oscillation (10°, 20°, and 30°) the curve flattened out at about z = 2, i.e. only a small further reduction in draught can be expected at values of z smaller than this. All the points plotted on these axes fell within a relatively narrow band, but when z was plotted against the power required by the oscillating drive, a family of curves resulted, with the slowest forward speeds requiring the least power. For least power demand z ought not to be lower than 4–7.

In much of Eggenmüller's work it was not possible to show that a reduction in overall power can be obtained by the use of oscillation. Charts in this paper show that careful selection of the oscillating regime can lead to a worthwhile reduction in power even at the highest forward speed investigated, 1·1 m/s. Additional compaction of the soil had little effect on the operation of the tool beyond increasing the power required for oscillation. Oscillation produced a finer tilth than the rigid tool, and the higher the frequency the finer the tilth produced, though clod analysis showed that 40 Hz produced only a slightly finer tilth than 30 Hz.

The investigation was repeated with 'L' blades in place of the duck-foot blades and very similar results were obtained.

Eggenmüller also investigated two types of oscillation, simple harmonic motion imparted to the tine causing it to move in a path inclined at an angle ø to the horizontal (if the toolcarriage does not move forward then the top of the tool moves along a straight line inclined at ø to the horizontal), and motion causing the tip of the tool to describe an ellipse with its major axis inclined at ø to the horizontal when the tool carriage is stationary. In the former case the tool tip describes a zig-zag course through the soil when the tool is moved forward, in the latter case the tip describes a loop. There was no discernible difference between the results obtained with the two processes.

In a paper on power-driven cultivator tools, concerned with producing a cultivator which did not become choked when

working on weed covered land, Vernyaev[20] described an implement in which A blades were oscillated about a vertical axis. It was also noted that the draught of the implement was reduced by oscillation and this was attributed to the acceleration of the soil particles on the tine by the oscillation applied to it, hence the draught of an individual tine constantly varies and is a maximum at the two extreme positions. No figures for draught reduction are quoted.

Furthur investigations of this type of cultivator were made by Smirnov and Dyachenko[21]. The effect of variations in frequency and amplitude on soil movement, draught, and adhesion of soil to the tines was noted. It was concluded that lateral soil movement varied inversely as the frequency whilst vertical soil movement varied directly; soil displacement, both vertically and laterally, was greatest when the distance between tine tip and leg was least; lateral soil displacement varied directly as the amplitude of oscillation, whilst vertical soil movement tended to decrease as the amplitude increased. Draught decreased with increasing frequency and generally decreased with increasing amplitude. The force on the connecting rod increased markedly with amplitude and tended to increase slightly with frequency. The optimum working conditions for the particular configuration studied were a frequency of 260 oscillations/min (4·33 Hz) and an amplitude of 25° of movement either side of centre, the distances from the tip of the blade to the pivot point being 3, 7, and 8·5 cm for three types investigated (i.e. amplitudes of 0·65, 1·52 and 1·84).

Tetsuka and Endo[22] investigated an oscillating sub-soiler fitted to a two-wheeled tractor. By oscillating the chisel point a reduction of 20–40% in the power required by the traction wheels was obtained, the total horsepower required being the same for rigid and oscillating tines. The most favourable oscillating conditions were at frequencies above 20 Hz and an amplitude of 15 mm.

Endo[23] described a machine for a larger tractor. This machine worked at amplitudes in the range 4·7–27·8 mm, at frequencies of 7–35 Hz and oscillating direction of the tip in the region 0–20°. Power for draught was reduced 20–40% by oscillation and the ratio $\frac{\text{velocity of tractor}}{\text{velocity of tine}}$ was less than one. The best direction of oscillation was found to be horizontal. A second type of machine was made, fitted with four tines working at an amplitude of 1·7 mm and a frequency of 20·7 Hz.

