THE AGRICULTURAL ENGINEER

JOURNAL and Proceedings of the INSTITUTION of AGRICULTURAL ENGINEERS

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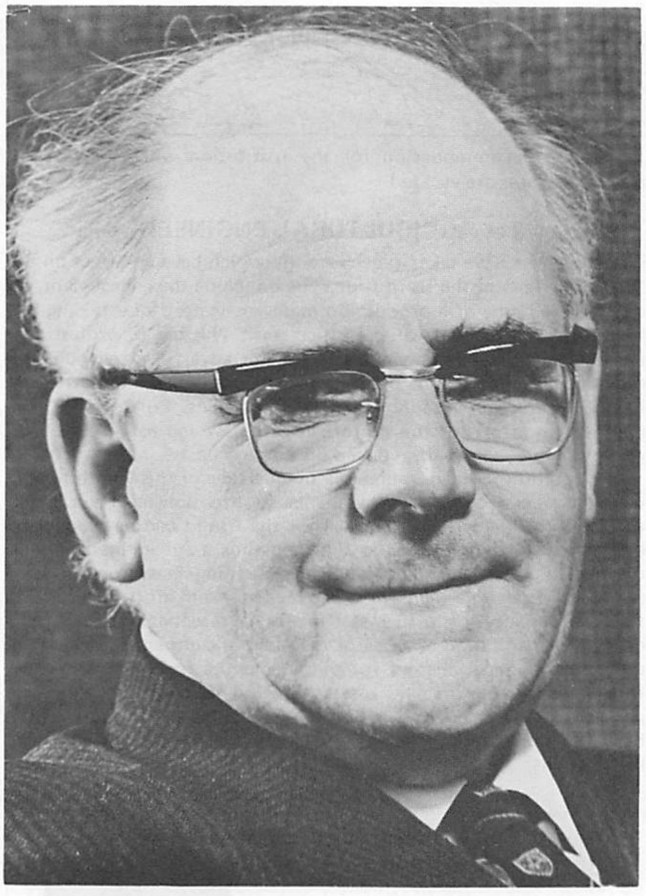
by J C Turner



MY connection with the financial affairs of the Institution dates back to the autumn of 1971 when the previous Honorary Treasurer, Eric Bates, left the UK to take up a post in America. Until then I had, like many members of professional institutions, been primarily concerned with the services which the Institution offered rather than the arrangements necessary to provide finance for these services. Having had to make myself *au fait* with the special conditions applying in the organisation of Institution finances and having realised the value of this exercise, I was pleased when the Editor invited me to write an article for THE AGRICULTURAL ENGINEER setting out the financial state of the Institution and explaining the reasons for recent changes which have affected financial and organisational arrangements.

The Institution relies almost entirely on subscriptions for its income although there are minor incomes such as examination fees and sales of publications, and any surplus of income over direct expenditure on conferences. I believe that it will be helpful to discuss these incomes under separate headings.

Subscriptions

There are several ways by which income from subscriptions can be increased eg by increasing subscription fees, in one or more grades, by increasing the membership or by making sure that all due fees are collected as soon as they are due and without unnecessary expense. Unfortunately the budget which had been prepared in mid-1971 proved inadequate to meet rapidly rising costs, which took place in 1972, and members will remember that it was necessary to hold an Extraordinary General Meeting in December to authorise increased subscription fees. However, two factors came to my notice in 1972; one was that the previous accounts procedures had lead to the inclusion of all members on the membership list, whether paid up or not, as assets, although a reserve was shown to allow for lapsed membership. However, figures tended to be optimistic and lead to the impression that the expected income was higher than in fact turned out to be the case. A mammoth exercise has been undertaken, primarily by the Acting Secretary, to check the accounts of all members so that the true position regarding 'real' membership can be known. There was an exercise during 1973 which led to the collection of substantial sums: but it became apparent that many of those in arrears, especially those who had not paid for several years had lost interest in the Institution and cannot be regarded as financial assets. A difficulty arises, due to the Articles of the Institution, in immediately removing from the membership list the names of those who are substantially in arrears (there is of course no intention to remove from membership those whose arrears of payment can be attributed to normal delays). However, the names are being placed on a suspense list and will thus not influence the financial records.

A further point which came to light was that, due to the unwieldly membership approval arrangements, newly elected members were not being invoiced as soon as they were elected and part-annual subscriptions were being lost. Members may recall that under the new arrangements, proposed by the Working Party set up in 1973, straightforward applications are dealt with by small groups working under Lionel Evans, the Chairman of the Membership Panel. This procedure brings newly elected members into a subscription payment situation at an earlier date.

One useful change in the structure of membership deriving from the recommendations of the Working Party, was the revision of the conditions for the grade of Companion. Whilst the change was primarily intended to provide a better service for those who had been catered for, often less than adequately, by general associateship grade, it may well have significantly beneficial effect on subscription income in the future.

Whilst there would seem no need at the moment to reconsider the level of personal membership fees, the President-elect has been considering an arrangement by which the income from affiliated organisations could be increased by providing a membership scheme which is more attractive than the present one, but in view of the present industrial situation, it would not seem likely that this would have a dramatic effect on income in the immediate future.

Examination fees

For many years the Institution, via the Examinations Board, operated the Institution examination, generally for mature candidates, and the National Diploma in Agricultural Engineering. Entry fees generated an income, from which assessors' fees were paid, but there is no way of accurately measuring the net income. However, since examination papers were set and marked by the colleges submitting students the Institution's expenses cannot have been very large and it is probable that there was a real income of several hundred pounds a year. Unfortunately, the Pilkington Report 1966 recommended the discontinuation of various diploma examinations and, alas, courses leading to the NDAgricE are now virtually no more. Furthermore the existing technician courses under the City and Guilds schemes, and in the future, under whatever arrangements are set up by the Technician Education Council would seem to preclude the opportunity of there being any income to the Institution for educational services, although it is almost certain that there will be some expense due to the need for the Education Committee, or some other group designated by Council, to hold a watching brief to look after the educational interests of the Institution.

Other sources of income

Seen within the context of the turnover these are not significant. But it would be inappropriate to dismiss them without pointing out that the present Editorial Panel 'inherited' a number of bad debts for advertising. Whilst these had involved the Institution in direct printing and lost opportunity costs rather than significant charges, their presence in the balance sheets of 1971 and 1972 gave an optimistic look to the figure in the balance sheet for debtors and they were written down significantly in the 1973 balance sheet.

Another financial factor giving an unduly optimistic view of the Institution's position was the inclusion of the Proceedings of the Agricultural Engineering Symposium, which was held in 1968.

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These originally stood at £9 each; but of course their sale potential is limited, though their value to an interested person is very high. Several hundred of these are still in hand but they have been written down severely so as to represent a more realistic picture of their value.

The expenditure items incurred by the Institution can be seen from recent balance sheets but it might be helpful to comment on certain items in some detail. Major items are staffing, establishment expenses and printing of The AGRICULTURAL ENGINEER and it is interesting to note the pattern which has developed. Some consideration of these in more detail would probably be helpful to members.

Staffing

Records going back to 1965, show that the numbers of staff at headquarters has been reduced; this in spite of the fact that the same range of services has been maintained. Certainly, salary expenditure, has not shown the same dramatic increase as other items in the budget. There are a number of reasons for this including the very significant decrease in the numbers of administrative meetings, also the streamlined arrangements for dealing with membership applications. The previous organisational structure involved a variety of committees which had advisory rather than executive powers. This meant that virtually all matters passed before Council often to be re-considered by many persons who had already considered them in committee. This procedure generated high demands for staff time, both at the meetings themselves and also in the enormous amount of servicing and paper work.

Establishment expenses

These have naturally shown an increase in sectors such as postage and telephone, but the rent and rates, at Rickmansworth, which were based on a lease signed some years ago were quite modest. However, for various reasons the Council accepted the recommendation of the Working Party to move the office to West End Lane, Silsoe and this will effect a saving of several hundred pounds a year. It is important in this context to note that the President-elect negotiated the sale of the remainder of the lease for a substantial sum. It is proposed that this be set aside towards the provision of permanent accommodation for the Institution when the present rented premises are vacated.

The Autumn issue of The AGRICULTURAL ENGINEER will be published on 5 September 1974. Advertisement orders and copy should be forwarded to the advertisement office by 5 July 1974.

The AGRICULTURAL ENGINEER

Many changes have taken place recently which have an affect on the financial affairs of the Institution. These include the engagement, on a part-time basis, of a production manager, instead of servicing this function by a member of the office staff. This use of professional services, together with a vigorous drive for advertising revenue have dramatically changed the net cost of production for the better and helped to contain rapidly rising printing costs. Furthermore, the unremitting efforts of the Editorial Panel have led to a publication of very high quality with reduced production costs.

It would have been impossible in an article of this length to deal with all aspects of Institution finance so attention has been drawn to factors of major significance. Thus the future can be seen in the context of the factors such as the following; a streamlined method of enrolling new members and of collecting fees from existing members, a possible increase in the revenue from affiliate members, the maintenance of office staffing at a reasonable level by an efficient organisation system for meetings and other administrative duties, economical charges for premises and a realistic view of the true value of debtors and assets: Bearing in mind the very real goodwill of members and the tremendous amount of work which has been done by members, both singly and in groups, the future looks bright.

The Institution—its past, its present and its future

NO Presidential address in recent years has been concerned with the Institution itself; the topics chosen have ranged widely across the spectrum of agricultural engineering, and each has formed a facet in that kaleidoscope pattern of multiple interests and disciplines which makes up our industry.

However, in the light of recent and current events it seems to me appropriate at this time to review the aims and achievements of our Institution, and more particularly to consider its present and future place in a rapidly changing world.

There has in the past been an element of stability in our national life and institutions which today is lacking, and it is therefore imperative that we should endeavour to monitor these changes continuously so that we can, where appropriate, adjust to them and, more importantly, bring our influence to bear in directing them.

In a further departure from precedent the Council asked me to address the Institution at the start of my term of office, instead of in a year from now, and there may have been in their minds, as there is in mine, the feeling that things needed to be said, and that events were moving too fast to brook delay.

What I propose to do, therefore, is to set the scene by briefly reviewing the Institution's history, to go on to look in some detail at the challenges which face us, as an Institution, as agricultural engineers and as Europeans, to consider how the Institution can maintain and increase its relevance to the contemporary environment, and to attempt to pick out some guidelines for the future. A tall order, but I will do my best.

On 25 February 1938 a small group of progressive and far-sighted agricultural engineers met and formally proposed the formation of an Institution of British Agricultural Engineers. Colonel Philip Johnson, later to become the Founder President, took the chair. The others present were Messrs Alexander Hay, H. J. Hine, W. Lupton, A. C. Nicholson and W. J. Nolan. The Institution was formed in October of the same year, whilst the war-clouds were gathering over Europe, and its progress during the early part of the next decade was necessarily slow. In the aftermath of the war, with the emphasis on the rapid mechanisation of British agriculture, the Institution came into its own, and provided not only a focal point for those involved in the newly emerging agricultural engineering industry but also gave to agricultural engineers a professional status and prestige which hitherto had been non-existent. The importance of the Institution's contribution to the pre-eminence of British agricultural machinery, world-wide, in the late post-war period is impossible to quantify, but there can be little doubt that it was significant.

Facilities for agricultural engineering education at Diploma level did not exist until the Institution took the initiative by setting up its own Examination Board and arranging for courses to be run, leading up to the examination for the National Diploma in Agricultural Engineering. The first examination was held in 1951, and the last will be in 1974. During the 23 year period 804 candidates were awarded the Diploma, and the majority of them are still Institution members. The NDAgrE course has served its purpose and will be no more; so also has the Examination for Graduate Membership. The Institution is no longer in the front line of agricultural engineering education. That is the fact; what are the implications? I believe them to be far-reaching, and I shall return to them anon.

Perhaps the brightest star of all in the Institution's firmament is the National College of Agricultural Engineering, which very probably would not exist today but for the vital part which the Institution, together with AEA and AMTDA, played in its inception. Conceived in the ninteen fifties, formally announced in 1959, the year of the Institution's own Incorporation, it opened in 1962 and has since gone from strength to strength under the guidance of Professor P. Payne, an able Principal and a Fellow of the Institution. I do not feel I can pass on without digressing for a moment to place on record our warmest appreciation of the action of the College Governors and the Principal in making facilities available to us to establish the Institution Secretariat on the College campus, from 2 January of this year. We believe it is right and in all respects appropriate that the Institution should now have come 'home' to Silsoe; the centre of agricultural engineering in this country. We are indeed grateful.

John V. Fox NDA NDAgrE FIAgrE, Managing Director of Bomford and Evershed Ltd, President of the Institution 1974/75.

At about the time the College first opened, in 1962, a series of meetings between the Institutions of Civil, Mechanical and Electrical Engineers led to the framing of proposals for an Engineering Institutions Joint Council, which were submitted by them to ten other Chartered Institutions*. The Joint Council was set up, and in 1965 secured a Royal Charter, becoming from then on The Council of Engineering Institutions (CEI) and having sole powers to designate corporate members of constituent member bodies as 'Chartered Engineers'. This Institution made an approach to EIJC at an early stage and there began a dialogue of seemingly infinite length and complexity, which has continued now for a decade. The fundamental issues were those of reconciling the principles laid down by CEI with the special situation of IAgrE, and of creating a situation wherein those members of IAgrE whose qualifications met the criteria of Chartered Engineer could be so designated, without at the same time jeopardising the position of the majority of IAgrE members. The importance of these discussions may well have become obscured by the passage of time and by their confusing complexity. I shall refer to them again when considering the challenges which now face us.

Less protracted, although in themselves a major task, were the rounds of discussions leading eventually to the formation of the Engineers Registration Board (ERB) within CEI. As a constituent member of ERB this Institution is able to register appropriately qualified members as TEng(CEI) and Tech(CEI). To date 246 and 137 members respectively have been so registered. This is an immensely important part of our function, and one which must continue to develop in the future.

We come now, 34 years on, to a Council Working party, set up on 26 October 1972 to carry out a fundamental review of the whole

**(Royal Aeronautical Society, British Institution of Radio Engineers, the Institutions of Chemical Engineers, Gas Engineers, Mining Engineers, Marine Engineers, Mining and Metallurgy, Municipal Engineers, Production Engineers and Structural Engineers).*

organisation of the Institution, and to make recommendations to Council on its future development. Why was such a study needed at that time? The reason can be expressed in one word: SURVIVAL. The immediate crisis was financial, but it was the Working Party's task to isolate the underlying causes and to recommend solutions. As you know, the Working Party's Report was adopted by the Council and its recommendations were implemented at an Extraordinary General Meeting on 3 July 1973. It is much too early to make a reliable assessment of the results which these changes have achieved, but I believe that the problems and the challenges with which the Working Party grappled are of such importance that they should be considered here.

Once again it will perhaps be helpful to paint in a little of the background. Inflation, at unprecedented rates, is a constant companion, and its effect upon an organisation with a static or low growth rate needs no elaboration. Government intervention to limit rises in prices and incomes encourages us all to put expenditure under ever closer scrutiny, whilst the rise in world prices whittles away whatever savings we make. Entry into the European Community poses its own special problems, including those with regard to international comparability and recognition of technical qualifications. The Department of Education and Science, in assuming responsibility for virtually all engineering and technical education, calls into question the relevance of many long-established independent bodies. Increasing specialisation in all technical fields encourages the establishment of new associations and societies whose interests, though limited, frequently overlap those of other more broadly based organisations. Over all this looms the threat of the Energy Crisis, and the spectre of zero growth. There are of course some rays of light: the importance of agricultural engineering can never have been greater, the time for cost and energy saving systems never more opportune. This is without a doubt a great time to be an agricultural engineer, but I believe it is also a cross-roads of opportunity for this Institution.

As a result of the decisions taken at the Extraordinary General Meeting last year we now have a streamlined administration, reduced overheads and the capability of a faster response to external events. In the short term the financial crisis has been overcome, and we have the time to take stock; we must be sure to use that time to the fullest advantage, and to choose the road which will take us where the action is going to be in the coming years.

In this context one word seems to me to point the way: RELEVANCE. Relevance to the needs of our members and to our industry; relevance in the field of UK engineering education and qualification, relevance in the broader spectrum of the European scene, where the first tentative steps towards standardisation and comparability of qualification are now being taken.

