# JOURNAL AND PROCEEDINGS
# OF THE
# INSTITUTION OF AGRICULTURAL ENGINEERS

VOL. 18 NO. 4 - OCTOBER 1962

# JOURNAL AND PROCEEDINGS OF THE INSTITUTION OF AGRICULTURAL ENGINEERS

**VOLUME 18 - NUMBER 4 - OCTOBER, 1962**


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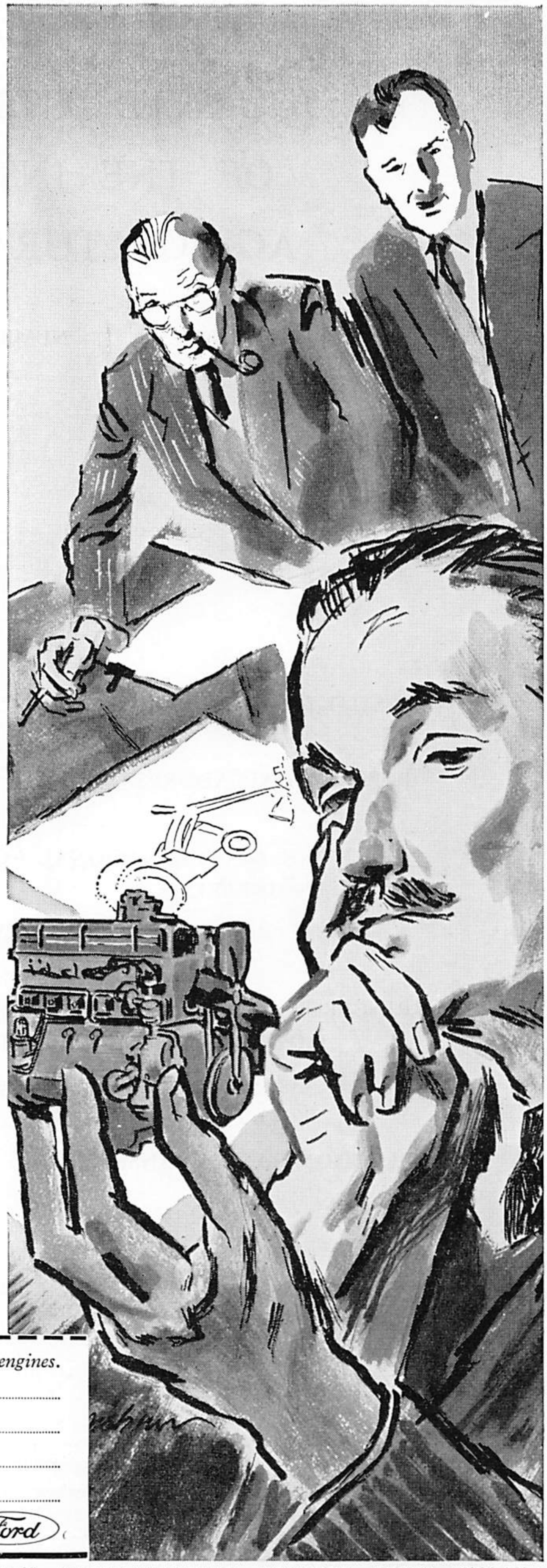

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# INSTITUTION NOTES



### All-Day Meeting at the Royal Society of Arts

THE first all-day Open Meeting of the Institution was held on Tuesday, October 16th, at the Royal Society of Arts. Over 80 members and visitors attended, and in spite of distances to be travelled, the Branches were well represented. Encouraged by the success of this experiment, Council is planning further such meetings.

### National College News

One of the highlights of the all-day Meeting was the Principal's Paper on the work of the National College of Agricultural Engineering, which is reported in this issue, together with the lively discussion that the Paper evoked. His audience were pleased to hear Dr. Payne say that building on the permanent site at Silsoe has now commenced. For this session the College has 20 students at the Ford Mechanisation School at Boreham in Essex.

Mr. Ian Gibb, Chairman of the Institution's Education Committee and Deputy Chairman of the Examination Board, has now joined Mr. John Chambers and Mr. Alexander Hay as Institution representatives on the Board of Governors of the College, succeeding Mr. Douglas Bomford. Mr. Bomford's guidance, from the first days when the establishment of a National College was first urged, has been invaluable, and the Council would like to take this opportunity of expressing appreciation to him.