The tip of a tine was vibrated in a vertical arc by means of a solenoid and wire, by Hendrick and Buchele[24]. This was attempted after consideration of Eggenmüller's paper (8), but appears to have used a direction of oscillation which he rejected. Passage for the tine stalk was excavated before the experimental run. Draught was reduced as the tip movement increased up to a rotation of 15°, beyond this the draught was not reduced. As frequency was increased up to the natural soil shearing frequency (about 5 cycles/ft) draught rapidly decreased with increase in frequency of oscillation. Above the natural frequency of soil shearing draught remained fairly constant. The maximum reduction in draught obtained was 25%.

Ogorodnikov[11] described an electro-magnetic drive for oscillating a plough mouldboard about a longitudinal axis to assist in soil inversion. The operating frequency was 50 Hz and the power input to the coil 400–500 watts. The decrease in draught at a forward speed of 4·95 km/h (1·375 m/s) ranged from 15–51%. The author also describes an hydraulic vibrator for use on a plough. The hydraulic pump used incorporated a distribution valve which diverted oil under pressure to either side of a hydraulic ram, and was driven from a petrol engine. The throttle control of the engine was connected to an elastic link so that change of soil resistance resulted in an alteration of the frequency of vibration. Frequency was increased as the load on the plough body increased, but amplitude fell. The plough fitted with this mechanism was regarded as satisfactory.

Aleksandryan[25] described a sub-soiler with a vibrating tine, specifically designed to reduce draught in the reclamation of heavily compacted rocky soils. The implement incorporated a flexible link in the drive to the top of the tine to allow the amplitude to fall slightly when soil resistance rose. The unit was driven by an electric motor. The maximum reduction in draught was 64% at 1 560 rpm (26 Hz) and an amplitude of 4 mm. The greatest reduction in total power was 35%.

Kemnitz *et al*[26] described the use of vibration in ploughs used for burying telephone cables. Two systems were employed, one using out-of-balance weights, thus not constrained to a particular amplitude, the other a share tip rotating in a circular orbit of about ½ in. diameter (i.e. amplitude = 6·7 mm) at a frequency of 1 250 cycles/min (20·83 Hz). A reduction in draught of 80% was reported with a plough of the latter type. Two types of plough using out-of-balance weights were described, one adopted an amplitude of about 1¼ in. (31·75 mm) under ideal conditions, at a frequency of 350–400 cycles/min (5·03–6·67 Hz), the other an amplitude of ⅜ in. (9·525 mm) at a frequency of 2 000 cycles/min (33·33 Hz). All the ploughs investigated were considered successful, a particular point being made of their ability to maintain working depth in the presence of oscillation, while without oscillation they tended to work shallower.

In a paper discussing the results of research into oscillating tools published up to 1966, Larson[27] lists some potential advantages of oscillating tillage, (1) reduced draught, hence lower wheel loading and thus less soil compaction, also operations such as deep sub-soiling, which could not otherwise be carried out, are possible. (2) Improved tilth, and the possibility of the operator controlling the size of clod produced by selecting the appropriate oscillation characteristics. (3) More effective application of power to the soil by directing the forces to the soil so that shear failure is produced with a minimum normal load.
The possibility of obtaining some of the advantages of oscillation from soil reaction without externally imposed oscillation was examined by Moller[28]. A cultivator was fitted in turn with various patterns of spring and spring-mounted tines, the mounting allowing a degree of oscillation through changes in the resistance of the soil to the passage of the tine. Results showed that a reduction in draught is possible, and that draught does not seem to increase with speed as rapidly when the tine is sprung as when it is rigid. In general the sprung tines showed a reduction in draught of 20–30% compared with the draught of the same tine rigidly mounted.