We have to face, squarely, the fact that no longer is it necessary, or even possible, to take an Institution examination to become a qualified agricultural engineer in this country. That, I believe, should be a matter for pride: pride in a job well done, in foundations which this Institution has truly laid. But it also strikes a warning note. The control of agricultural engineering education at Technician level is now in the hands of people who, however competent and able they may be, are not necessarily agricultural engineers, and I see it as a vital part of our function to keep a close watch on developments in this field, and to use all the influence we can bring to bear to ensure that young men wishing to enter our industry in the future are presented with educational opportunities which are as relevant and appropriate to their chosen career as those which our Institution courses and examinations offered in the past. It has been my experience that chance plays a very minor part in the regulation of affairs, and on this basis the close and influential involvement of agricultural engineers in the restructuring of education must be regarded as essential. This matter is already occupying the attention of the Council.

In addition, however, these changes in the pattern of education also mark the end of an era, and the opening of a new chapter in our history. If we are not to be overtaken by the tide of events, perhaps to be left high and dry on some deserted shore, we would do well to look carefully at what the future may hold and plan accordingly. The opportunities are great, but we need the wisdom to see them and the will to seize them. To those who see in these changes the beginning of the end, I would say, with due deference to Sir Winston Churchill; 'No, but I think it is the end of the beginning'.

Whilst politically the future of this country within EEC may be in some doubt, we would be wise to base our thinking on the premise that we are there to stay, and to take account of the many differences, as well as similarities, which exist between the member countries.

Over the past two centuries or so, engineering education on the European mainland, and particularly in France, Germany and Italy, has been the responsibility of the State. This has resulted in the development of, by our standards, highly centralised and formalised systems, with a marked degree of uniformity of standard and qualification within each of the major countries concerned. It is also fair to say, I believe, that the graduates of the *Grandes Ecoles* of France or of the *Instituti di Ingegneria* of the Italian universities have received a technical education to a far higher standard than that generally available to their British counterparts. For this reason we tend to be regarded with a degree of suspicion by continental engineers, who at the same time view our independent professional institutions as a further manifestation of the British penchant for amateurism. However that may be, we in this country have always retained the virtue of flexibility, and it is perhaps ironic that it would be very much easier for us to move to meet our European partners in standardising technical education than for them to meet each other.

It is clear, therefore, that any moves in this direction are likely to be very long delayed, and even mutual recognition of qualifications within EEC is meeting with severe difficulties. This does not mean, however, contrary to alarmist rumours in the press and in other quarters, that the freedom of engineers to practise in other countries is in any way curtailed. Article 54 of the Treaty of Rome provides for 'freedom of establishment' of the citizens of member states throughout the Community, and this is respected by all countries. The only situation where difficulties can arise is that in which a specific technical qualification is required in a particular post, for example, where an engineer is called upon to carry out statutory safety inspections of industrial or other plant. In such a case an officially recognised national qualification would be mandatory.

This is where Article 57 of the Treaty comes in, or rather should come in. It requires member countries to arrange for the mutual recognition of academic qualifications, and instructs the Commission of the EEC to issue directives accordingly. So far, after 16 years, not one directive has been ratified, although as many as 40, in draft, are under discussion at the present time. What this means to us is that we have by no means missed the 'European boat'; British engineering qualifications will have as great, or as little, opportunity for Community recognition as those of the long-standing members. It also means that there is likely to be a further long delay, unless the fresh approach from this side of the Channel can break the log-jam.

The British contribution to the discussions is being co-ordinated by the Department of Trade and Industry, with CEI in a central rôle in the field of engineering qualification and registration. The shape of things to come has been evident in the rationalisation of technical education over the past few years, and this process, which has already brought about the demise of many time-honoured examinations, including our own, is soon to overtake the City and Guilds as well as the Ordinary and Higher National Certificates. Although technical education itself will be controlled by the Department of Education and Science, the registration of engineers at all levels will remain with the Institutions, and through them with CEI.

It is therefore in this direction that we must look, and seek to build upon our already important link with CEI as a constituent member of the Engineers Registration Board. The policy of the British Government, at least until recently, has been to work towards Community recognition of the three grades of ERB registration, and to recognise CEI as the sole qualifying body. It has also been specifically stated that 'loners', people who are technically qualified but who do not belong to a recognised Institution, will not be eligible to be registered as engineers. It follows from all this that further rationalisation of the position of non-chartered Institutions *vis-a-vis* CEI would seem to be necessary and probably inevitable, leading in the not so distant future to the ability of our Institution to register suitably qualified members as Chartered Engineers, even if, as at present appears possible, they are called by a slightly different name. It is also evident that whilst the rôle and shape of the British Institutions may be changing, they have an increasingly important part to play in the years ahead.

The primary need in the arena of professional qualification and status is unity; national unity leading eventually, if our sights are set realistically and wider issues do not intervene, to comparability within the European Community. This will inevitably mean that disciplinary boundaries must become blurred, and we may well find in the future a single UK Institution of Engineers, with responsibility for technical qualification, registration, professional standards and discipline. Provided that this is achieved in close consultation with the existing Institutions, as well as with HM Government and the European Community, we, as a country, could be very well placed to make a positive and constructive contribution to the achievement of the long-term goal of comparability. We might, as I said earlier, break the log-jam in Europe.

Throughout these coming events, however, we would do well to remember that agricultural engineers are the men responsible for providing the means of producing food; an industry to which even oil and coal take second place. It is the duty and obligation of this Institution to be strong, to make its voice heard in the corridors of power, and to ensure that agricultural engineering is accorded the important place to which it is entitled, and which it must have, in the educational and professional structure. It is virtually certain that if we do not stand up for ourselves, no-one else will; and agricultural engineering as an identifiable discipline could then quietly disappear. This I believe would be damaging to the future of this country, and eventually to all people.

The danger in this situation is that there would be nothing dramatic about the quiet downward drift; none of the trauma of a sudden closure of the oil taps, or of a major industrial dispute. All that would happen would be that over the years there would be fewer and fewer agricultural engineers. These people, in whom a background of agriculture and engineering is linked by their training, I believe to be necessary if we are to continue effectively to apply engineering to agriculture. The counter-argument, however, is plausible and is widely accepted.

It is pointed out, quite correctly, that only a very small proportion of those employed in the industry have any direct connection with agricultural engineering as such, being mainly concerned with mechanical, electrical or civil engineering, office work, accountancy and so on. It is suggested that the agriculturalists can quite well tell the engineers what machines to make, and in fact when you come to consider it, so the thinking goes, agricultural engineering does not really exist at all. The NCAE is an embarrassment to this school of thought, as are the degree courses in agricultural engineering at the University of Newcastle, but it is conceded that perhaps a few of the hybrid engineers are useful. The argument contains the necessary grains of truth to make it difficult to refute; and it is a convenient one for the rationalisers and planners who of necessity must reduce to a workable minimum the multiplicity of technical education courses and qualifications.

We, of course, know that the fallacy of this argument lies in the assumption firstly that the non-engineering agriculturalist will be able to determine the correct engineering solution to his problem, and secondly, that the non-agricultural engineer will be able to correctly interpret the agricultural requirements in his design. The result is likely to be a rough approximation, and in the competitive and cost-conscious world in which we live, that just will not do. However, the fact that these hares are being raised at all should make us stop and think.

It is possible that we have in some ways failed to match up to the unique challenge of being an Institution of Agricultural Engineers? I believe we have, and I will give you, if you don't mind, another one-word summary: IMAGE. If you were to stop a man in a London street and ask him what he understood by the term 'agricultural engineer', the chances are perhaps ten to one on that he would say 'Someone who makes farm machines'. Out in the country the answer might be 'A farm machinery dealer'. How many people, if asked the profession of a man who advised on the prevention of erosion, or who designed milking parlours, or who determined the electrical loading for a farm, would reply 'agricultural engineer'? Very few.

There can be no doubt that we have a narrow image, not only in the public eye, but within our industry, and even within our own membership. The idea that we are concerned primarily with mobile machinery for field use is deeply rooted, and may, indeed, have led to the situation where a preponderance of our members is involved in that area of activity. This narrowness of our image has also been a contributory factor in the formation of other learned societies or associations with specialised interests which are as directly related to our profession as is farm mechanisation. Yet the members of these other societies do not necessarily see themselves as agricultural engineers. It is urgently necessary that we take steps to rectify this situation, which is affecting us seriously in at least three ways; firstly, it means that we are not fully discharging our responsibility to the people and the industry which we are here to serve, secondly, it means that from the point of view of our contacts with Government and with CEI we are not fully representative of all agricultural engineering interests, and thirdly, it means that a great many potential members are being lost to us. In each of these areas, and particularly in the last, time is not on our side. It is vital that we project our true image throughout the country, and project it more forcefully and more effectively than we have done in the past. The image we should have is that of a body in which all the disciplines which make up agricultural engineering have a place, and in that context there is perhaps no better summary than the descriptions applied to the five Technical Sections of CIGR; the International Commission of Agricultural Engineering. They are as follows:

- Section 1 Sciences of soil and water in their applications to the work of agricultural engineering. Techniques of soil protection and conservation, irrigation, and land improvement and reclamation.
- Section 2 Agricultural buildings, structures and related equipment.
- Section 3 Agricultural machinery.
- Section 4 Rural electrification and agricultural applications of electricity.
- Section 5 Scientific organisation of agricultural work.

There indeed we have a challenge, and one which must be met if we are to fulfil our purpose of truly representing agricultural engineers. This Institution's great strength is in its branches, and it is my hope that they will direct their attention particularly to Sections 1, 2 and 4 in the coming years. If we can broaden our base of operations, and bring our activities to the attention of a wider public, it will not be long before the movement develops a momentum of its own. Nationally, too, we must be increasingly aware of this broader front, and must constantly seek to create new opportunities for its development.

A current example of the kind of problem a narrow image can create, and of the kind of opportunity we must seize, is to be found in the imminent formation of a new body: The British CIGR Association, which is to be inaugurated later this month. Its purpose is to become a member of CIGR, as the national body representing British interests in the international context, a function which this Institution has been performing, albeit on a restricted budget, for many years. Previous attempts on our part to arouse wider UK interest in CIGR had been less than successful, and it is immensely encouraging to see that the tide is now turning. Following our most recent initiative, this Institution, the Electricity Council, the Farm Buildings Association, the Royal Institute of Chartered Surveyors and the Soil and Water Management Association have decided to participate in the new Association. The aims and objects of CIGR are closely parallel to those of our own Institution, with the added dimension that CIGR is essentially an international grouping of national agricultural engineering associations, and as such offers the opportunity of the broadest possible contacts and co-operation between agricultural engineers of the many member countries.

It might be thought, therefore, that the Institution of Agricultural Engineers would automatically be accepted as the one body whose qualification to represent the United Kingdom in this sphere is unimpeachable. However, this was not so, and the discussions which led to the formation of the British CIGR Association brought forcibly to mind the old truism: that we never see ourselves as others see us. To those other bodies we are as specialised in farm mechanisation as they are in their own individual fields, and personally I respect and accept their point of view. If that is how we appear to these experienced and distinguished agricultural engineers, then that is how we are.

I submit, however, that that is not how we can afford, or would wish, to remain.

In a future where the need and opportunity for direct involvement in the academic field will inevitably be less, the learned society aspect of our work must be increasingly to the fore. It is our task to create and maintain a climate in which agricultural engineering in its true and widest sense can flourish and be recognised for what it is; a profession vital to the present and future well being of all people. To achieve this we need, and this is my last one-word summary: PARTICIPATION by all members in our activities, in the work of publicity and recruitment to ensure our SURVIVAL, in the deliberations and policy decisions needed to broaden and increase our RELEVANCE, and in the all-important task of projecting our IMAGE to the world.

We have the cause for which to fight, we have the ability and the will; let there then be no doubt that the Institution of Agricultural Engineers is and will remain a powerful and progressive force, directed ever more positively towards its principal broad objective, the general advancement of agricultural engineering and mechanisation.

J. V. Fox

The agricultural engineering challenge of the mid-1970's

by J A C Gibb MA MSc FRAgrS FIAgrE MemASAE

Introduction

THE present year marks the watershed for agricultural engineering — as for almost all other technical and engineering activities — between an old pattern of growth and development based on cheap and abundant energy and a new pattern based on energy sources which may be of unconventional kinds, or conventional kinds which are less readily available and more expensive. A re-appraisal of the ways in which engineering techniques will be applied to agriculture thus seems desirable.

I should like to discuss the trends which have become apparent in the development of agricultural engineering, and of the agriculture it serves, and then to look ahead a little to try to envisage what sort of future activities there are likely to be for agricultural engineers. While the British scene is uppermost in my mind, inevitably there must be some reference to agricultural engineering overseas.

The past development of agricultural engineering

No doubt the history of agricultural engineering development could be written in a variety of different ways, and it is of little value to argue whether the engineer has followed in the wake of the farmer, providing the machines and equipment the farmer has demanded, or anticipated those needs and thus led the farmer forward. But, it must be generally true that agricultural engineering activity has reflected the trends and needs of agricultural production in the past, and that present and future trends in farming will determine the kind of activities that agricultural engineers will be engaged on in the future.

Thus, as we look back we can see that agricultural engineering in Britain in the past has been biased towards tractors and farm machinery, and based mainly on mechanical engineering. The scale of manufacturing operations has increased from that of the village blacksmith to that of the large mass-production plant, often controlled by an organisation that is international in character. With increased scale of operation there have come the benefits of standardisation and the specialisation of function in manufacturing industry, with the countervailing disadvantages of reduced flexibility of design and of the function of the people concerned.

As a result of specialisation in the agricultural engineering manufacturing industry and the concentration of the greatest proportion of the total production of tractors and machinery into a relatively small number of large firms, the number of specifically agricultural engineering jobs in the manufacturing sphere is likely in the future to diminish to some extent rather than increase, though those agricultural engineers who remain will be of particular importance in linking the design and production capacity of the firm with the realities of farm conditions and needs. But standardisation long ago began to cross both oceans and national frontiers, so that design tends increasingly to be aimed at international rather than local markets and may be carried out thousands of miles from where the machines are made and sold. From the farmer's point of view this may mean a limitation of choice, to some extent at least, in that the economics of production do not permit design variants for limited sectors of the market. The situation is now quite the reverse of that in which almost every village had its own smithy which catered for the needs of the local farmer, with little regard for the world beyond.

Developments in farming

While aggregation and standardisation of manufacturing enterprises have been taking place, parallel changes in farming organisation and production have also occurred. Thus, farm sizes have increased to an average figure of 234 acres in Britain, the investment in machinery/man employed has increased, and so has the sophistication of much of the equipment. The total engineering input into farming is thus increasing rather than diminishing, but that total is likely to be constituted in ways which are not necessarily the same as in previous years, and are always subject to further change.

Let us, therefore, consider the trends in farm production which are apparent. Farms are larger and more specialised. Their products, as well as engineering products, are more standardised. A relatively new feature is that the farmer can no longer grow any crop he likes and expect to sell what it produces. He, too, is subject to market demands as to type, quantity, quality, time of production and possibly the requirements of preliminary processing and packaging. Limitations or quotes are imposed on producers by marketing boards and the food processing industry is also becoming more closely concerned with primary farming activities and exerts a considerable measure of control over the production of some crops — such as peas and other vegetables for quick freezing. Such control may include specifying the type and timing of field operations, or the operation of harvesting and first-stage processing machinery; or of drying or storage processes for cereals, or pest control for fruit and vegetable crops, and so on. Some of these sources of control or supervision external to the farm must employ agricultural engineering expertise, and opportunities for agricultural engineers to be associated with process control of this kind are likely to increase.

Other engineering inputs into agriculture

It appears, therefore, that agricultural engineers with a mechanical background will continue to play an important part in applying their expertise to agriculture. There will also be growing opportunities for a range of other kinds of engineering. In many overseas territories soil and water engineering is more important in its application to agriculture than any other branch of engineering, in connection with erosion control, irrigation and drainage. The intensification of livestock husbandry and the control of environment that may go with it involves heating and ventilating engineering, mechanical handling of feed materials, and some aspects of automation. In intensive glasshouse crop production there are similar needs, which require a considerable range of engineering expertise, and so also does farmstead mechanisation — mechanisation of operations in and around the farm buildings.

One characteristic of many of these applications of engineering is that if they are to be fully effective there must be a measure of understanding of scientific subjects which agricultural engineers in the past have not necessarily had to worry about. Thus, agricultural engineers working on the control of environment for animals or plants may well have to know a little of animal or plant physiology as well as something of animal behaviour. Those concerned with the design and installation of automatic control systems will be unable to use their own expertise to the best advantage unless they are able to reach part way towards an understanding with the animal or plant physiologists. They, in turn, must have some appreciation of the limitations of practical engineering installations, and of the fact that engineers cannot design systems of any kind unless they are provided with at least the basic information or parameters involved. So agricultural engineers concerned in these relatively new applications of engineering in the agricultural sphere will find it increasingly necessary to work in collaboration with agricultural scientists.