### Other Education News

On completion of the 1962 examinations, Mr. Alexander Hay announced his retirement from the position of Chairman of the Examination Board. The President, Mr. C. A. Cameron Brown, said the Council received Mr. Hay's resignation with regret and paid tribute to his long, effective service and great contribution to agricultural engineering education. Mr. Hay has been Chairman of the Board since its first meeting on October 1st, 1951, and the Institution will continue to profit from his work on the Academic Committee and Board of Governors of the National College. The Council and the Examination Board are fortunate in his consent to remain a member of both bodies.

The Chairman of the Board for 1962/63 is Mr. D. I. McLaren, Head of the Mechanisation Division of the National Institute of Agricultural Engineering, a member of the Examination Board since 1955 and Deputy Chairman, 1961/62. The new session of the Board opened with a visit by Mr. McLaren, Mr. Gibb and the Secretary to the North-West Wiltshire Area College of Further Education and the Lackham School of Agriculture, which train students for the Intermediate N.D.Agr.E. and Membership examinations respectively.

The Membership examination has recently been revised, and the Regulations and Syllabus are now available from the Secretary. Members and other enquirers who have written to the Secretary in the past year for details of this examination will shortly receive their copy. The Examination will be held for the first time in 1963 ; candidates registered under the Regulations of the Graduate Membership Examination will, however, be examined on that syllabus, together with students already on approved agricultural engineering courses at the present time. A short article on the new Examination appears on page 118 of this issue.

### Appointments of N.D.Agr.E. Holders

It is important, of course, to remember the end product for which our examinations are designed, and we were pleased to hear recently that Mr. J. B. Underwood had been appointed Technical Representative by Penney & Porter Ltd. for Essex, Hertfordshire, Buckinghamshire, Hampshire, Surrey and Kent. Mr. Underwood gained his N.D.Agr.E. in 1959 and joined his present Company in 1961 on completion of National Service.

### Liaison with the American Society of Agricultural Engineers

The Secretary recently met Dr. Arthur W. Farrall, President of the A.S.A.E., on the occasion of a brief and busy visit by the latter to this country. Greater co-operation between our two bodies was a major topic of conversation, and Council is giving consideration to the implementation of closer liaison. The American Society plays a major part in agricultural engineering education and sponsors courses at various Universities in co-operation with the industry.

The pattern of American agricultural engineering education is shown in Fig. iv of the Paper on the National College by Dr. Payne, who spent the early months of this year in the U.S.A. Also across the Atlantic recently were Council members Mr. A. T. Gilling, Mr. W. J. Nolan and Mr. H. C. G. Henniker-Wright.

*Institution Notes Continued on page 118.*

# INSTITUTION NOTES CONTINUED

### Appointments Service

The attention of members interested in using their training and experience abroad is drawn to page 142 of this issue, where details of an appointment in the Public Service of the Northern Nigerian Government are given. Members are again reminded that a monthly list of posts available may be obtained regularly from the Secretary.

### Representation on the British Standards Institution

Mr. W. J. Whitsed is now acting as Institution representative on one of the B.S.I. Panels—Iron and Steel for Agricultural Machinery.

### Award by Institution of Mechanical Engineers

Mr. T. C. D. Manby, M.Sc.(Eng.), B.Sc., M.I.Agr.E., has been awarded the prize known as " Engineering Applied to Agriculture Award " (1961) for his Paper on the " Measurement of Tractor Performance," presented at the Symposium on Agricultural Tractors held by the Institution of Mechanical Engineers in November, 1961.

### Institution Tie

Following the announcement in the last edition of the Journal that an Institution Tie would shortly be available, numerous orders have been received. It is regretted that it has not been possible to fulfil these, owing to unexpected manufacturing delays, but supplies will be shortly forthcoming. Order forms are still obtainable from the Secretary for the tie, the design of which has been based upon that for the Presidential Badge, with a dark green or blue background as preferred.

### Articles for the Journal and Correspondence Column

The Editor will be very pleased to receive from members articles for consideration for publication in the Journal, or indications of articles which they would wish to see published.

Letters to the Editor will also be welcomed, and it is hoped that a correspondence column will become a regular feature in future editions.