4. Conclusions drawn from published work

All the papers agree that a reduction in draught can be accomplished through vibration of a tillage tool. This reduction may be very substantial indeed; figures of up to 80% are quoted. As forward speed is increased it is necessary to increase amplitude or frequency, or both, to maintain a substantial draught reduction. The power required by the tine increases as either amplitude or frequency is raised, but increasing the amplitude is more economical than increasing the frequency, and is thus to be preferred. If the total power required by an oscillating tool is not to rise far above that required by a rigid tool, the characteristics of the applied oscillation must be selected carefully. The efficiency of conversion of engine power to draught has been completely disregarded in all this work, but clearly this must affect the engine power required by a rigid tool more than that required by an oscillating tool. Taking this into account, together with the increased soil working produced by the oscillating tool may make the latter more attractive. The ideal oscillation characteristics for a particular soil depend on the properties of that soil. Hendrick and Buchele[24] refer to "the natural frequency of soil shear", quoted as "about 5 cycles/ft" in their

investigation (although these are not the units of frequency). Draught was a minimum when the frequency of oscillation approximated to that of the natural frequency of soil shear. Thus for optimum operation it would appear that frequency, forward speed, and the natural wavelength of soil shear should be related:—

$$\frac{\text{Forward speed}}{\text{frequency}} = \text{natural wavelength of soil shear}$$

all in consistent units. The natural frequency of soil shear will have to be established for each particular soil used. This, however, takes no consideration of the amplitude of oscillation.

An oscillating tine produces a finer tilth than a rigid tine, and this ought to be considered in evaluating the usefulness of oscillation. Oscillation in the direction of travel is more effective than at right angles to this direction, but when inclined at about 30° to the direction of travel may be more effective still. Imparting a 'zig-zag' path to the tool tip during each cycle, thereby separating the functions of cutting and lifting, may be advantageous. A more elaborate form of motion is of no particular advantage.

The range of frequencies examined by the various workers quoted is about 4–50 Hz, and amplitudes in the range 0·65–32 mm have been used.

Oscillation may be applied by some form of crank mechanism imparting a definite amplitude, or it may be by out-of-balance weights imparting no fixed amplitude. Both forms appear to be effective but no direct comparison seems to have been made. For the high frequencies required to put a short soil working tool into resonance ($f = \frac{C}{2L}$ where f = fundamental frequency of tool, L = its length in feet and C = speed of sound in the material of which the tool is made) out-of-balance weights would probably be the better solution.

The mechanism of draught reduction by oscillation may be due to fluidization of the soil at the tip of the tool when operating at high frequencies (60–130 Hz may be used in pile driving) though at lower frequencies this is less likely to be the explanation of the phenomenon.
It has been suggested that oscillation of a soil working tool may reduce both soil to tool friction and internal soil friction.

It has also been shown that soils containing a percentage of clay exhibit thixotropy in the presence of a vibrating tool. This temporary softening of the material leads to more rapid penetration by the tool.

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APPENDIX

Summary of Oscillation Characteristics Reported

Frequency cycles/min	Amplitude, mm	Forward speed, m/s	Reduction draught, %	Eggenmüller's z^1 (16)*	Reference No.
600–800	3–5	0·3–0·5	57	17·0–4·5	2
2 000	2	0·3	20	4·5	6
2 000	8	0·3	40	1·13	6
2 000	8	1·8	30	6·73	6
1 200	9	0·4	50	2·2	8
1 200	12	0·4	50	1·7	8
1 200	5	0·3	50	3·0	16
1 200	9	0·3	60	1·7	16
600	5	0·3	10–30	6·0	16
840	—	0·4	30–50	—	17
1 800	—	0·4	25–40	—	17
1 800	—	0·6	30–50	—	17
1 200	25	0·4	60–70	0·8	1
1 200	25	0·8	40	1·6	1
1 200	25	0·6	50	1·2	1
260	0·65	—	—	—	21
260	1·52	—	—	—	21
260	1·84	—	—	—	21
1 200+	15	—	20–40	—	22
420–2 100	4·7–27·8	—	20–40	—	23
1 242	1·7	—	—	—	23
1 560	4	—	64	—	25
1 250	6·7	—	80	—	26
350-400	32	—	—	—	26
2 000	9·5	—	—	—	26
—	—	—	25	—	24
603	4	1·11–1·39	17·6	27·0–34·6	34
603	8	1·11–1·39	28·1	13·5–17·3	34
603	15	1·11–1·39	42·6	7·2–9·2	34
1 025	4	1·11–1·39	35·3	16·2–20·3	34
1 025	8	1·11–1·39	48·2	8·1–10·1	34
1 025	15	1·11–1·39	61·8	4·3–5·4	34
3 000	4 approx	1·4	28	7	36
3 000	7·5	0·25–0·95	23–57	0·67–2·5	50
1 650	8–10	0·3	60	1·09	11
1 500	4	—	64	—	11