Figure 1 attempts to show some of the relationships between the engineering disciplines and applied sciences on which agricultural engineering may draw, the pure sciences which support them, and the economic and other constraints which may affect the ways in which these engineering inputs contribute to agricultural production. It is not possible for such a diagram to be exact in the juxtaposition of subjects, but it gives an indication of the breadth of span of knowledge which may be required of agricultural engineers,

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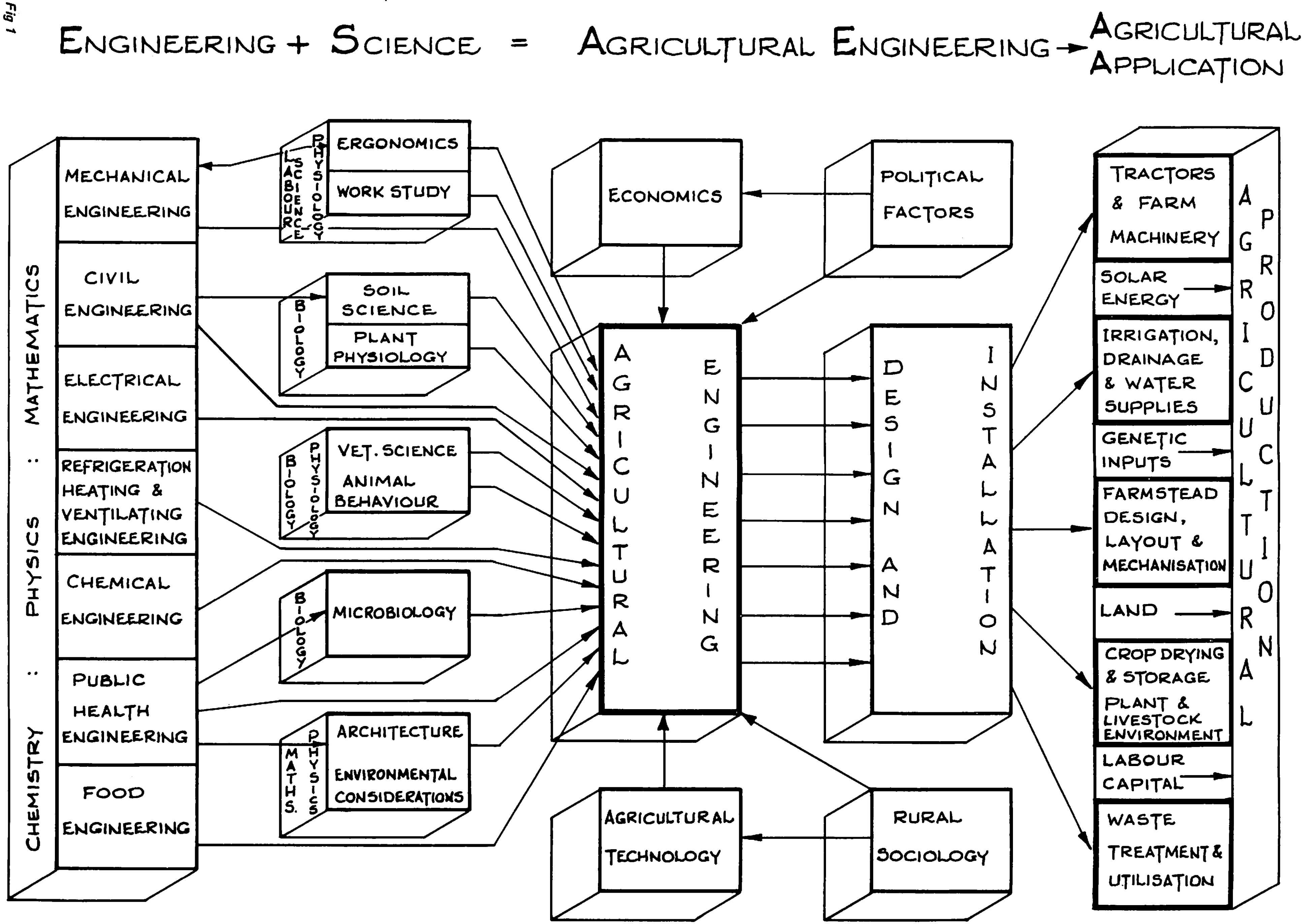
A paper presented before the Yorkshire Branch of the Institution of Agricultural Engineers on 15 March, 1974. Mr Gibb is Head of Agricultural Engineering Section University of Reading, and immediate Past President of the Institution.

Fig 1


ENGINEERING + SCIENCE = AGRICULTURAL ENGINEERING → AGRICULTURAL APPLICATION
CHEMISTRY : PHYSICS : MATHEMATICS
MECHANICAL ENGINEERING
CIVIL ENGINEERING
ELECTRICAL ENGINEERING
REFRIGERATION HEATING & VENTILATING ENGINEERING
CHEMICAL ENGINEERING
PUBLIC HEALTH ENGINEERING
FOOD ENGINEERING
ERGONOMICS
WORK STUDY
LABOUR SCIENCE
PHYSIOLOGY
SOIL SCIENCE
PLANT PHYSIOLOGY
BIOLOGY
VET. SCIENCE
ANIMAL BEHAVIOUR
BIOLOGY
PHYSIOLOGY
MICROBIOLOGY
BIOLOGY
ARCHITECTURE
ENVIRONMENTAL CONSIDERATIONS
MATHS.
PHYSICS
ECONOMICS
POLITICAL FACTORS
AGRICULTURAL ENGINEERING
DESIGN AND INSTALLATION
AGRICULTURAL TECHNOLOGY
RURAL SOCIOLOGY
AGRICULTURAL PRODUCTION
TRACTORS & FARM MACHINERY
SOLAR ENERGY
IRRIGATION, DRAINAGE & WATER SUPPLIES
GENETIC INPUTS
FARMSTEAD DESIGN, LAYOUT & MECHANISATION
LAND
CROP DRYING & STORAGE
PLANT & LIVESTOCK ENVIRONMENT
LABOUR CAPITAL
WASTE TREATMENT & UTILISATION

and of some of the major ways in which engineering thought and design are applied to agricultural needs.

Another field of activity which is likely to become important within the near future is 'synthetic' protein production. Considerable quantities of re-synthesised and retextured protein have been produced in the USA from soya beans and are marketed in various ways, including synthetic bacon pieces and other meat analogues. In Britain similar activities are in progress on an experimental scale, but using plants which are more suited to the British climate. The volume of research by plant physiologists, agronomists and others is now such that it may not be long before the growth of field crops specially for protein extraction becomes standard farming practice. The probability is that the engineering impetus may come initially from the food industry, but it seems clear that the primary extraction of protein from green material must take place on farms, for logistic reasons. There are likely to be tasks associated with the design and installation of farm-scale equipment for protein extraction, and the associated harvesting, handling and temporary protein storage processes, which will fall naturally to agricultural engineers.

There are also possibilities of producing food materials of non-traditional kinds, either for human or animal consumption. These include bacterial protein from waste materials, including some derived from livestock excreta or plant wastes, and similar opportunities for agricultural engineers to those just mentioned are likely to arise, probably on a rather longer time scale.

Waste treatment and utilisation

This subject is so important that it justifies a separate heading. Before we reached the crest of the energy watershed a few months ago, agricultural engineers were becoming increasingly involved in farm waste disposal. Waste materials included excreta from livestock enterprises, silage liquor, vegetable wastes and contaminated water, poultry processing wastes, and straw. The need to dispose of them included provision for control of smoke and smells offensive to the neighbouring population, avoidance of contamination of surface and ground water, and elimination of the risk of dissemination of pathogenic organisms. All of these provisions are still desirable, but the overriding new factor of the scarcity and increased costs of oil fuel and electrical energy — costs which are virtually certain to rise still further in the future — makes it essential to look carefully at the possibilities of making productive use of these so-called waste materials. In circumstances in which a shortage of materials of many kinds and the need for economy in use of energy are likely to be with us indefinitely, it is well said that one man's waste is another man's raw material.

Thus the disposal of waste materials in ways which are acceptable from the point of view of public health and public amenity must be achieved at the same time as every opportunity for constructive re-use is facilitated. There will be many ways in which agricultural engineers will have a part to play in this kind of activity, and they will find themselves working increasingly with sanitary engineers, microbiologists and chemical engineers.

However, it would be a mistake to think that the productive utilisation of farm waste materials is an easy matter which can be put into practice at once. One of the topics which has attracted considerable attention at the present time is the possibility of using anaerobic digestion processes to produce methane for animal and plant wastes. It is perfectly true that such a possibility exists, and that very substantial quantities of heat energy could be obtained in this way.

For example, if all the manure from a dairy herd of 180 cows could be collected and digested efficiently, the gas output would be equivalent in heat value to about 273 litres of petrol a day — worth £30 a day at present prices. But these are very big 'ifs', and the fact remains that the biogas that is produced, containing some 65% of methane, gives energy in a form that is only likely to be utilised efficiently if it is burned directly in a heat-requiring application close at hand. Converting it to electricity would lose 80% or more of the heat value, and it is not normally practicable to compress it for use as a fuel for moving vehicles. These points emphasise that there are problems to be overcome before this potentially valuable energy source can be utilised, and that considerable research and development will be required before farm-scale plants become practical, at least for the average farm. A further very important point is that biogas becomes highly explosive when mixed with air, so that there is a strong element of danger in the process unless it is very carefully controlled.

Changes in farming in the immediate future

Thus far I have been considering some of the factors which will affect farming and agricultural engineering gradually over the next few years. Fortunately, one can say with some confidence that changes are likely to be gradual and not sudden. Although it seemed at the end of 1973 that there might be a danger of drastic restriction of fuel supplies, it would now appear likely that restrictions will be moderate, and that the main practical restraining factor is that of cost. Because the cost of fuels has already increased by at least 50% in the last six months, farmers and others must now have a very urgent interest in reducing consumption of traditional fuels. The present and expected future high levels of fuel costs, together with the benefits to the national economy through reducing fuel imports, must also give fresh impetus to the development of techniques of using waste materials where this had previously been regarded as uneconomic — uneconomic, that is, by comparison with the supply of fuels and other materials at low price levels which have now gone for ever.

I do not believe that developments on the farm in this new situation will to any real extent consist of putting the clock back — re-introducing animal power, or reversing the rapid fall in the number of people working our farms. The proportion of the national fuel supply needed in primary food production on the farm is only 1 or 2% of the total. People must eat, and, in any logical analysis, priority must be given to food production rather than uses of energy for amenity or luxury. It is interesting to note a few statistics on this point, which I take from Professor K. K. Barnes, writing in the American Journal *Implement and Tractor* dated 4 January 1974. The proportionate use of energy in putting food on the dining table in the USA in 1970 consisted of:

		approximate % of US total
Agriculture (ie primary farm production)	18%	2.7
Food processing	33%	5.0
Transportation	3%	0.5
Wholesale and retail trade	16%	2.4
Household preparations	30%	4.5

These uses of energy together represent about 15% of the total US energy requirements in 1970. The 18% figure in the above breakdown represents 1—1½% of the US total for direct use on farms, plus a further figure of 1—1½% required for the indirect needs of farming, such as production of fertilisers and other chemicals, farm machinery and other supplies and materials for use on the farm. Very similar figures apply in Britain.

It is certain that discussion of ways of economising in fuel and other inputs and materials which must inevitably be more expensive in the future than hitherto will occupy very many agricultural engineers and others extensively from now on. I do not propose to try to anticipate such discussions now in any detail, but the developments one can foresee are not dramatic. The trend towards ever-increasing tractor engine size is likely to flatten off or even reverse. Farmers may well be impelled to curtail the number of field operations, and to ensure the maximum effect from such operations as they do carry out. Tandem use of machines, and possibly the use of new types of machines incorporating two or more functions, may become common. The high price and energy cost of artificial fertilisers will encourage frugality in their application and greater readiness to use farmyard manure or the effluents from waste treatment plants instead.

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Agricultural engineering overseas

Most of the preceding sections relate particularly to the farming operations in developed countries in Europe and the USA, as well as in Britain. But we have to remember, as we look to the future, not only that there is a continually increasing world population and a corresponding necessity for increased food production, but that we in Britain have a vital interest in the agriculture of other countries which now supply more than half of our food requirements. The problems of intensifying food production in many developing countries are very great, even where the potential to do so is high. There is a paradox in that the energy requirements of peasant farming are usually very low, so that their efficiency in energy utilisation is correspondingly high. But the yields are often much lower than they might be and the labour requirements is high – so high that intensification cannot be achieved without mechanisation of at least some operations. The need for an engineering approach to agriculture in these conditions is very great indeed, and often the standard products of western tractor and machinery manufacturers are either only partly appropriate, or not suitable at all until major programmes of land redistribution and reshaping are carried out – if it is possible to do so in the human, social and political circumstances of the area concerned – together with massive educational development of the rural population. Such an engineering approach must be particularly well-informed, and able to range from the soil and water-based disciplines through to mechanisation of field and farmstead operations, with an appreciation of the rural economic and sociological background of the peasant farmers concerned.

The longer-term future

I have tried to confine my remarks to the immediate future in which radical changes of direction are unlikely, and there will be a progressive development of the application to agricultural production of a wider range of engineering disciplines than in the past. The keyword will be economy in the use of fuel and materials, and there must be great and rewarding challenges for agricultural engineers of many different kinds in helping to achieve it. As one looks further ahead, towards the end of the century, the avenues of opportunity to serve the agricultural industry become still wider. The possibility of obtaining usable energy from waste materials, of nuclear power in a form controllable for farm-scale operations, and perhaps of power sources as yet unexploited, all lie before us. Such a prospect seems to me to be stimulating and highly demanding. Precisely how agricultural engineers will organise themselves to make their uniquely versatile contributions, spanning a wide range of engineering disciplines and penetrating far enough into the supporting sciences to enable meaningful and fruitful communication to be established, remains to be seen. But I am convinced that the emphasis in the future is not going to be on retrenchment, but on development, and that the work of agricultural engineers cannot fail to be of even more vital importance to farmers in this country and abroad, and indeed to the vast populations dependent upon them for their daily sustenance, than in the era of cheap energy now ended.

Educational routes to graduate membership

GRADUATE membership is the grade offered to those who have achieved the necessary academic qualifications but who have not, to date, had the appropriate industrial experience to apply for full membership. The academic requirements for graduate membership include degrees in agricultural engineering, other types of engineering, agricultural mechanisation, agriculture and other natural sciences; although particular types of practical experience will be required of those with the latter types of qualification. Also approved are the Higher National Diploma (or Certificate) in engineering and the Agricultural Engineering Technicians Certificate City and Guilds No 030 part III (if passed at the appropriate level). The diplomas awarded by some colleges are also valid.

A degree is normally required in order to progress to the Fellow grade of membership. Full details of membership requirements will be published in the next issue of The AGRICULTURAL ENGINEER in the form of a revised 'Guide to Membership'.

Degree level courses

The entry requirement for a first degree course is usually two GCE 'A' level passes, at appropriate grades, in specific subjects. Those who intend to apply for places on degree courses are strongly advised to inquire from the colleges of their choice regarding acceptable subjects before embarking on any course of studies at 'A' level.

Alternatively, those passing at approximately 60% or over in certain key subjects (usually mathematics, physics, applied mechanics and electrical engineering science) in the Ordinary National Diploma in engineering may be accepted for degree courses. Certain colleges who provide courses leading to the Ordinary National Diploma in engineering, include additional agricultural engineering subjects in the curriculum.

Grades of pass, similar to those noted above, in the Ordinary National Diploma in technology (engineering) are also acceptable as an entry requirement for degree level courses. It should be noted that success, at any level, in the Ordinary National Diploma in Agriculture will not provide an entry to a degree course.

There are three centres in the UK providing courses leading to first and higher degrees in agricultural engineering. These are:

National College of Agricultural Engineering, Silsoe, Bedford MK45 4DT.	Three year BSc courses. MSc and Diploma courses. Higher degrees by research.
University of Newcastle-upon-Tyne, 6 Kensington Terrace, Newcastle-upon-Tyne NE1 7RU.	Three and four year BSc courses. MSc courses and higher degrees by research.
University of Reading, Reading, RG6 2AT	MSc courses and higher degrees by research.

Higher national diploma (certificate) in engineering

The only difference between these is the number of subjects studied and the mode of attendance. The curriculum contains subjects such as mathematics, engineering measurement, properties and forming on materials, mechanical technology, manufacturing technology, properties of materials, machine tools, jig and tool design etc. The diploma courses are normally conducted on a full-time or sandwich basis, whilst the certificate courses are normally of a part-time nature. These courses have no particular reference to agricultural engineering but they are very suitable for those wishing to work in design and manufacture. They are provided at many technical colleges; details of any local courses are available from the Education Office of the local authority.