### Special General Meeting

The Council's proposed amendments to the Memorandum and Articles of Association, previously circulated to members, were considered at the Special General Meeting held at the Royal Society of Arts on October 16th last, and were adopted.

It was agreed at the meeting that a letter should be sent to all members setting out in detail the reasons which led to the proposed increase in subscriptions. This letter is being sent with subscription renewal notices and will reach members shortly.

### European Agricultural and Industrial Fair

The third European Agricultural and Industrial Fair, ELMIA 63, will be held in Jönköping, Sweden, from 6th to 16th June, 1963. Advance publicity tells us that building problems and mechanisation in the farmyard will be foremost in the agricultural section. The organisers report that large areas for direct display have been booked from overseas. Further details are available from the Secretary, Institution of Agricultural Engineers.

### Annual General Meeting and Annual Conference

Will members please note that the date of the Annual General Meeting and Conference has been changed from Tuesday, April 23rd, to Thursday, April 25th, 1963. A notice with full details will be sent in due course.

National Institute of Agricultural Engineering.

## THE INSTITUTION EXAMINATION

The Institution Examination " for candidates who desire to become corporate members of the Institution " (a quotation from the Regulations) will shortly replace the Graduate Membership Examination. The changed title not only corresponds to that of the membership examinations of other engineering Institutions, but has a practical significance. Recently an increasing number of enquiries concerning admission to membership have been received from applicants of corporate membership calibre, but lacking a formal qualification in agricultural engineering. These applicants fall into two categories—the first group have been drawn into agricultural engineering by the application of another science such as electrical engineering ; the other group prepared themselves to enter agricultural engineering at a time when a course at professional level in the subject was not available to school-leavers, and so the group generally trained in agriculture or engineering. This does not mean that they are very old ! The first N.D.Agr.E. course commenced in 1951, and a youth of 18 in 1945 is only 35 to-day.

Thus the title of Graduate Membership Examination has become inappropriate. The increasing number of students entered by agricultural engineering and farm mechanisation training centres, however, means that there will continue to be a steady intake of younger members to the transitional grade of graduate.

But the new Examination represents more than a change in title. An increased minimum period of training is now required—two years' full-time or three years' part-time—on the one hand, in view of the improved training facilities since the Graduate Membership Examination wsa instituted in 1958 ; on the other, in view of the fact that candidates will now be required to do five Papers instead of four.

Like the old syllabus, the new demonstrates that this branch of engineering is unique in having two basic sciences—agriculture and engineering ; but, in addition, it to some extent reflects that diversity of special aptitudes of the agricultural engineer, for the new syllabus introduces Farm Mechanisation Management and Field Engineering. It is expected that the latter option will be of particular value to Land Drainage Officers and to overseas candidates.

# THE FULL ELECTRIFICATION OF BRITISH FARMING

## PRESIDENTIAL ADDRESS

by C. H. CAMERON BROWN, B.Sc., M.I.E.E., M.I.Agr.E.

*Presented at an Open Meeting on 16th October, 1962*

ON looking back over nearly 40 years of personal activity devoted in increasing, and eventually entire, degree to the various problems involved in applying electricity as effectively as possible to agricultural practice and production, I cannot do better than start by referring to a relevant statement which I appear to have made in 1940*.

In drawing attention to the need for a due sense of the proportion and place of electricity in agriculture, I quoted from what must surely now be regarded as a historic Paper by Dampier Whetham to the R.A.S.E. in 1924†, in which he directed to both mechanical and electrical engineers an appeal for a due sense of proportion in regarding their place in the farming picture. He had in mind, of course, the basic and tremendous natural energies of Nature towards the effective release and utilisation of which the farmer's basic, and still main, activity is directed.

Since that day, of course, mechanical engineering—mainly in the form of " field mechanisation "—has developed to a degree which could hardly have been anticipated in 1024, and the horse-power-hours of man-directed mechanical energy must now reach a total of some significance in relation to the nation's power applications. Even then, however, the annual four million horse-power-hours of energy made available to each acre by the sun still put man's 80 or so horse-power-hours of arable field power into humble perspective ; and yet the equivalent use of electrical energy—say, 20,000 to 30,000 kW.h.—on the average farm each year would revolutionise the economics of effecting supply to farms !