*Eggenmüller's $z^1 = \frac{\text{forward speed}}{\text{amplitude} \times \text{frequency}}$

In paper (16) it is suggested that if $z^1 = 1·5$ to $2·5$ a reduction in draught of 20–50% over that of the rigid body may be expected. This appears to be an over-simplification as it is not borne out by the figures above.

Paper by D. P. Blight—*from previous page*

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Please turn to page 180

A Challenge from the President

Sir,

Through your columns, I want to draw attention to two events of historic significance. *Both* are certain to be providential for the agricultural engineering community.

First, this Institution is now virtually certain to be a Founder Member of the Engineers Registration Board. As regular readers of our *Journal* are bound to know, this Board is shortly to be created under the Charter of the Council of Engineering Institutions (CEI). It is not quite official yet but that is how it looks right now and there is not an obstacle in sight. When it happens, every one on our books as a Member (MI Agr E) will be able to get himself registered via the Institution as a Technician Engineer of CEI and should be able to show himself as (for example), J. Smith, T Eng(CEI), MI Agr E. It will be the first major recognition of agricultural engineering as being, in its own right, a part of the wider engineering profession. It will also pave the way for talks now taking place about Fellows (and suitably qualified Members) of the Institution becoming Chartered Engineers. This is not an easy one but I assure you that a lot more is going on behind the scenes than I am at liberty to disclose at this moment.

The second major event is the Institution Council's recent decision to extend the Associate grade so as to provide recognition of technicians. From now on an Associate who has one of our Part I qualifications (like the City and Guilds 260/261 Certificates) and has three years of combined training and experience as a technician in agricultural engineering or mechanization, whether in industry, trade, teaching, research or whatever, can come in and be classed as a *Technician Associate.*

The point is that a Technician Associate should before long be able to register via the Institution as a Technician of CEI and show himself as (for example), J. Smith, Tech(CEI), AI Agr E.

These developments are of very great importance to our industry and to those engaged in it.

I want the Institution to seize its opportunity and make 1971 a boom year for membership growth at all levels. This is where every existing member can help. I would like every member in 1971 to accept a specific task. The technician sector of our industry represents a huge, untapped source of potential Technician Associates. There must be thousands of these anonymous and unrecognised technicans scattered over the length and breadth of our industry. We want to find them, tell them what it all means, get them to enrol and then the Membership Committee will take over. Here is a useful piece of ammunition. Anybody who joins the Institution as an Associate in 1971 will not be charged the £5 entrance fee. He can come straight in at the ordinary subscription rate of £6 per annum and no entrance fee on top. This concession applies to *all* Associates admitted in 1971, not just Technician Associates, so I hope this will encourage recruitment among the farmers and in the distributive trades where we really do want to see more strength.

It is up to every member to do a bit of energetic recruiting. I want to see some acceleration in membership growth before my term of office as your President ends next May. When we come to sum it up, we have plenty going for us. Here is an Institution to be proud of. It looks like being among the first of the reputable non-chartered institutions to receive CEI recognition. It has a Fellowship grade which is the envy of a good many chartered institutions. It has a Membership grade which will be first to benefit from the new system of engineering registration. It has introduced a Technician Associate grade which will, in its turn, get our people on the CEI Register as Technicians. It all adds up to solid career status for a lot of people in a vital industry. That is what the Institution is all about.