The normal entry requirement for a higher national diploma or certificate course is five GCE passes, one at least at 'A' level. Students wishing to take this type of course should make inquiries as soon as convenient at the technical college of their choice to get full details of the subjects offered and the need to study specific GCE subjects.

Agricultural engineering technicians certificate City and Guilds no. 030 part III

The course is modular in structure and the scheme provides nine subjects for the general public. These subjects, each being based on 120 hours of tuition are:

Applied Hydraulics, Field Test and Development, Design Evaluation in the Selection of Equipment, Structure and Organisation in the Agricultural Engineering Industry, Field Engineering, Mechanisation of Crop and Animal Production, Farm Buildings, Installation of Equipment in Farm Buildings and Dairy Engineering. To be eligible for graduate membership, an applicant must have passed in six subjects at credit level; all subjects to be taken during one academic session. Two colleges offer courses leading to the agricultural engineering technicians certificate part III;

Kesteven Agricultural College, Keythorpe Court, nr Grantham, Lincs., Rycotewood College, Thame, Oxfordshire.

Special arrangements are available for Drainage and Water Supplies Officers employed by the Ministry of Agriculture. An additional three subjects are provided namely Field Engineering

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Dry conservation of grass

by G Shepperson BSc DipAgric FIAgricE

1. Introduction

EVERY tonne (0.98 ton) of high quality freshly mown grass contains only 164 to 254 kg (3 to 5 cwt) of dry matter; the object of 'dry' conservation is to remove a large amount of the water:

- to produce a high quality feed, which will store without deterioration,
- to reduce handling costs at various stages between cutting and feeding, especially by the development of reliable mechanical handling equipment.

Moisture content at cutting will usually vary between 75% and 85% and so from 3 to 6 tonnes of water must be removed per tonne of dry matter stored depending on the method of conservation.

I have been asked to deal with dried grass, haylage (ie very high dry matter silage) and hay and will start my paper by discussing the particular problems of water removal in each case.

2. Removal of moisture

2.1. Dried grass

The water in grass cut for drying is known as the Drying Load, and it is expressed in terms of the amount of water which must be removed to produce a given weight of dried product. The normal drying load, on which most driers are rated, is 3.5:1, which is based on a fresh crop moisture content of 80% and a dried product of 10% mc. Average mc of freshly cut grass over a whole season is likely to be about 82%, which increases the load to 4 tonnes of water for each tonne of dried crop. An increase to 85%, common in wet weather in early season, produces a drying load of 5:1 and when moisture content reaches about 88%, 6½ tonnes of water must be removed per tonne of dried crop. At this level the low throughput of the drier, which has an almost constant evaporative capacity, and the high cost of fuel per tonne dried may make it necessary to cease operations.

Costs of drying can be reduced by field wilting, in all but the worst weather. Reduction of moisture content to 75%, which is possible in a few hours of swath wilting, given suitable mechanical treatment, reduces the drying load to 2.6:1, and it will often be practicable to obtain a reduction to 70% mc and a drying load of only 2:1 within 24 hours of cutting. Unfortunately removal of excess water in this way is unreliable, least effective when most needed, and may be difficult to manage. In the future, mechanical extraction of water to reduce the drying load, followed by recovery of the extruded protein rich dry matter for feeding to monogastric animals may offer a useful and more certain alternative.

The effect of drying from four different levels when using a drier with a nominal capacity of 1 tonne of dried product/h, ie an evaporative capacity of 3555 kg/h (7840 lb/h) when drying all the crop to 10% mc is shown clearly in table 1.

Apart from the extra cost of fuel and the higher overheads charge which low throughput incurs, very high moisture contents can make it impossible to work to a carefully planned cropping schedule; surplus crop must either be made into silage or hay, or it may even be wasted.

Over a whole season, in which the seasonal target for 1 tonne/h drier might be as high as 3000 tonnes, a mean moisture content of 82% would reduce the amount to about 2600 tonnes, a shortfall of 12.5%; at 85% mean mc the shortfall would be 30% with a production of only 2100 tonnes. But if mean mc could be reduced to 75% then output could be increased to over 4000 tonnes.

In practice, the overall output likely to be achieved will vary between 200 and 300 tonnes of dried product per 454 kg (1000 lb) evaporative capacity.

2.2. High dry matter silage

The amount of water contained in herbage mown for silage is 3.5 to 4 tonnes/tonne dm, similar to grass cut for drying. Although silage is often made at this high moisture content, removal of some of the water by means of field wilting between mowing and ensiling, is highly desirable for all storage methods and absolutely essential for storage in depth, as in towers for example.

Wilting is worthwhile because it:

- reduces the total weight to be transported,
- concentrates plant nutrients and improves quality of the dry matter,
- reduces effluent losses and the chances of structural damage to silos,
- reduces the likelihood of breakdown in mechanical handling equipment, provided that a satisfactory chop length is maintained,
- increase intake when the silage is fed.

Reduction of moisture content to somewhere between 65% and 50% is necessary, depending on the type of tower silo and the loading height, and the aim should be to achieve this in the swath within 4 to 24 hours to keep nutrient losses to a minimum. Apart from actual loss of feeding value, extension of wilting time to two days or more adds appreciably to management problems, and continuing wet spells delay further mowing, so allowing the herbage digestibility to fall below a level at which the silage can be used as a production feed.

Assuming a cutting mc of 80%, common with high quality grass cut at the optimum stage of growth, wilting to 65% removes 0.75 tonnes of water for every 1 tonne of wet crop carted to the silo. The water removal is increased to 1½ tonnes per tonne wet, at 50% mc and if the crop yields 5 tonnes of dry matter per ha this means that only 10 tonnes of wet crop has to be carted, instead of 25 tonnes. In practical terms, and allowing for the lower density of the wilted herbage, 0.4 ha (1 acre) can probably be hauled in two trailer loads instead of three.

The loading rate of silage, which can be a continuous process is not directly affected by the ingoing moisture content, as it is with grass for drying but of course the total dry matter ensiled daily will vary with the amount of wilting.

2.3 Haymaking

Moisture content at cutting is usually 75% to 80% in a good crop, equal to 3 to 4 tonnes of water/tonne of dry matter, and 2 to 3 tonnes of this water must be lost in the field. Over half this amount can be removed within 24 h of mowing but several days may elapse before the hay is fit to gather from the swath and place directly into

Paper read to East Anglian Branch IAgrE Conference Mechanical Livestock Feeding on 21 November 1973. Mr Shepperson is Head of Forage Conservation Department, NIAE.

→ *concluded from page 39*

(advanced), Engineering Geology and Water Supply to Agricultural Holdings. Courses, which are open only to Officers already employed by the Ministry of Agriculture, are held at the Farm Drainage School, Ministry of Agriculture Buildings, Lincoln, in conjunction with Rycotewood College, Thame, Oxfordshire.

The usual entry to part III of the agricultural engineering technicians courses is through parts I and II of the same scheme but applicants with Ordinary National Diplomas in Engineering or Agriculture and those who have passed the City and Guilds Mechanical Engineering Technicians Certificate part II examination may also be accepted. Other comparable qualifications are also valid at the discretion of the college authorities.

College diploma courses

Two colleges, listed below, provide courses which are recognised by the Institution for graduate membership. Each course has a particular emphasis and those interested are advised to write to the Principals of the colleges concerned for full details of the curriculum and entry requirements.

Institute of Agriculture, Writtle, nr Chelmsford, Essex.

West of Scotland College of Agriculture, Auchincruive, Ayrshire, Scotland.

Only the main avenues to graduate membership ie those with a particular emphasis on agricultural engineering, have been noted above. Students who are in any doubt, and careers advisors who require further information, are invited to write to the Secretary of the Institution who will arrange for specific advice to be given on particular queries. *JCT*

Table 1 Effect of fresh crop moisture content on drier throughput and costs

Fresh crop mc %	Water evaporated to produce 1 ton dried grass		Output at 10% mc		Oil consumption*		Relative output %	Calculated cost/ton		
								Fuel+ £	Over-heads £	Total £
	lb	kg	lb/h	kg/h	gal/ton	l/ton				
80	7840	3556	2240	1016	65	290	100	6.50	6.00	12.50
82	8960	4063	1958	888	74	330	87	7.40	6.86	14.26
85	11 200	5079	1568	711	92	411	70	9.20	8.57	17.77
75	5824	2641	3015	1367	48	214	135	4.80	4.46	9.26

+Assumes fuel cost 10p/gal
**1 gal = 4.54 litres*

a store which is not equipped for artificial ventilation. As with wilting for dried grass and silage this time can often be substantially reduced by mechanical treatment applied to the crop during and shortly after cutting.

3. Mowing, conditioning and swath drying

3.1. Rate of drying

Grass mown and left to lie undisturbed in a compacted dense swath dries slowly and unevenly. Rapid wilting and acceptable overall drying rates can be obtained only by the expenditure of capital on suitable machinery, and by the input of power, applied in such a way that it does not cause excessive physical loss of crop dry matter.

Suitable treatments to increase rate of loss of water may vary from using a simple tedder, requiring 3.7 to 7.5 kW (5 to 10 hp) mower conditioners taking 4 to 8 kW/m (10 to 20 hp/5 ft) width of cut, to flail mowers and large mower conditioners with a power requirement of over 16.8 kW/m (40 hp/5 ft) width of cut, depending on forward speed[1,2].

An example of wilting grass cut on 13 May and mechanically treated at three levels of severity is shown in table 2. This range of drying is relevant to the production of both dried grass and silage.

Table 2 Drying rate of ryegrass/clover mixture, cut 13 May

Treatment	Moisture content at time intervals			
	As cut	1 h	2½ h	5 h
Lacerated	79.3	76.4	72.9	66.1
Crushed	78.0	75.8	73.0	68.2
Tedded	78.5	77.2	75.6	72.0

Crop from the same field was cut one week later, and the results measured over a longer period, table 3, are especially applicable to the use of tower silos, and to some methods of in-barn hay drying.

Table 3 Drying rate of ryegrass/clover mixture, cut 20 May

Treatment	Moisture content at time intervals				
	As cut	4 h	7½ h	24 h	48 h
Lacerated	82.1	75.9	68.4	63.4	55.3
Crushed	81.6	76.4	71.4	66.8	55.4
Turned	81.9	76.5	73.4	72.4	60.6

These figures, which are fairly typical for reasonable drying conditions in May show what can be achieved and indicate the added value of applying some form of conditioning treatment to improve drying rate, both on the day of cutting and subsequently.

I want to turn briefly to a look at machinery available now, and likely to be available in the future, which can be used for mowing and conditioning, to speed up drying without causing excessive loss of crop dry matter.

3.2. Field machinery

Machinery for mowing and swath treatment must:

- have a high rate of work, to cut the crop quickly,
- set the swath up in a form in which it is not easily beaten down again, preferably during mowing, to give immediate aeration,
- perhaps lacerate, bruise or simply graze the surface of the thicker parts of stems, to hasten diffusion of water; this will usually mean treating the stemmy bottom of the crop more severely than the leafy top and the action of the machine should mix the crop throughout the depth of the swath.

Apart from a wide selection of tedders and turners a number of commercial machines are available, based both on reciprocating cutterbars and disc and drum mowers, which combine mowing with conditioning, varying from a fairly gentle tedding to severe laceration and bruising[2]. In the past these have often been unsuited to UK grass crops because of performance limitations and cost, but some of the recently introduced equipment has been designed for European farming conditions.

Developments at NIAE, Silsoe during the past four years[3] have attempted to bring together in one machine the simplicity and low cost of ordinary reciprocating cutterbars, or the better performance of drum or disc mowers, with the fast drying rates obtained by using a fixed flail rotor. This unit takes conditioning of the herbage into the centre of the swath, and gives a more vigorous treatment to the stem than to the leaf. Considerable development has taken place with machines which have a 1.52 m (5 ft) width of cut. The reciprocating mower has been equipped with a rotor which applies its conditioning treatment across the full width of the mown swath. It would also be possible to do this by fitting such a rotor to a disc mower. With the top driven rotary drum mower however, the conditioning rotor must be reduced in width to handle the swath as it is concentrated whilst passing between the drums.

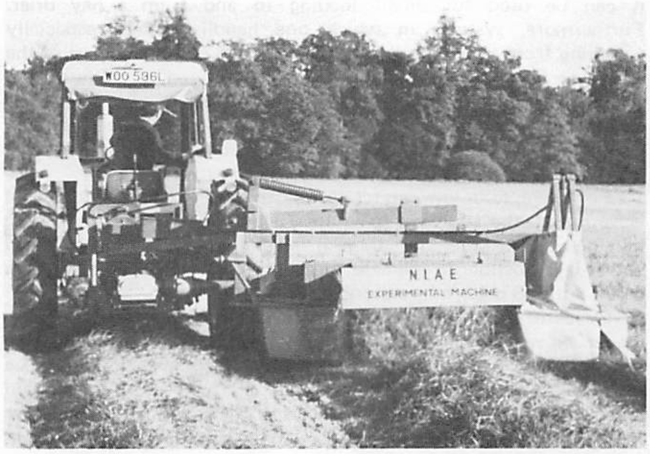


Fig 1(a) Two drum 2.13 m (7 ft) experimental semi-mounted mower — conditioner developed at NIAE, general view of machine at work showing swath.

The most recent development is an experimental semi-mounted rig, (fig 1) incorporating a 2.13 m (7 ft) wide 2-drum rotary mower with conditioner, and a number of mechanical features to assist smoothness of operation. The working unit has been suspended in a bridge frame which is mounted at one side on the tractor 3-point linkage and is supported on the crop side by a castor wheel. This arrangement has minimised fore-and-aft articulation, ensuring good ground following and uniformity of stubble length. The structure of the swath produced reduces the amount by which it is compacted in wet weather, and the resulting continuous ventilation allows the number of secondary treatments to be reduced.

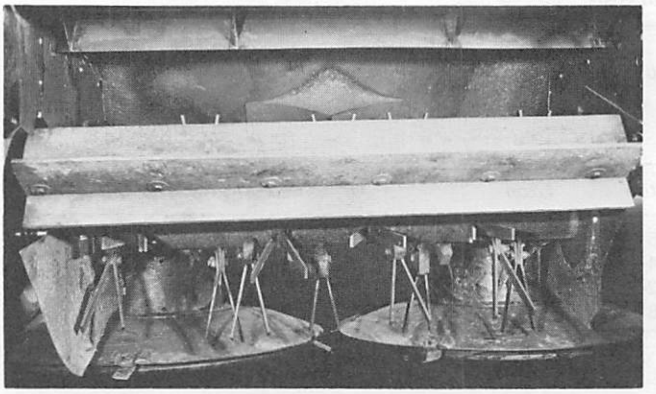


Fig 1(b) Close-up of working components of mower-conditioner.

Two important objectives of increasing width are to obtain a high output, for high power input and to avoid running tractor wheels on adjacent swaths. Net working rates of up to 3.23 ha/h 8 acres/h have been possible and overall working rate has been about 1.21 ha/h (3 acres/h) using a 52–60 kW 70–80 hp tractor and consuming 30–37 kW 40–50 hp at the pto. A problem with a 2.13 m (7 ft) machine is that it may not fit in with other equipment too well, and for the future a machine of about 3.04 m (10 ft) cutting width may be more appropriate.

4. Hay handling from field to store

In hay making, losses during swath drying can almost be matched by losses during handling and storage, unless field are cleared quickly and sufficient water has been removed from the herbage to prevent in-store heating and moulding.

The total amount which can be removed from the swath to a more weatherproof place in one day, using a particular handling system, is often more important than removing pence from the cost/tonne in terms of either capital or labour. But increased output per man/h is becoming more important, especially where only one or two men are available to do the job. An equally important consideration may be whether or not a mechanical system can easily incorporate a semi-weatherproof holding stage, preferably as an integral part of a unit-load handling system, or alternately whether it can be used for direct loading to and from a hay drier. Furthermore, systems in which one handling stage, especially gathering from the swath is held up by failure of another part of the system, – as can happen with direct trailer loading methods and chopped hay drying, are often at a disadvantage.

Most farmers are familiar with simple bale collectors, side gripping loaders, and even with automatic sledges and flat 8 systems and I will use these as standards for comparison.

For example, a low capital cost system using hand pitching and elevators at the stack may require 75 man min/tonne for baling, hauling and stacking[4], but three men can load and haul 250 bales/h and if it is possible to increase the number of men a large gang can easily put 500 bales/h into store.