And as a bonus to stimulate recruitment of Associates, technical or otherwise, I repeat that no entrance fee will be charged to any of these who join in 1971. What about 1972? I will tell you. If we succeed in recruiting *two* Associates in 1971 for every *one* that joined in 1970, I shall personally recommend to the Council that the entrance fee for Associates be dropped for good.

Lest it be thought by any that I am setting a stiff task, let me assert my complete confidence in the ability and willingness of our members everywhere to respond to this challenge. I have already written personally and in very similar terms to all our Branch Chairmen in the UK and we can be sure that they will use all their influence and resourcefulness to stimulate regional membership growth. What I now ask is that every member throughout the world plays his part. I know that we will attain our target.

I take this opportunity of wishing all our loyal members every success and good fortune in 1971.

H. C. G. HENNIKER-WRIGHT
(Fellow)

President,
The Institution of
Agricultural Engineers

Pre-history and the Olive

Sir,

On a recent visit to Southern Portugal I was on several occasions an interested observer of the olive harvesting. The method must date back to pre-history since it consisted of beating the tree with long canes and then picking up from the ground the fallen olives. This was obviously a family affair since the labour force was numerous and ranged in age from three to seventy years old.

As an engineer, albeit in another discipline, it seemed to me very surprising that agricultural engineers had not devised a mechanism to do this laborious task which is at present inefficient, uneconomic and to say the least unhygienic. Such a machine should command a very good market in the Mediterranean countries and elsewhere.

M. A. HENDERSON

Immediate Past President,
The Institution of Plant Engineers

The International System of Units (SI)

Sir,

Mr Statham's letter in your Autumn issue is strictly correct but makes metrication sound much more restricting than it need be.

Based on BSI publication PD 5686 'The Use of SI Units' the following is a reasonable classification of units:—

1. **Base SI Units**—Metre (length), kilogramme (mass), second (time), ampere (electric current), kelvin (temperature) and candela (luminous intensity).
2. **Coherent Derived SI Units**—Examples:— Square metre, cubic metre, newton (force), joule (energy), watt (power), newton per square metre (pressure and stress), kilogramme per square metre (mass per unit area). There are many others. A coherent unit can be defined in terms of base units without the use of numerical factors.

Please turn to next page

Viewpoint—*from previous page*

3. Multiples and Sub-multiples of the above:—
   Examples:—Millimetre, gramme, millisecond, hour, hectare, kilonewton, etc.
   Nearly all multiples are decimal multiples but minute, hour, etc., are not.

It is important to note that only units coming into categories 1 and 2 above are "SI units" but those which come into category 3 are "Units of SI" and may be freely used subject to any restrictions imposed in particular industries.

Rule A.3.1. in PD 5686 suggests that calculations should be performed using SI units and not multiples of SI units. It is thus important to be able to identify the SI units so that data presented in multiples can be converted to these units before beginning a calculation. Otherwise there is little restriction on the use of multiples where it is more convenient to use them than the SI units.

The degree celcius (°C) is of exactly the same magnitude as the kelvin and can be treated as the SI unit except when dealing with absolute temperature. It is a unit of SI.

It should also be noted that some "metric" units are not units of SI, in particular the kilogramme force and the calorie which are replaced by the newton and the joule. I fear that I find the unit kg/cm² in your autumn issue misleading. In SI this means mass per square centimetre and not pressure!

W. D. CARR

Chairman, Metrication Sub-Committee,
Agricultural Education Association,
West of Scotland Agricultural College,
Auchincruive, Ayr.

□

DISCUSSION (Second Session) —*from page* 172

Lorries had been loaded up; they had small wheels and very high tyre pressures, and then used to compress the whole of the soil surface. It was surprising that there was any real yield. The possibility of permanent roadways would bear much greater scrutiny and thought than had been given to them up to the present time.