By contrast, a high capital cost system using a flat 8 impaler loader allows a rapid build-up of unit loads and provided that large trailers are available, the manpower for baling and handling can be reduced to less than half, at about 30 man min/tonne. Two expensive items of equipment, the automatic sledge and the impaler loader are required, to give an overall daily output comparable with a high labour input, cheap and simple system; however, the important consideration on many farms is that at least 3–4 tonnes/h (150–200 bales) can be handled from field to store by one man and the trend is towards the production of even larger unit loads, handled from the tractor seat.

What are the possible future alternatives to bale handling as it is now generally known?

One recent development is the banding of 20 bales into a unit load, either by manual tying, using a simple unit on a tractor mounted buck-rake type of pick-up or on a semi-automatic pick-up device; it is anticipated that a fully automatic banding machine may be available in the foreseeable future.

A second alternative is the development of systems which produce a tractor-sized rather than man-sized package. Examples of some types of product available are described in fig 2 but in addition to these large round and other stacks, weighing up to 9

LARGE PACKAGING MACHINES

Specifications and data with hay

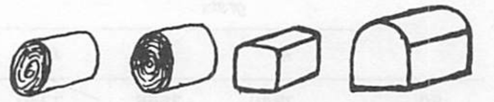
	Hawk Bilt 480	Vermeer 605/706	Howard Bigbaler	Hesston Stackhand 10	Hesston Stackhand 30	Hesston Stackhand 60/A
PACKAGE:						
shape						
X-section, ft	6d	6/7d	5 X 5	7 X 8	8 X 9	8 X 11
length, ft	6.4	4.6/5.5	8	8	14	20
nom. weight, cwt	11	14/22	12	20	60	120
density, lb/ft³	6–10	9–18/11–20	5–7	5–7	6–8	7–9
TWINE:	optional	yes	yes	no	no	no
PICK-UP	raddle	standard	standard	flail	flail	flail or standard
MIN POWER REQUIREMENT, H.P.	35	45/60	40	40	60	80

Fig 2 Table of large packaging machines and their products.

tonnes can be produced by mechanical means[5]. Big rectangular bales produced in the UK are best made from a wide flat-topped swath and, with a weight varying from 508–711 kg (10–14 cwt) can be handled by tractor front-end loader to a trailer, and then be unloaded by the same side-gripping attachment into store. After storage they can be handled by one man to a feeding passage, depending on building lay-out, and lend themselves to easy-feeding into mangers. Early figures for handling big bales have shown that one man can collect from the field and load into a store about 0.8 km (0.5 mile) away at from 5–7 tonnes/h and that baling plus removal to store may be done at a rate of 5 tonnes/h. Rate of handling out for feeding is important, but even more important is the fact that a worker who is physically incapable of handling normal bales (eg a young girl) can feed out the hay unaided. Other interesting alternatives to the large rectangular bale, shown in fig 2 are as yet largely untried in the UK although some have had extensive use in America, where weather at baling and after storage may be more favourable. These include round balers which either roll-up the hay on the ground or in a series of belts, to produce a bale which is within the lifting and carrying capacity of a large tractor. Such bales can be left in the field to weather and then be handled as required with a simple loader. Stack builders (fig 3) use a

Fig 3 The Hesston Stakhand stack builder about to deposit a stack.

simple compression device to produce 1, 3 and 6 tonne stacks, made without string, with a density low enough to allow them to ventilate, and a sufficient naturally formed thatch to enable them to shoot water. Stacking on to each other is difficult, if not impossible, and so they must be stored outside, where there is a considerable risk of loosing some of the top in grass crops; the tops of lucerne stacks remain intact but they are less effective than grass at holding out heavy rain. Further work needs to be done to study the weatherproof characteristics of these and other large packages and possibly to develop simple methods of protecting those stored outside against the worst effects of wind and rainfall.

5. Grass drying and packaging equipment

5.1. Type of drier

Three basic types can be considered:

i High temperature, (1000°C) rotary drum pneumatic driers, of triple or single pass type, which may be either fixed equipment or mobile. These are available with an evaporative capacity ranging from 1360 to 22 675 kg (3000 to 5000 lb) of water an hour. Oil consumption depending on size, varies from 114 to 1907 litre/h (25–420 gal/h) and from 10 to 12.5 kg water will be removed per litre of oil burned (100 to 125 lb/gal).

ii Low temperature conveyor driers, with an operational range from 95° to 150°C and an evaporative capacity from 1814 to 3175 kg (4000 to 7000 lb) water/h. Oil consumption may be up to 9 kg/l (70 gal/h) and about 41 kg (90 lb) water will be removed for each 4.5 l (1 gal) of oil consumed.

iii Low temp, rotary drum batch drier with an operating temperature up to 150°C, evaporative capacity of about 2500 kg/h (5500 lb/h) and oil consumption of 9 kg/l (70 gal/h). One litre of oil will remove from 32 to 34 kg water (70 to 75 lb water per gal oil).

Before the correct type can be chosen detailed consideration of the technical facts and economic considerations must be made, and I can only categorise them broadly, because the final choice will be related to each individual set of circumstances.

i Output in excess of 1000 tonnes of dried grass annually

High temperature rotary drum unit, installed as fixed equipment, with an evaporative capacity of at least 1814 kg/h (4000 lb/h) per 1000 tonnes required dried product.

ii Output of 500–1000 tonnes annually

(a) Smaller models of a high temperature rotary drum drier, as fixed or mobile equipment, with 1360–1814 kg/h (3000–4000 lb/h) evaporative capacity.

(b) Conveyor drier.

iii Output of less than 500 tonnes annually

(a) Conveyor drier, also used for drying grain and other seeds.

(b) Rotary drum batch system.

5.2. Methods of processing the dried crop

The alternatives available are milling and high density pelleting, cobbing or wafering, low density packaging in a bale or container, or loose storage, without any form of packaging.

5.2.1. Type of high density package

Two main points must be considered before deciding which type of package is likely to prove satisfactory. Firstly, will the final product be suitable for direct feeding to all classes of animal or is more than one type of package necessary from a given drier? Secondly, will the available machinery produce a package from all types of herbage, cut and dried at all stages of growth, which is durable and remains intact during handling and storage?

The most severe treatment is grinding prior to pelleting or cubing, which generally ensures stability of the product, and improves feed intake which may be advantageous for fattening animals[6]. The product may however be less suitable for feeding to dairy cows than cobs; these are produced by feeding unground crop to the press, but considerable grinding is inherent in this packaging process as the crop passes between die and roller, and a stable package can usually be made, except from low quality herbage. The use of a reciprocating piston press produces a wafer, in which grinding is kept to a minimum.

The two basic methods of packaging, both of which modify the feeding quality according to the amount of grinding, are therefore wafering presses, and ring die or flat bed rotary presses. Experience has shown that such machines probably have an installed load of 107–134 kJ/kg (40 to 50 hp/ton/h output[7]).

The reciprocating piston wafering press has a low total power requirement and a relatively low output, which is restricted by die diameter and the limited number of dies which it is feasible to use. It is not usually possible to change the diameter of the die on an installed machine. The wafers produced may have a diameter from 50–80 mm, length to diameter ratio of 0.2 to 0.5, will contain a proportion of grass with a relatively long staple, and have a fineness modulus of 3 to 4. They can be easily handled in bulk with a tractor-loader and bucket, but they are often unstable and may break down to an excessive amount of fines, especially if passed through complicated mechanical handling and conveying systems. The bulk density of 400–480 kg/m³ (25–30 lb/ft³) is comparatively low. If the diameter is too large or the wafer is too thick in relation to the diameter, it may be wasteful when fed, and can cause a choking hazard, especially in young catle.

The rotary press is usually a compact unit and it is possible to obtain a high output from a relatively small size of machine. Production of cobs from unground grass and pellets from ground grass is possible within the same machine and the diameter of the product can be easily changed, by replacing the die. Provision must be made for a high power requirement, and the larger machines, with a throughput of 5 tonnes/h will have motor sizes of 150–187 kW (200–250 hp).

Cobs may have a diameter of from 12–30 mm and preferred sizes now appear to be 12 and 19 mm; pellets diameter is normally 7–9 mm. A length diameter ratio of about 1:1 gives optimum handling characteristics, and an angle of repose about 45°. The grinding inherent in the process may help to bind the product together but it may also produce a too hard cube with some crops. Modulus of fineness will usually fall in a range from 1.5 to 2.5 for cobs, and will be 1.0 or less for pellets. Structure of the cob may be modified slightly by operating the die at a reduced speed, but more important, power requirement is reduced markedly, and a more stable product, with less fines may also be produced. Cobs and pellets require less storage space than wafers with bulk densities respectively of 700 kg/m³ (44 lb/ft³) and 830 kg/m³ (52 lb/ft³).

6. Harvesting and transport

Harvesting for haylage will usually be done with a trailed full-chop metered feed forage harvester. So long as chopping knives are kept in good condition to ensure an even short chop, of about 1 in, adequate power is provided, and enough large trailers, preferably with tapered sides and automatic opening tail gates are available, there should be no serious problems in carting from 10 to 15 tonnes/h to the silo. Loading at the tower silo requires a quick turn round system which can ensure that about 3.04 m (10 ft) is added each 8 h day, amounting to about 12 tonnes of grass of 40% dry matter in a 6.3 m (24 ft) diameter silo.

The silage season is fairly short and working more than an 8–10 h day is the exception; harvesting for grass drying is quite different however, as the machinery must work for a long season, possibly 5 or 6 months, and must produce grass for processing 24 h/d, even if actual harvesting time is limited to 12 h.

Crop requirements for various drier sizes, when grass is cut at 80% mc, are shown in Table 4.

Table 4 Harvesting requirements

Drying crop from 80% initial moisture content

	Evaporative capacity of drier/h							
	lb	*kg*	*lb*	*kg*	*lb*	*kg*	*lb*	*kg*
	5000	2268	7840	3556	10 000	4535	20 000	9070
Output at 10% mc – cwt	12.8		20.0		25.6		51.2	
kg	650		1016		1300		2600	
Wet grass – tons/h	2.9		4.5		5.8		11.6	
t/h	2.8		4.4		5.7		11.4	
Wet grass/tons/ 24 h	70		108		140		280	
t/24 h	69		106		138		276	

A number of factors particularly affect harvesting for drying. Harvester output is closely related to yield, especially if direct cutting, and grass for drying often has a lower yield than for silage eg 1.25 compared with 5 tonnes dm/ha. Where wilting is practiced, wind-rowing two or more swaths into one may help to maintain output, but it increases the risk of harvester damage by stones and other foreign matter. Harvesters for silage making work for up to 80% of their time in the field, compared with only 60%, or less, for grass drying in early season. The low yield of dry matter and low crop mc, with its associated low drying load, in July and August, severely strains any system which may have been adequate in early season, but is unable to cope with the doubled acreage which may need to be covered each hour to keep the drier functioning at maximum capacity.

At the drier a large number of handling systems, often requiring expensive equipment, albeit of limited capacity, have been tried. Many have been discarded in favour of the most simple system, of tipping crop on to a concrete pad, followed by loading the drier feeder, or an extension of it, with a front-end loader preferably mounted on an industrial tractor.

The most important requirement of any harvesting system is that

→ foot page 44

A system of mechanised feeding of grass silage from horticultural silos

by H W Whitton JP MA(Agric)

Requirements

ANY mechanical system for feeding silage to livestock will work at its best with wilted, precision chopped material. To be specific, the aim should be to make silage of 25–30% dry matter with an average length of chop of 50 mm (2 in) in a large quantity with uniform dry matter content and analysis. Moreover the silos or storage units should be as deep and high as practical to reduce external waste to a minimum. Silage clamps using 300 X 150 mm (12 X 6 in) RSJ's with 3.4 m (11 ft) above ground and 1.2 m (4 ft) below ground, set in concrete 1.2 X 1.2 X 1.4 m deep (4 ft X 4 ft 6 in) at 2.7 m (8 ft 6 in) centres and infilled with sleepers should give good economic storage units. A 'U' shaped five bay unit is the minimum size and this can be easily expanded. In general the silage can be stored in such a clamp to a settled height of 3.7 m (12 ft).

Filling the silo

Rapid filling of such a clamp with wilted, conditioned and precision chopped material at about 200 tonnes/d seems to give good average material when working with grasses. In our own operation, a Krone 2740 mm (9 ft) mower conditioner coupled with a New Holland 880 forage harvester driven by a Ford 7000 tractor and serviced by three tractors and trailers could perform to this level on a three and a quarter kilometer (two mile) haul. (See Table I).

This grass is bulldozed into the silo by a crawler tractor giving a six man team to ensile the 200 tonnes/d under optimum conditions. The bulldozer works across the pit filling in layers on the 'Dorset Wedge' system and no further consolidation is necessary. The resultant silage has an analysis fairly consistent between one season and the next and two seasons results are given in Table 2.

With present high feed costs it is vital to keep down waste and careful covering of the clamp with polythene sheet and sealing of the sides is vital. Our own silos hold 1,220 and 810 tonnes (1000 and 800 tons) respectively, with the larger for the first cut, and the smaller for the second cuts from pure stands of Italian ryegrass.

Mr Whitton is a partner in Whittons Kexby Farms.

Table 1 Silage harvesting 5 June 1973*

	Grass cutting	
Average width of cut	2.5 m	8.1 ft
Spot rate of work	1.26 ha/h	3.12 acres/h
Wet grass yield	35.7 t/ha	14.22 tons/acre
	Harvesting	
Overall rate of work	0.69 ha/h	1.72 acres/h
Spot rate of loading	0.88 ha/h	2.18 acres/h
Wilted grass yield – day 1	18.9 t/ha	7.53 tons/acre
day 2	20.7 t/ha	8.25 tons/acre
Overall loading rate	13.2 t/h	13.0 tons/h
Sport rate of loading	16.7 t/h	16.4 tons/h
Harvesting spot forward speed	3.55 km/h	2.23 miles/h
Average load per trailer	3.19 t	3.14 tons
	3190 kg	7042 lb
Average time to fill trailers	12.5 min	12.5 min
5 loads/hr equivalent to	15.97 t/h	15.72 tons/hr
Average time for return journey to clamp	19.6 min	19.6 min
Average speed on road	13.79 km/h	8.57 miles/h

**Source: ADAS Survey*

Table 2 Grass Silage Analysis*

	1972		1973	
	Dry matter basis	*As recd basis*	*Dry matter basis*	*As recd basis*
Dry matter %		25.2		27.0
Crude protein %	11.8	3.0	14.96	
Crude fibre %	35.3	8.9	29.20	
Calcium %	0.61	0.15	0.67	
Phosphorus %	0.32	0.08	0.43	
Magnesium %	0.18	0.05	0.20	
Potassium %	3.40	0.84	2.98	
Copper – ppm.	6.2	1.6	9	
Manganese – ppm.	47.5	12.0	45.5	
ph. (acidity)		4.0		4.24
Quality of fermentation – well made				
Est. starch equiv.	46	11.5	44.86	12.10
Est. digest crude protein %	7.3	1.8	10.45	2.8

**Source: ADAS*

Removal from the silo

Without care there can be considerable losses from secondary fermentation and waste when removing the silage from the silo. ADAS Farm Mechanisation Study No 23 compares various means of silo emptying and for detailed comparison I would refer you to it. I would merely pinpoint three factors:

(1) Top waste on bunker silos can vary from negligible to 250–300 mm (10–12 in) depending on how careful it was sealed.

(2) Waste on the silo floor can be considerable if it is not cleaned up daily either by hand or machine.

(3) A roofed silo does not of necessity ensure less waste.

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concluded from page 43

it should provide a reservoir of temporary storage, at least big enough to allow for a complete breakdown of field machinery lasting for up to 4 h, during which time repairs can be effected or a stand-by machine can be brought into service.

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Hydraulically driven Ensiloader 56 in wide.

Our own silos are unloaded by an 'Oswalt Ensiloader' which is a simple but robust machine capable of working in clamps up to 4½ m (15 ft) high. It comprises a chain-driven cutting reel, 1220 mm (4 ft) wide by 915 mm (3 ft) in diameter, mounted on a hydraulically-angled boom with its fulcrum point over the tractor driver's head. The cutting reel may be fitted with spring steel teeth or knives and moves over the silage face from top to bottom, normally by gravity, but also under hydraulic control. Silage falls into a collector at ground level where a cross auger carries it to an inclined conveyor which runs to one side of the tractor and delivers into a forage box, reversed end on to the rear of the unit. One of the

Ensiloader and 5·1 m³ (180 ft³) truck mounted Ensilmixer.

attractive features of this sort of loading mechanism is that the silage is shredded and well mixed. This should result in regular and trouble-free forage box discharge which should in turn promote even feeding and reduced wear and tear on the box. Power requirement to operate the loader is low and an old TE20 Ferguson was used. Loading rates of 450 kg (1000 lb)/min are attainable with this machine in grass silage, and maintenance costs of the unit which has been in use for three years handling 5080 tonnes (5000 tons) have been low. When performance data from the Ensiloader were obtained by ADAS in October 1970 it had only just been assembled. It is now modified to suit UK conditions with a big increase in performance.

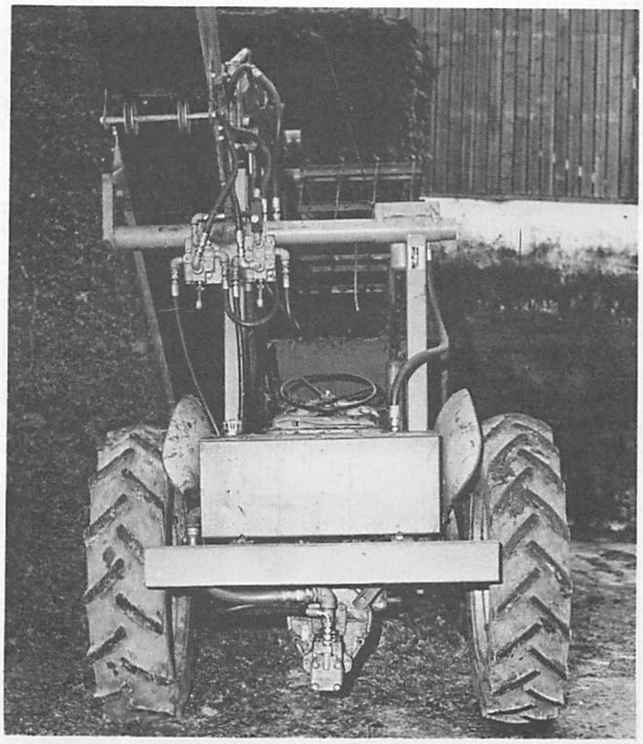
Feeding

On most farms today, silage is analysed before being fed and, on the strength of the results, rations are formulated. ADAS recommendations for our own feeding in 1972 were as follows:

(1) Dairy Cows – 27 kg (60 lb) of silage plus 3.6 kg (8 lb) of mineralised rolled oats would provide M + 9 kg (2 gallons) for Ayrshires.

(2) Beef Cattle – 225 kg (500 lb) beef cattle would need 23 kg (50 lb) of silage plus 1.8 kg (4 lb) of mineralised oats for M + 1.1 kg (2½ lb) daily gain. 450 kg (1000 lb) cattle would need 32 kg (70 lb) of silage plus 3.6 kg (8 lb) of cereals.

Although the concentrate portion of the ration is carefully controlled there is no factual appraisal of actual daily consumption of silage. One of the lessons we must learn from the USA is the concept of low cost production and least cost formulation. The addition of a weighing system to any forage box so that silage consumption can be observed and the most economic ration fed must be an advantage at current high cereal prices. It is in this context that uniformity of silage is vital if we are to use it efficiently. Moreover, high cost cereals make the opportunity cost of silage much higher. If barley is worth £50 per tonne it can be argued that silage is worth £9 per tonne as a source of starch equivalent and digestible crude protein.



Control layout; pump drive and mounting arrangements on hydraulic Ensiloader.

Electronic scale systems are available and have many years proven performance in feedlot feeding in the USA plus three years field experience in the UK. Therefore having added a weighing device to the forage box to weigh silage, why not use it to weigh the concentrates and feed both at the same time? The mixer-feeder trailer complete with scales provides one machine which will mix and feed complete cattle diets, including any mineral or urea supplementation. Ninety per cent of all beef cattle in the USA are fed complete mixed rations and an increasing proportion of dairy cows are being fed in the same way. Work there shows significant yield increases with complete ration feeding. (Table 3). Mixed feeds should, therefore, show two advantages in the UK. First ease of feeding and management and secondly improvements in performance of the cattle being fed. Our own commercial activities suggest a 7–10% better conversion than when feeding straights separately.

The 'Oswalt feeder/mixer' is amongst the most widely used of such machines in the USA. It is robustly constructed, simple in design and easy to maintain as it has few moving parts. We have used such a machine for two years to feed 400 head/d on a once a day basis in conjunction with a large crimping type mill which feed direct into the feeder. With a 7.5 kW (10 hp) motor, capacities of 45 kg (100 lb)/min are usual on oats, with barley at a higher level. The use of a high capacity mill does away with the need for finished product storage and simplifies the system.

Let us now run through the techniques of using this system of

Table 3 Milk production and composition

	Control[1]	*Complete ration*[2]
Milk kg/day (lb/d)	20.55 (45.3a)	21.95 (48.4b)
Milk fat (%)	3.69a	3.69b
Milk kg/day (lb/d)	0.75 (1.66a)	0.81 (1.79b)
Solids-not-fat (%)	8.77a	8.94b
Solids-not-fat kg/day (lb/d)	1.81 (3.98a)	1.96 (4.32b)

a, b values with different letters are significantly different (P 0.001).

[1] Concentrates based on milk production fed in milking parlour and dry hay free-fed in lot.

[2] Concentrates mixed with moistened, shredded hay and all free-fed in lot.

feeding. The cereal portion of the diet is rolled direct into the forage box, the scale system having previously been preset to the required amount. When this level has been reached, the mineral portion of the ration or other concentrated ingredients are then added; but for small amounts a spring balance is used as the digital scale work to a 4.5 kg (10 lb) unit. Whilst moving from mill to silo, the mixing unit is run to ensure complete mixing of the concentrate portion of the ration. With the mixing augers still running and the scale reset to the total weight of the feed, the silage is added until the warning light is illuminated. By this time, the contents will be completely mixed and ready for feeding.

Feeding techniques

With our lorry mounted box we feed all groups once a day on rations of silage with the addition of an average of 10% concentrate by weight. Each load feeds 100 animals or thereabouts and as D.M. intake increases, the proportion of the diet remains the same. Cattle have continuous access to food and clean up once a day. Feed bunks are always simple and all buildings have a feed passage for the lorry. With cattle at three farms 2½ miles apart, four lorry loads are fed in two hours and all feeding records are kept by the driver. The scale system can be used in reverse to weigh out the feed to individual pens of animals or to check assumed food consumptions. The whole feeding operation is thus controlled by one man who could feed up to 1000 head/d.

Electronic scale control unit.

The system

The complete ration system can be used with many varied ingredients and we have worked with chopped hay or straw mixed with urea/molasses and cereals. We have experience with maize silage and urea prills and also with by-products such as sugar beet pulp and brewers grains. The versatility of the system coupled with its simplicity and reliability are the major factors to commend it to the large scale feeder.

How much does it cost? Systems start for loader and trailer with scales at £6163.00 and should have a five year life with low maintenance costs and complete control of the feeding programme. A summary of the capital invested in the harvesting equipment is given in Table 4.

Table 4 Silage Harvesting capital costs 1973*

	Gross cost £	*Dep. in years* +	*Annual charge* £	*Interest on ½ capital at 10%* £	*Total charge per year* £
NH 880 Harvester 2740 mm (9 ft)	2,720	5	544	136	680
mower conditioner	1,230	5	246	61.5	307.5
Super Major	400	3	133	20	153
Ford 7000 (⅓ cost to silage)	2,973	5	198	99	297
Three 6 tonne trailers and silage sides.	427	7	82	57	139
(⅓ of cost to silage)+	150	—	—	—	—
					£1,576.5

**Source: ADAS Survey*

+ The silage trailer tractors have not been costed in.

Sources

Mechanised Silage feeding from horizontal silo's HMSO, London 1972.

D. L. Bath – Managing and feeding of large herds. Dairy Herd Management 1970.

MAFF – Mechanised handling and feeding of bunker silage.

Maize

R. H. M. ROBINSON, an enthusiastic maize grower, reviewed the current position and future potential of maize production in British agriculture. Maize production in Northern Europe started to develop in the late 1960s and since then, the area grown has risen enormously. In France the area rose from about ¼ million to 3 million hectares between 1965 and 1973 and in Britain from 400 to 10,000 hectares over the same period; the projected maize area for 1974 in Britain is 20,000 hectares. Whilst forage maize yields in Britain have been fairly consistent over the past seven years at around 5–6 tonnes dry matter/hectare for the whole crop, grain yields have fluctuated with the seasons, from 2–3 tonnes/hectare (15% moisture content), to the disastrous failure in the cold summer of 1972.

Seedbeds must be prepared carefully and the need for accurate drilling is very important, particularly for grain maize. Plant populations and drilling date have a big effect on the final yield.

One big advantage of the maize crop is that it can be utilised in many ways to suit the circumstances of the particular farm. At Hyde Hall (Dr Robinson's farm) the crop has been zero grazed, ensiled at about 25% dry matter, utilised as ground ear corn, and harvested for grain. In addition to normal feeding practices, maize silage lends itself for use in both winter and summer feeding as an extra energy supplement. The potential for grain maize is much less than for forage maize and it is advisable wherever possible, to regard maize as a single entity and not to distinguish between grain and silage varieties.

Maize is a crop with a big potential and there is a great need for more closer collaboration between the scientist and the farmer to enable its potential to be realised quickly.

Summary of a paper presented to the East Anglian Branch Conference on Mechanical Livestock Feeding 21 November, by R H Robinson, an Essex farmer.

Livestock feeding

by Bill Butterworth BSc (Hons) MIAgrE AMASAE MIMH

SPACE allows us to include only a brief summary of Mr Butterworth's stimulating and lively paper, presented to the East Anglian Branch Conference on Mechanical Livestock Feeding on 21 November.

In his paper Mr Butterworth argued that developments in the handling of livestock feeding materials are in his own words 'the biggest revolution since stock stopped walking to market.'

Materials Handling has more to offer to British livestock farming than any other applied science in the next five years, and can contribute—

- by securing greater finished output from existing resources such as men, land, feeding stuffs and stock
- by reducing costs.

There are three areas in which we need deeper study:

- better costings on techniques and machinery
- the practical application of better layout planning to reduce labour and machinery inputs
- new ways of exploiting the potential of existing equipment and rations with mechanisation and automation.

Costings

We are sadly short of cost surveys, but we do have some information from the NIAE and ADAS. For example, NIAE/ADAS Farm Mechanisation Study No. 23 compares different methods of unloading horizontal silos (Table 1)

Table 1 Horizontal Silo Unloading

Overall loading and feeding rates (man min/tonne)

Loading and feed method	*Overall time cost (man min/tonne)*	
	Excluding transport	*Including transport*
1. Fore loader and forage box	10.2 (21)	11.7 (21)
2. Slew loader and forage box	8.3 (10)	10.6 (10)
3. Fore loader into modified manure spreader	13.9 (6)	16.1 (6)
4. Buckrake, bucket or fork direct to feed point	10.6 (6)	12.5 (6)
5. Fore loader. Hand feed from trailer	23.5 (2)	26.0 (2)
6. Hand load and feed	68.7 (1)	70.0 (1)
7. Rear loader. Hand from moving floor trailer	29.2 (1)	31.2 (1)
8. Fore loader to shredder and belt feeder	13.0 (1)	15.0 (1)
9. Ensiloader to forage box	7.8 (1)	8.8 (1)

Having gathered such cost information, we may need to consider not only a choice between alternatives, but what balance of the possibilities is needed. For example, it is quite common in Germany for high protein silage from grass or legumes to be put into a tower with a clamp of maize silage alongside it. Both silages may be fed simultaneously. When the tower is empty in spring and the cows go out to spring grass the maize silage is loaded into the tower and fed from there.

There is a case in this country where a dairy farmer uses his machinery along American feed-lot lines, filling his tower ten times each year; one 50 ft tower feeds over 500 cattle. The lesson is simply that we need to make better use of our existing equipment.

Mr Butterworth is Senior Lecturer in Farm Mechanisation, Writtle Agricultural College.

Layout planning

The application of integration studies and feasibility studies can be used to:

- minimise costs of construction
- minimise managerial facility
- minimise inputs of labour, machinery, and other resources
- allow for future change and expansion.

Mr Butterworth used examples of pig feeding units to show how properly planned layouts can achieve these objectives.

Exploitation of the potential

We have known for some time that wet feeding of pigs has given significant advantages in labour inputs and feed conversion rates. Some work in this country has applied liquid feeding of concentrates to dairy stock, and work in the USA appears to indicate similar advantages with beef. This gives an indication of one way we can work out how to use equipment more economically and get better performance from stock.

To go one step further, having set up the right rations, it may be possible to use automated equipment in different ways to advantage. Work in this country with the automated feeding of pigs, and in the USA with beef, suggests that feeding 'little and often' may give advantages in conversion rates. Obviously, automation is necessary to make such systems commercially viable.

Conclusion

We need to study the detail of materials handling to cut our costs of production, improve our managerial control, and achieve better performance from stock. We already have many of the techniques in this country and we can look at research abroad for more ideas.

Plant, soil and water data

Methods for estimating evapo-transpiration

1. Evaporation pans

EVAPORATION pans should prove successful providing the following requirements are met:

(a) Standardise on pans of similar size, material, colour and position relative to ground surface.
(b) Clean regularly and prevent growth of algae.
(c) Minimise water level changes within pan.
(d) Select even, level, open site but not too exposed.
(e) Site upwind of irrigated areas (at least 100 m away).
(f) Prevent animals and birds drinking from pan.
(g) Pan coefficient used to correct pan evaporation to evapo-transpiration must be appropriate to area.

2. Atmometers

Atmometers have the advantages of simplicity, low cost and portability and so can be used in relatively large numbers for survey purposes. Their main disadvantage is that in dusty areas, dust changes the characteristic of the evaporating surface. Common atmometers are the Piche, Livingston and Bellani. A local correction factor is required.

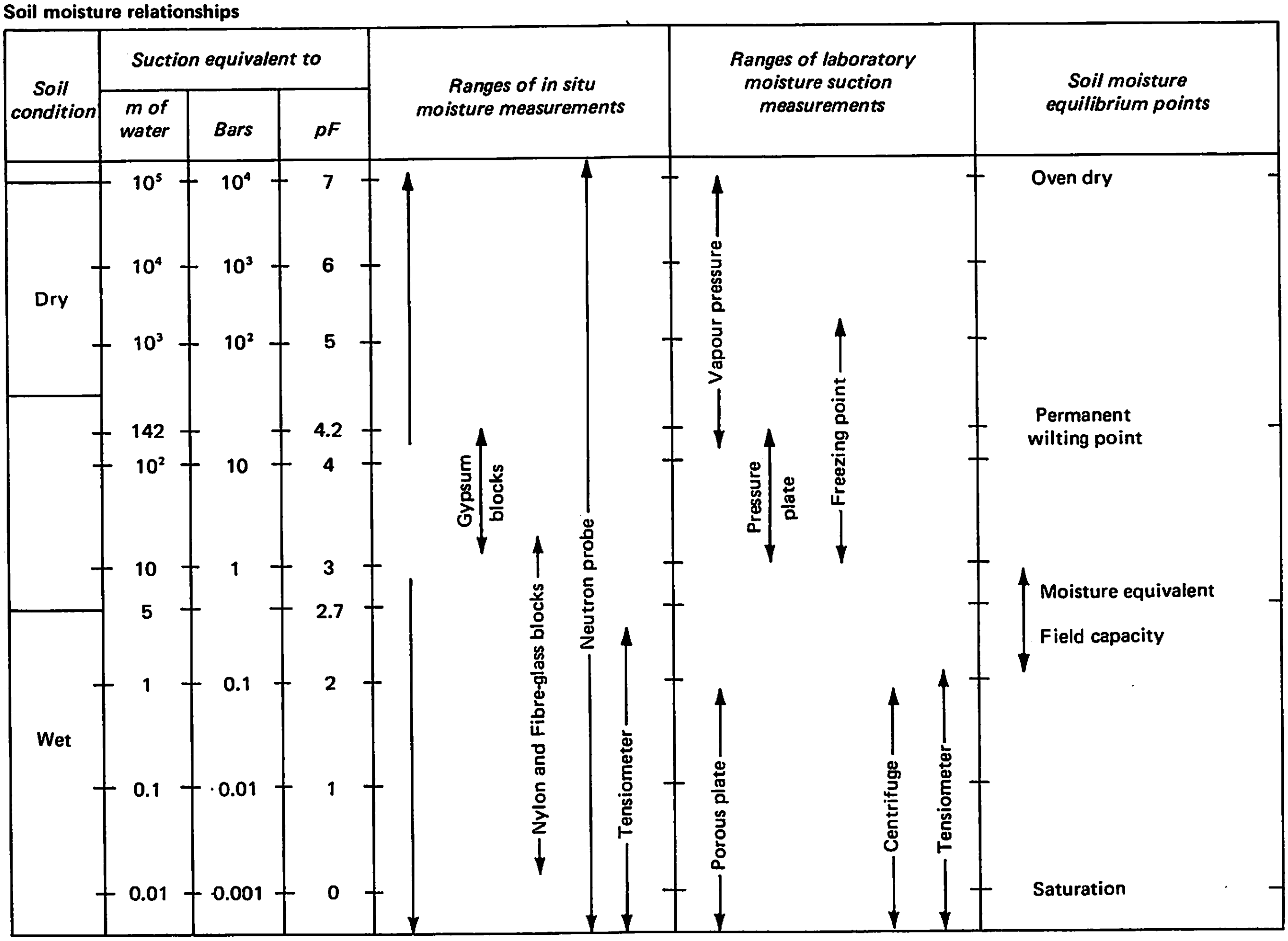
3. Penman equation

Widely used and tested, estimating monthly evaporation with an error of less than 10%. Can be used for weekly estimates. Meteorological data required for estimate is mean daily temperature, number of bright sunshine hours, wind run and vapour pressure of air. Local correction factors required to convert estimate to evapo-transpiration.