Mr Manby said that as a research worker starting to look at problems of compaction his greatest need was to find a means of testing the efficiency of what was being done. It was all very well to say "Well now, let us see what the effects of lower tyre pressures, dual tyres and so forth are". It was known that a tremendous number of influences which would affect yield would be brought to bear after one had carried out one's compaction treatment. Yield was therefore a very doubtful yardstick to use. Nevertheless, it was the economy overall that was important. The Rothamsted gapping experiments, which no one had referred to today, had shown that one could remove a surprising amount of crop, literally just cutting the crop out by the square yard or in yard wide strips and the effect overall on yield was surprisingly small. How was one therefore to know how much money one could afford to spend to reduce compaction when there were at the moment no means of measuring these effects? Statistically valid experiments were required on a grand scale, some in the north and some in the south before it could ever really become known how much could be spent on modifications of machines to reduce compaction.

Finally, there had been references today to timeliness. Mr Manby said that in his opinion if automatic control of tractors was going to pay off, probably the best pay-off would be not on small tractors where the arguments ran that if you dispensed with the driver you could keep your tractor small and run it for twenty-four hours a day. In his view the best return from automatic control could be with the big tractor, also without a driver, to get the maximum benefit from improved timeliness. □

Paper by D. P. Blight—*from page* 178

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admissions and transfers

At a meeting of the Council of the Institution on 15 October 1970 the following candidates were admitted to the Institution or transferred from one grade to another, as stated below.

ADMISSIONS

Member

Armitage, P. G.	*Sussex*
Farzan, N.	*Iran*
Hutton, M. E.	*Essex*
Sayeed, M.	*Beds*
Wainwright, E. S.	*Yorks*

Associate

Blaker, R.	*Sussex*
Couper, F. X. P.	*Rhodesia*
Cree, J.	*Warwicks*
Hulbert, P. J.	*Yorks*
Lalsa, H. N.	*Guyana*
Phillips, A. J.	*Oxon*
Robinson, R. E.	*Bucks*
Settle, A. J.	*Warwicks*

Graduate

Atoo, C.	*Uganda*
Baldwin, G. W.	*Surrey*
Bennett, P. C.	*Surrey*
Brockbank, R. B.	*Malawi*
Dent, A. A.	*W Lothian*
Lavender, J. A.	*Sussex*
Sam, A. K. S.	*Ghana*

Student

Moseley, B. A.	*Lancs*
Paul, D.	*London*
Platt, G. D.	*Lancs*
Ripley, M. T.	*Devon*
Walker, J. G.	*Lancs*

TRANSFERS

Member

Dwyer, M. J.	*Herts*
Morris, J. L.	*Salop*

Graduate

Alagendra, A. R.	*Ceylon*
Brown, S. R. H.	*Ayrs*
Grossmith, J. A.	*Devon*
Heath, R. P.	*Devon*
Jones, G. O. S.	*Mon*
Judson, C. A.	*W Lothian*
Lewis, P. G.	*Hants*
Sivanesan, S.	*Ceylon*
Willy, R. J.	*Dorset*

OBITUARY

The Council announces with deep regret the death of the following members of the Institution:

Harper, F. L. M.	*Fellow*
Harvey, M. M.	*Fellow*
Hawke, H.	*Fellow*
Muir, A. H. J.	*Associate*
Rutherford, W.	*Member*