4. Empirical formulae

Main application is in areas where little climatological data is available. Most methods give fairly accurate estimates for the total evapo-transpiration over a season or year, but large errors can arise if used over short periods. Minimum period should be one month. When selecting a method for a particular area, first preference should be given to methods developed in areas with similar climate. Great care must be exercised when using crop factors developed in another area, wherever possible, the appropriate crop factors should be determined on site.

Soil moisture relationships



Method	*Climatic data required*	*Region where developed*	*Type of irrigation*	*Crop factor incorporated*
Blaney – Criddle	Mean daily air temperature	Arid	Continuous	Yes
Thornthwaite	Mean daily air temperature	Humid, well vegetated area	Supplemental	No
Turc	Mean daily air temperature Total short wave radiation	Humid, well vegetated area	Supplemental	No
Hargreaves	Mean daily air temperature Relative humidity at mid-day	Arid	Continuous	Yes
Olivier	Wet and dry bulb temperatures at specified times	General	General	Yes

5. Determination of crop factors and pan coefficients

These must be determined empirically, using lysimeters, in the area to be irrigated. The optimum agronomic and irrigation treatments must first be found and these practices used in the test. The test should be performed on a representative site and if possible within the cropped area. In arid regions, guard areas of at least 75 m must be provided.

6. Ranking of methods

Recommendations of Working Group on Practical Soil Moisture Problems in Agriculture, World Meteorological Organisation 1969, Technical Note No 97. Order of preference:

(a) Evaporation pans.
(b) Penman equation and atmometers.
(c) Empirical formulae.

Methods for measuring soil moisture content in the field

	Oven Method	*Electrical resistance block*		*Neutron probe*
	Oven Method	*Gypsum*	*Nylon fibre-glass*	*Neutron probe*
Nature of moisture content reading required				
Absolute mc	Yes	No	No	No
Volumetric mc	Difficult	Difficult	Difficult	Good
Change in mc with time	Yes	Yes	Yes	Yes
Change at same position	No	Yes	Yes	Yes
Continuous reading	No	Yes	Yes	No
Mc near surface	Yes	Yes	Yes	Difficult
Mc of individual layer	Good	Good	Good	Moderate
High soil mc	Yes	No	Yes	Yes
Suitability for different soil types				
Saline soil	Good	Good	Poor	Good
Cracking soil	Good	Poor	Poor	Moderate
Stony soil	Difficult	Moderate	Moderate	Moderate
Labour and capital				
Labour requirement	High	Low	Low	Low
Measuring skill	Low	Low	Low	Moderate
Maintenance skill	Low	High	High	Very high
Capital cost	Low	Low	Low	Very high
Reliability	High	Low	Low	High
Stability	Good	Poor	Moderate	Good
Time lag	One day	One day	One day	Zero
Soil disturbance	Excessive	None	None	None

Soil/water data

Soil texture	*Available water holding capacity mm/m depth*	*Infiltration rate mm/h*
Sand	80	50
Sand/loamy sand	(60 – 100)	(20 – 250)
Loamy sand	160	25
Sandy loam	(100 – 200)	(10 – 75)
Fine sandy loam	210	12
Very fine sandy loam	(190 – 250)	(7 – 20)
Loam		
Silt loam	240	10
	(150 – 280)	(5 – 15)
Clay loam	150	7
Sandy clay loam	(130 – 190)	(2 – 15)
Silty clay loam		
Clay	170	5
	(130 – 180)	(1 – 10)

Note 1. Figures in brackets indicate the range of values.
2. These values must be used as a guide only and wherever possible field measurements should be made.

Values for soil hydraulic conductivity are not expressed above, because soil structure has a much greater influence on hydraulic conductivity than soil texture. To indicate the order of magnitude, hydraulic conductivity values can vary from 30 m/day in coarse sands to 0.1 m/day in fine sands, from 3 m/day in sandy loams to 1 m/day in loams and 0.1 m/day in clays. However, the hydraulic conductivity of a clay can vary between 0.001 m/day to 30 m/day depending upon its structure.

Crop response to a moisture deficit at different stages of growth

The table lists the growth stages at which a plant is particularly sensitive, in terms of final yield, to soil moisture stress. In areas where water supplies are limited, best use can be made of the water, by irrigating during these sensitive periods.

Crop	*Moisture sensitive period*
Beans, broad	Flowering, pod swelling.
field	Flowering, pod swelling.
runner	Flowering onwards.
Cabbage	Throughout season, but especially at heading.
Carrots	Throughout season.
Cauliflower and broccoli	Throughout season, but especially at early stages of curd development.
Cereals	Flowering, grain swelling.
Cotton	Early growth period, flowering onwards.
Cucumbers	Flowering onwards.

INSTITUTION OF AGRICULTURAL ENGINEERS

West End Road Silsoe Bedford

APPOINTMENTS REGISTER

This service is available to members who wish to learn of vacancies in specific branches of agricultural engineering and the related services; it is also designed to assist organisations and employers to bring any such vacancies to the attention of persons who have a direct interest. It will operate in the following way:

MEMBERS

Broad areas of interest have been categorised and identified by a letter as shown below:

A. Design/Manufacture
B. Administration
C. Technical representation for manufacturer
D. Technical representation for distributor
E. Service for manufacturer
F. Service for distributor
G. Farmbuilding
H. Field Engineering
I. Education
J. Advisory

OTHERS

New categories will be included as and when it proves necessary.

NB: Members may wish to include details of qualifications and any other information which, it is felt, could help in ensuring that suitable information is forwarded; but this is optional. Any information will be treated as confidential.

Members wishing to use the scheme should write to:

J. Turner, Ryecotewood College, Thame, Oxon (Tel. 2501) indicating the types of vacancy on which they would like information and enclosing some stamped addressed envelopes up to ten in number, suitable for A4 or foolscap size papers.

As vacancies are notified, Mr Turner will arrange for photocopies of particulars to be forwarded to members who have expressed interest in the particular type of post involved.

This service will continue and the penultimate stamped addressed envelope, returned to the member, will contain a reminder that the supply of s.a.e's is almost exhausted. If the member wishes to continue the service, more s.a.e's should be sent. Particulars of vacancies will continue to be sent until either the supply of s.a.e's is exhausted or the member writes asking that the service be discontinued.

ORGANISATIONS/EMPLOYERS

Details of vacancies should be sent to:

J. Turner, Rycotewood College, Thame, Oxon (Tel. 2501) in a form suitable for copying by the thermal photocopying process. Copies of information will be sent to members who have expressed an interest in the type of work in question.

There will be no charge to either party for the service.

Groundnuts	Flowering, nut swelling.
Lettuce	Throughout season.
Onions	Throughout season.
Peas	Flowering, pod swelling.
Potatoes, early	Marbling stage.
maincrop	Throughout season.
Soya	Flowering onwards.
Strawberries	Bud formation, before picking.
Sugar beet	Throughout season.
Tomatoes	Fruit set onwards.

Sprinkler irrigation

Minimum height of risers

The recommended minimum riser heights to prevent turbulence being carried through to the sprinkler nozzle are:

Discharge m³/h	*Riser height m*
Under 3	0.15
3 – 7.5	0.22
7.5 – 15.0	0.30
15.0 – 36.5	0.45
More than 36.5	0.90

Spacing of sprinklers

In wind – free conditions, good uniformity of watering is obtained if the spacing is not greater than 65% of the wetted diameter of one sprinkler. In windy conditions, spacing perpendicular to the wind direction should be limited.

Average wind speed km/h	*Spacing*
No wind	65% of the diameter
Up to 7	60% of the diameter
7 to 13	50% of the diameter
Above 13	30% of the diameter (Conditions unsuitable for irrigation)

Friction losses in laterals

For good uniformity of water application, the pressure loss along a lateral should be limited to 20% of the operating pressure. The pressure loss is due to friction plus any rise in ground level. The frictional loss is found from pipe manufacturers charts or tables in conjunction with a correction factor F to allow for the effect of flow being reduced continuously along the pipe. If h_f is the frictional loss with the full discharge passing down the full length of the pipe, then the actual friction loss is equal to F X h_f, where F is a factor depending on the number of outlets, providing the first sprinkler is at a distance of 1/2 the sprinkler spacing from the inlet.

Number of outlets	*F*
1	1.0
2	0.639
3	0.535
4	0.486
5	0.457
6	0.435
8	0.415
10	0.402
15	0.384
20	0.376
30	0.368
40	0.364
50	0.361
100	0.356
More than 100	0.351

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The agricultural engineers manual

It was announced in 'The AGRICULTURAL ENGINEER' Volume 28 No. 3 that it might be possible to include some material originally prepared for the manual in future issues of the Journal.

The first sheets concerned with SI Units appeared in the last issue and were prepared by F. M. Inns. In this issue G. Spoor has presented some methods for estimating evapotranspiration for irrigation purposes suitable for routine use in agriculture.

A classification for sprinklers

Type of sprinkler	*Pressure range*	*Wetted diameter*	*Discharge*	*Equivalent rainfall*	*Comment*
Low pressure	10 to 30 lbf/in² 0.7 to 2.0 kg/cm² 70 to 200 kN/m²	30 to 80 ft. 9 to 25 m.	0.5 to 5.0 gal/min 0.15 to 1.5 m³/h	0.1 to 1.0 in/h 2.5 to 225 mm/h	Fair to good uniformity Tendency to large drop sizes? with large nozzle diameters, small wetted diameter with small nozzle diameters.
Medium pressure	30 to 70 lbf/in² 2 to 5 kg/cm². 200 to 5000 kN/m²	70 – 140 ft. 20 – 45 m.	2.0 to 20 gal/min 0.55 to 5.5 m³/h	0.13 to 1.8 in/h 3.3 to 45 mm/h	Good to very good uniformity. Suitable for most field applications.
High pressure	70 to 140 lbf/in² 5 to 10 kg/cm² 500 to 1000 kN/m²	110 to 400 ft. 35 to 120 m.	15 to 400 gal/min 4 to 110 m³/h	0.3 to 1.9 in/h 7.5 to 48 mm/h	Poor to good uniformity. Very sensitive to wind. Tendency to large drop dias. at end of throw. Wide variety of special-purpose sprinklers in this range.
Rain guns for Farm effluent	20 to 70 lbf/in² 1.4 to 5 kg/cm² 140 to 500 kN/m²	70 – 200 ft. 20 – 60 m.	40 to 150 gal/min 10 – 40 m³/h	0.2 to 0.9 in/h 5 to 18 mm/h	
Low angle	Usually adapted versions of low and medium pressure sprinklers.				As for low and med. pressure sprinklers. Low angle of trajectory intended to keep spray below foliage in orchards.
Frost protection	Usually adapted version of low and medium pressure sprinklers.				Good uniformity and low equivalent rainfall rates (1–4 mm/h) are required
Spray lines	Wide variety of types in low and medium pressure ranges.				Good uniformity on rectangular pattern. Most suitable for lawns and horticultural purposes.

Streamflow measuring devices for small discharges—a comparative table

Features noted on a scale 0 to 2.

Device	*Ability to pass sediment*	*Low head loss*	*Wide range of flow*	*Suitable for very low flow*	*Standard calibration*	*Simplicity of construction*
Weirs						
Thin plate (sharp crested)						
(i) V-notch	0	0	2	2	* +	2
(ii) Rectangular	0	0	1	1	* +	2
Broad crested	1	0	1	0		1
Flumes						
Parshall (USDA)	2	2	1	1	+	1
H-type (USDA)	2	2	2	2	‡	1
Trapezoidal	2	2	2	1		0

* *BS 3680 : Part 4A* + *USBR Water Measurement Manual* ‡ *USDA Agricultural Handbook No. 224.*

Reprint Service

CHANGES have recently been introduced in the reprint service offered to members of the Institution. The Editorial Panel has now made arrangements with University Microfilms Limited, St John's Road, Tylers Green, High Wycombe, Bucks., for THE AGRICULTURAL ENGINEER to be placed on microfilm from which enlarged copies of articles or papers can be obtained. Those members wishing to obtain copies of articles should now address their requests direct to University Microfilms Limited who will make a charge for this service at the rate of $3 each for articles and 8c. per page for complete issues. Charges will of course be made in sterling, the equivalent being obtained by conversion at the rate current at the time of placing order.

At the present time only Volume 28 is available under this service but it is planned to place earlier volumes of the Journal on microfilm in the future.

A few back numbers of the Journal are still in stock at Institution Headquarters and will be made available to members upon application. Once Institution Journal and paper supplies have been used up it will no longer be possible to offer members up to six items a year free of charge and post-free through University Microfilms Limited.

ADMISSIONS, TRANSFERS & RESIGNATIONS

The undermentioned have been admitted to the Institution, transferred from one grade to another, or have resigned.

ADMISSIONS

Companion

Whitsed J. W.	Huntingdonshire	14.2.74

Member

Dagg D. N. G.	Ethiopia	23.1.74
Lamond W. J.	Midlothian	5.2.74
Parkinson A. W.	Hampshire	5.2.74
Sudron E. F.	Kent	29.1.74

Technician Associate

Odufuwa S. A.	Ayrshire	5.2.74

General Associate

Balarajah J. T.	London	1.1.74
Darrell D. G. L.	Hampshire	5.2.74
Kinston I. V.	Berkshire	5.2.74
Lill J. A.	Lincolnshire	4.2.74
Mann R. D.	Bedfordshire	5.2.74

Graduate

Buckingham J. F.	Berkshire	4.1.74
Leonard J. J. B.	Australia	7.1.74
Knowles A. J. D.	Hertfordshire	4.1.74

TRANSFERS

Member

Burr J.	Northumberland	4.1.74
Key A. R.	Glamorgan	29.1.74
Lemon R. E.	Middlesex	23.1.74
Sparkes F. A. T.	Gloucestershire	24.1.74
Wain R. H. R.	Wiltshire	5.2.74

RESIGNATIONS

Companion

Harvey B. H.	Essex	12.73

Fellow

Bone G. W.	Suffolk	12.73
Collins F. L.	South Africa	10.73
Dearnley K.	Yorkshire	12.73
Hamblin H. J.	Beds.	12.73
Hollis L. C.	Shropshire	12.73
Mann S.	Lancs.	12.73
Rose E. C.	Australia	10.73

Member

Annandale J.	Cheshire	10.73
Cordy L. S.	Essex	12.73
Dalton R.	Lincoln	11.73
Hearn E. M.	Scotland	12.73
Howie J. B.	Glos.	10.73
White G. W.	Essex	11.73

Technician Associate

Roberts E. E.	Wars.	12.73
Westgate G. R.	Beds.	12.73

General Associate

Spearman J.	Northumberland	12.73
Webb T.	Somerset	11.73

Graduate

Brown S. R. N.	Ayr	10.73
Crallan B. R.	Notts.	12.73
Welsh C. M.	Perthshire	11.73

Student

Grice A. R.	Warwickshire	11.73
Orchard R. W.	Staffordshire	11.73

AROUND THE BRANCHES

Scottish

MEMBERS of the Scottish Branch of the Institution of Agricultural Engineers packed the conference rooms of Dunblane's Hotel Hydro for their 1974 Branch conference on 27 February.

The theme was 'Mechanisation of the Potato Crop' and, as a measure of the importance of damage-free crops of ware and seed to Scots farmers, Mr J. A. C. Gibb, national president of the Institution, commented in his closing remarks that attendance was far higher than at what was 'laughingly called a national conference' in the south of England.

A highlight of the day was the inaugural presentation of the Weir Shield and Prize for the outstanding craft apprentice of the year.

The silver tankard prize went to 19-year-old Thorald Munro, and the shield was claimed for J. Olding Limited, Coupar Angus, by service manager Bob Melville.

South east midlands

THE 1974 part of the winter programme had an unfortunate start, when it was found necessary, due to the energy crisis, to postpone the meeting at which Comte de Lauriston was to have addressed the Branch on the machinery requirements of the continental European farmer. However, with the help of British Petroleum Ltd, it has been possible to rearrange this meeting for 14 October 1974 and it is hoped there will be no hitches this time.

At the February meeting on 4 March, Mr A. J. Deaville of the Farming Representatives Department, Barclays Bank, presented a stimulating paper on machinery investment in agriculture from the point of view of a banker. He reviewed current sources of finance and discussed how banks were assisting farmers at present and possible future developments to meet changing needs.

THE INSTITUTION TIE

Members of the Institution are entitled to wear the Institution tie. As well as being an attractive emblem of membership in its own right it is also a particularly useful means of recognition at meetings, exhibitions, agricultural shows and other events at which members are likely to congregate. The tie is made of crease resisting and hard wearing terylene to a pleasing design displaying in silver the Presidential Badge of office on a background of navy blue, dark green or wine, according to individual taste. Institution ties are available strictly to members only and cost £1.50 each; any number may be obtained in any of the three colours mentioned. Remittances should be made payable to 'I Agr E' and crossed.

The Annual General Meeting was conducted very smoothly at short notice by Mr J. Weeks, in Mr G. Shepperson's absence through illness, and the new Branch officers and committee were duly elected. The President addressed the members at the end of the meeting and informed them of the changes in the Institution structure over the past year. The Branch Committee for the 1974–1975 session is as follows: Chairman – G. Shepperson; Vice Chairman – J. C. – Weeks; Hon. Sec. – G. Spoor, Hon. Treasurer – B. A. May. Ordinary members of the Committee: Messrs K. J. Benfield, D. J. Bottoms, D. A. Bull, P. W. Carpenter, A. L. Cox, A. P. Davey, J. R. Dawson, R. J. Fryett, F. M. Inns, W. E. Klinner, R. T. Lindsay, J. H. Neville, J. Russell, E. S. E. Southcombe.

Following the AGM. Messrs G. Biggar, D. H. Sutton, and D. W. Smith all from NIAE presented a very interesting paper based on their work in helping set up a mechanisation centre in Chile. They outlined some of the main background problems affecting the development of agricultural mechanisation in Chile and gave specific details on the setting up of a machinery testing service in the country. A mechanisation centre has now been firmly established and the speakers were hopeful that on the testing side at least, this centre will continue to thrive and develop under the leadership of the local people.

West midlands

THE West Midlands Branch held its annual dinner in April at which about 100 members and their wives attended. A raffle held during the evening gained £23 for branch funds. The highlight of the evening was the Annual Technical Award which was presented by Mr J. A. C. Gibb to David Ralph a former student of agricultural engineering at the Mid-Warwickshire College of Further Education. The award is made annually to non-corporate members of the Branch with the aim of stimulating the development of new ideas and techniques for equipment and machinery. David, who is now a senior apprentice at Massey Ferguson won the award for his invention of a dual tractor attachment for putting-in and pulling-out fence posts.

The new Chairman of the Branch is Mr Stafford Burley, Technical Services Manager at Massey Ferguson. He is a graduate in agriculture from Reading University and worked for several years for Massey Ferguson in France.

Yorkshire

'THIS week in Huntingdon no one used a plough for winter cultivations.'

Mr Brian Finney of ADAS, Cambridge, made this point in his opening remarks to the November meeting of the Yorkshire Branch held at Askham Bryan College. Mr Finney's paper on *Cultivations without the plough* explained the background to the changes in cultivation techniques that were taking place with new machinery and methods.

Traditional cultivations for cereals were compared with reduced cultivations and direct drilling techniques. In a topical point on energy usage the speaker referred to the power taken up by accelerating soil particles and showed that ploughing at 3.5 km/h (2.2 miles/h) required only half the kWh/ha of ploughing at 10.3 km/h (6.4 miles/h). Trials at Boxworth Experimental Husbandry Farm using the same energy criteria showed that the energy used per ha could be almost halved when chisel ploughing replaced conventional ploughing. The latter method would never disappear completely from farms as it gave control over weeds and disease carry-over.

Physical effects on the soil from differing cultivations were difficult to measure said Mr Finney and he doubted whether the yield measurement from the following crop was always a good criteria. The pattern of plant root growth was being investigated as an alternative but there seemed no definite relationship between root growth and yield. Penetrometers were used by the speaker to measure soil pore space and infiltration rates and the speaker also mentioned x-ray analysis of soil profiles. In soils where plough pans occur the direct drilling technique often showed better soil drainage patterns.

This year over 100,000 ha (250,000 acres) of cereals would be direct drilled mainly with trailed machines behind large two wheel drive tractors and a forward speed of 33 km/h (20 miles/h) was mentioned in one case. Mr Finney emphasised however the need for a good clean burn of stubble for this technique and the need to harrow afterwards to pull soil over the slits.

Powered direct drills although not suffering from this problem had an output of about 0.81 ha/h (2 acres/h). Although direct drilling had a potential energy saving per ha of 10–12% the cost of drills would limit their use to the larger farmer and contractor. Reduced cultivation techniques were applicable to many more farms and if it meant it was possible to get winter wheat in rather than spring barley this was worth an extra £4/ha (£10/acre).

MR J. WHITAKER, past Chairman of the Yorkshire Branch and for the past three years deputy chief safety inspector, speaking at Holmfield House, Wakefield, on 10 January, started his talk on the subject of *Is the farm a safe place?* by saying that though it can be said quite definitely that places of work such as mines and quarries have become safer places to work in since 1900, it is not so easy to determine if the same can be said about the farm. What is true, though, is that changes have taken place. Comparisons with other industries tend to be crude and not strictly comparable. A basis, which has been used by both industry and agriculture, for determining injuries, was absenteeism in excess of three days duration due to injury. Unfortunately there was no distinction between a minor or severe injury as they had in the past been classified as one. Figures given showed that in the following areas of work fatal accidents were 2.6 in food and drink, 11.9 in metal manufacturing, 0.7 electrical engineering and 0.2 for clothing and footwear industries. The average was 3.6 but in agriculture in 1972 it was 11.0. A further look at the total figures for 1972 showed that of the fatal accidents 50% were from falls, but in agriculture falls only represented 18.5% whereas 67% of fatal accidents in agriculture resulted from working with farm machinery.

Still looking at figures, of the non-fatal accidents in 1971 the ratio to workers employed was 1.64% (34,871 workers, 5,711 accidents), which compared very favourably with the rest of industry.

Mr Whitaker explained that there have been success stories in making the farm a safer place over the years, the prime example being the tractor, which had been the biggest cause of deaths. Following Swedish development of safety cabs and subsequent introduction of tests and regulations in this and other countries, more and more details of lives saved were being received.

Other success stories could be seen in the improvement of safety starter devices on tractors and the introduction of guards for pto shafts, pulleys, chains and conveyors. As the output/man hour was becoming more and more important the operator could not afford to be concerned unduly about his safety.

Other areas of concern on the farm were unguarded slurry tanks, dust problems from milling and grinding operations, which caused a condition known as 'farmer's lung', as well as adequate start and stop switches on electrical machinery.

In looking to the future Mr Whitaker said that there was a lot to be done to improve safety, though a lot was being done, with new designs and with more and more industrial techniques being applied. The pattern was definitely changing.

The search continued to find the absolute cause of accidents and that the Romans report which recommended a unified safety authority, would go a long way to help the safety aspect of industry in the future, though for the time being agriculture was not included as one of those industries. Similar regulations might well be applied to agriculture as and when the Agricultural Minister was able to bring in new regulations. With British standards, International standards and EEC controls, safety was improving.

Concluding, Mr Whitaker said that in answer to the question 'Is the farm a safe place' he would say that it is not safe, but that it was safer. A lot had been done and he congratulated those involved but encouraged them to do more and better in the future.

The next issue of The AGRICULTURAL ENGINEER will carry papers read at the IAgrE Annual Conference on 7 May. They are:

Implement coupling and control, by Dr M. J. Dwyer

Basic considerations and experiences with the Intrac-System 2000, by Dr A. Gego

Factors affecting the optimum speed for least cost tillage, by Mr F. Zoz

A systematic tractor range, by Dr A. Grecenko

BOOK REVIEWS

Green book

NOW in it's 23rd year, the *Green Book* has once again been completely revised and up-dated by Harry Catling MIAgrE, Head of the Farm Mechanisation Department at the Royal Agricultural College, Cirencester. The 1973/4 edition has been published for the first time in one volume (previously it has been published twice yearly in consecutive parts). Contained in the book are details of 83 tractors and over 1,600 items of equipment for use in agriculture, horticulture and forestry.

A photograph of each item is included, together with a brief description, including performance details. Items are classified into specialised indexed sections for easy reference. An extensive list of names and addresses of equipment manufacturers and concessionaires and an index of items introduced in 1973 are included.

For use overseas, a multi-lingual glossary of French, Spanish, German and Russian terms enables the book to be used by readers with a limited command of English. The glossary also provides a useful list of technical terms for English-speaking agricultural engineers.

The Green Book is published by Thomas Reed Industrial Press Limited, Saracen's Head Buildings, 36–37 Cock Lane, LONDON EC1A 9BY.

Simulation of nitrogen behaviour in soils

THIS book describes a simulation model for the nitrogen behaviour in a cultivated, aerobic soil with a high buffer capacity. The model attempts to integrate all the individual microbial and transport processes relating to nitrogen which occur simultaneously in the soil. The microbial processes of decomposition of organic matter and the nitrification of ammonia and the physical processes such as the movement of water, heat and nitrate are considered.

The computer programme is written in the language CSMP/360 and to profit from this book the reader should have a basic knowledge of a language like FORTRAN, DSL or CSMP.

The model presented is by no means in its final form, but it summarised the work carried out in Wageningen so far and should allow an exchange of ideas on this approach. The book also indicates areas where experimental data is needed to allow further model development and testing.

Simulation of Nitrogen Behaviour in Soils, J. Beek and M. J. Frissel. Publisher: Centre for agricultural publishing and documentation, PO Box 4, Wageningen, The Netherlands. Price: Dfl 12.50.

G.S.

The Editor welcomes copies of new books on agricultural engineering for review notices in this Journal.

OBITUARY

Anders Tomter

ANDERS TOMTER FIAgrE, Winchburgh, West Lothian, who went to Scotland from Norway in 1926 and served for 17 years with the Department of Agriculture for Scotland as a specialist in peatlands, died in November 1973.

One of his most notable achievements was the development of milled peat especially for horticultural use. The process was subsequently copied by many other countries.

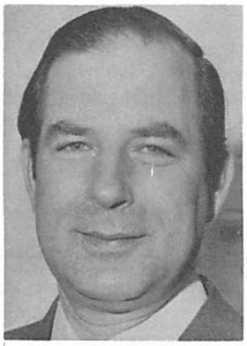
After his retirement, he continued working as a consultant and was concerned with the reclamation and management of many large peat bogs.

THE deaths have recently been announced of Sir A Glen FIAgrE and Mr R. H. Nocton MIAgrE.

PEOPLE

AEA

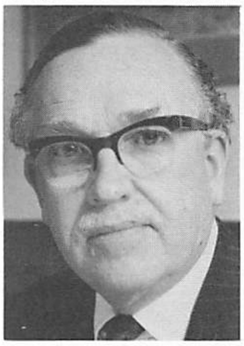
Mr W. T. A. RUNDLE FIAgrE, Chairman and Managing Director of Wright Rain Ltd, is the new President of the Agricultural Engineers Association; Mr Douglas Walker MIAgrE, Managing Director of John Deere Ltd, is first Vice President; and Mr G. E. D. Whitaker AIAgrE, Chairman and Managing Director of Sperry Rand Ltd, is second Vice President.



Above: W. T. A. Rundle

Left: D. Walker

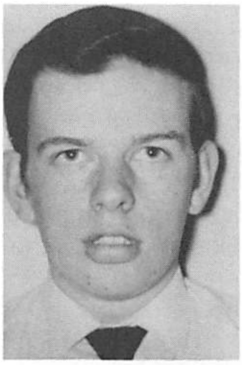
Right: G. E. D. Whitaker



SCHOLARSHIPS

THE following awards have been made in the gifts of the Institution to the following full time students of agricultural engineering during the academic year of 1973/74.

A Dunlop Scholarship was awarded to Roger Ian Fryer (23), who obtained an OND in engineering at Stafford College of Further Education in 1970. He spent two 6-month periods with an electrical engineering company while studying for the OND. In 1973 he was awarded a BSc Honours Degree in Mechanical Engineering by the University of Aston, Birmingham. His scholarship is being used to help finance his current MSc in Farm Machine Design studies at the National College of Agricultural Engineering, Silsoe.



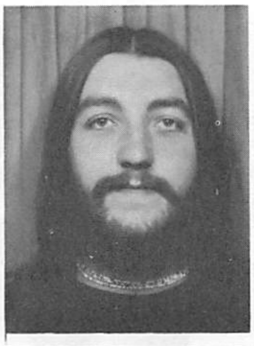
Shell-Mex & BP bursaries

Mr Frank J. Oppong (26) attended the Government Technical Institute, Tamale, Ghana, from 1964 to 1966 where he obtained his City and Guilds 260 Certificate. He then worked with the Ministry of Agriculture Mechanisation Division, Ghana, until 1969, when he became a Technical Instructor of Agricultural Mechanics at his former school. While an instructor, he obtained his 261 City and Guilds Certificate. He is now at the West of Scotland Agricultural College studying for the National Diploma in Agricultural Engineering.

Mr Michael J. Cottom (23) comes from a farming background and served an apprenticeship as a turner at BLMC (Truck & Bus Division). During this time he obtained a City & Guilds 293 Certificate. After completing a Government training course as a draughtsman, he worked for some time in jig and tool design and recently passed an HNC Bridge Course at Liverpool Polytechnic. He is now at the West of Scotland Agricultural College studying for a National Diploma in agricultural engineering.

Mr Stanley B P McCullagh obtained an agricultural diploma at Shuttleworth Agricultural College in 1960, and then had two years farm experience in England. From October 1962 until March 1971 he was a Senior Field Officer in East and Central Africa concerned with Agricultural Advisory work. He is currently studying for his National Diploma in Agricultural Engineering at the West of Scotland Agricultural College.

M. J. Cottom



F. J. Oppong

Stop Press

MR RAY FRYETT AssocIGasE FInstPet AIAgrE, who has been Acting Secretary of the Institution of Agricultural Engineers since 1 January 1974, was appointed Secretary on 1 May 1974. The President will be giving further details of the new secretarial arrangements in the next issue of The AGRICULTURAL ENGINEER.

Dunlop Scholarship

By courtesty of Dunlop Ltd,
the DUNLOP SCHOLARSHIP will be available for the 1974/75 academic session.

For further particulars apply to:

Secretary:
Institution of Agricultural Engineers,
West End Road,
SILSO, Bedford
MK45 4DU

not later than 1 August, 1974.

The Institution of Agricultural Engineers

Developments in Food Processing

A conference to be held on Tuesday 1 October, 1974
at Shuttleworth Agricultural College, Old Warden,
Biggleswade, Bedfordshire

THE planning and direction of primary food production in capital-intensive agriculture is becoming increasingly influenced by food purchasing, processing and marketing organisations and, as a consequence, agricultural engineers and food processing operations on the farm or in agricultural areas are becoming more common and often represent an extension of the techniques for livestock feed processing with which agricultural engineers have been concerned for many years.

The conference seeks to explore these trends and developments, to bring agricultural and food processing engineers together and to examine areas of mutual interest.

Papers on the following subjects will be presented:

Paper 1. Trends in the production and processing of farm-produced food materials for human consumption, by Dr R. Scott, Food Science Department, University of Reading.

Paper 2. Trends in food processing techniques and operations, by G. Evans, ICI Ltd, Colworth House, Bedford.

Paper 3. Food preparation and processing operations on the farm, by A. O. Roberts, Mather & Platt Ltd, Manchester.

Paper 4. Packaging and transport of locally-processed food products, by F. A. Paine and R. R. Goddard PIRA, Leatherhead.

Programme

10 00 Arrival, Coffee.
10 30 Paper 1, including 10 minutes for questions.
11 20 Paper 2.
12 00 DISCUSSION on Papers 1 and 2.
12 45 Lunch
13 45 Paper 3.
14 30 Paper 4.
15 10 FINAL DISCUSSION
16 00 Closure, Tea.

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