SITUATION VACANT

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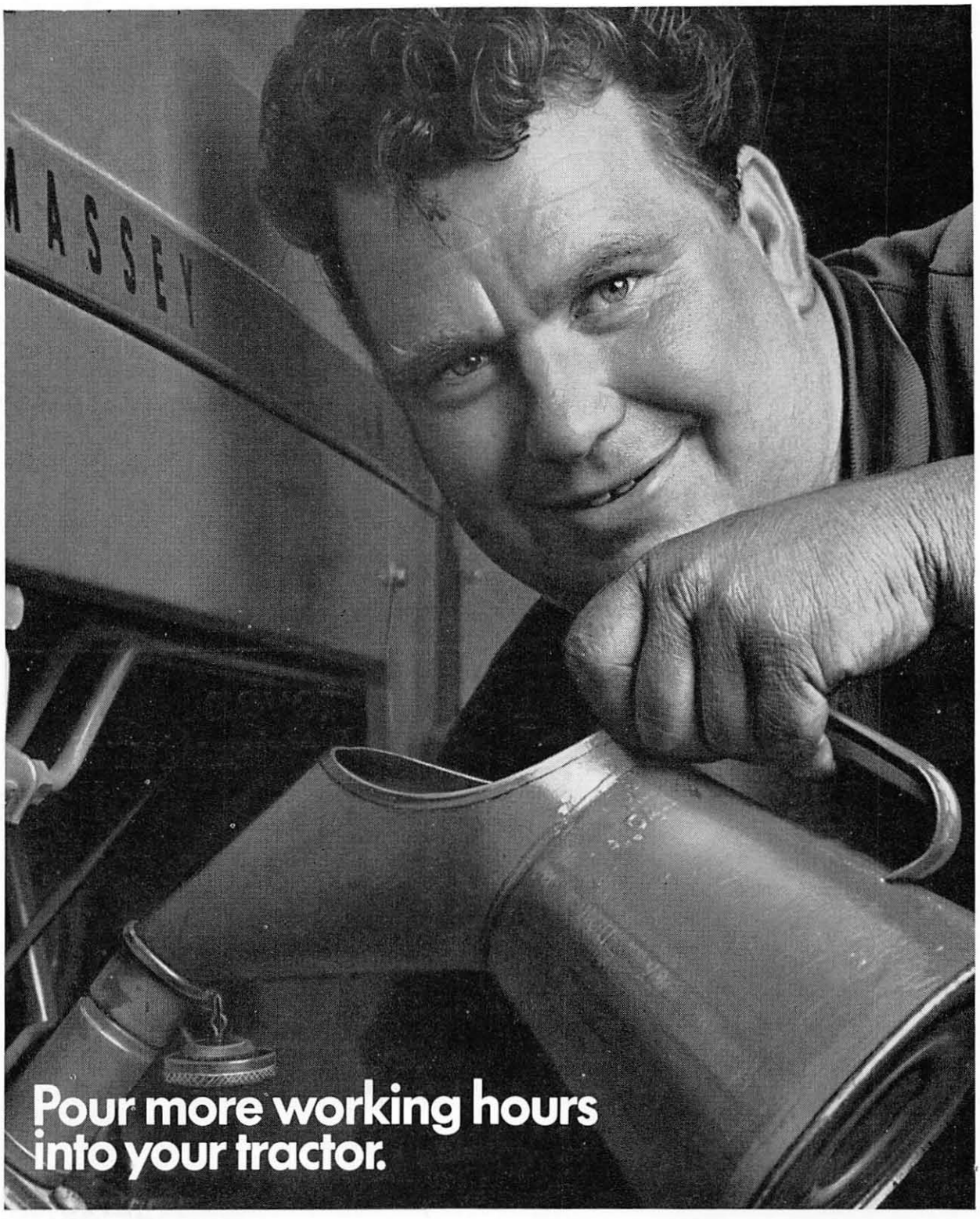

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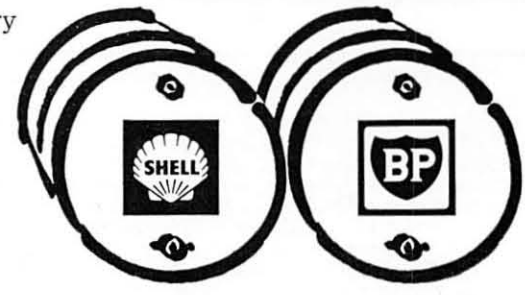

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