Electricity, however, has never, in any substantial degree, attempted to trespass on Nature's privilege, so far at least as farming proper is concerned, and none of the various attempts to apply electricity to basic farming processes, either as field power or as some electrical crop treatment, has shown any practical advantage. (I am deliberately excluding horticulture where circumstances are quite different, but which I hope to be forgiven for describing as having a comparatively minor part to play in British agricultural engineering.) Indeed, it is only within the past year that I have received personal information—not, so far as I know, confirmed in publication—that the most extensive attempt ever made to apply electricity to agricultural field power has quietly been abandoned by the Russians.

It is, I think, only right to refer in passing to the persistent but fruitless attempt over many years by the late Andrew McDowall to demonstrate in Scotland a case for electrical field power ; the latest attempt in Norfolk to establish a practicable technique for the McDowall idea does not appear to have found the English more easily attracted. It might not be unreasonable, however, to accept the various attempts—in particular those of the Russians—as indicating that should some catastrophe, or sheer exhaustion, dangerously deplete our national oil resources, we could at least carry out the basic and heavier field work by electrical means.

Nevertheless, despite electricity's failure to affect basic agriculture, it would be no exagggeration to say that over the past 25 years the subject of rural electrication in general, and farm electrification in particular, has been one of the most outstanding and persistent subjects of debate, controversy, speculation and, I venture to say, achievement. Such progress as has been made, both in affording supplies and in developing consumption, has proceeded to a running accompaniment of criticism and injunction which would seem at first sight to belie my earlier suggestion that electricity has no *prime* part to play in farming proper.

Indeed, I might, perhaps, be allowed to dwell in passing on *rural electrification per se*, if for no better reason that in the course of time some sort of " near-mystique " has been placed on it and it has, as a result, gone through most trying and, indeed, exciting days of controversy and discussion, rising to the floors of both Houses of Parliament—not to forget the letter columns of *The Times*.

It might, indeed, be no exaggeration to suggest that the nationalisation of the electricity supply industry was largely and finally agreed on the grounds that it would ensure the large operating unit with the stronger economic " urban-rural " balance necessary to carry the less viable rural areas. Even so, all the groupings have not enjoyed the same strong position—the South-Western Board is probably the outstanding example of a largely rural area lacking any strong industrial element. Even the Merseyside and North Wales Board, despite its powerful industrial and commercial element, is finding the responsibility of handling North Wales a serious financial burden indeed. Nor could the North of Scotland area gladden the heart of an electrification planner—at least, one with overall economics to consider.

But while to the " man in the street "—indeed, even to most agricultural engineers—rural electrification boiled up only with the post-war surge of general

* Tech. Report W/T2 : Electrical Research Association, 1940.

† C. Dampier Whetham : " Electric Power in Agriculture," *Journ. R.A.S.E.*, Vol. 85, 1924, p. 246.

nationalisation, the subject and its problems, economic and technical, have been actively—and even hotly—debated in electrical circles over the preceding quarter-century. There is, to my knowledge, no reliable record of the first farm in this country to be supplied with electricity ; I have known that in 1912 an electric motor was used on a farm in Sheffield, of all unlikely places, in the agricultural sense, but there may well have been much earlier instances.

But soon after the " first " war electrical engineer were in full voice on the new problems arising, and " fringe " rural schemes were opening out in the '20's. By the end of the decade the technical and economic problems of effectively supplying entirely rural areas were being authoritatively debated and consolidated schemes were being laid out. Bedford, Norwich and Chester were the urban cores of three such schemes, but the Dumfriesshire County Council Scheme was started in the mid-thirties as a large-scale scheme neither based on, nor connected with, an urban undertaking. At the same time—and almost entirely unsung—many of the Company Undertakings were quietly dealing with much of the rural areas covered by their authorisations—some of my earliest work was done on farms supplied by the Wessex Company and in conjunction with engineers who later became my colleagues in my short but hectic interim with " private enterprise," when I joined Edmundsons in 1945. This was one of several electricity supply organisations which recognised that economic farm loads could not grow by themselves, or by chance, and that if the supplier complained of poor and unremunerative farm loads he might take a hand at helping the farmer to improve the situation by providing experimental and advisory services. On nationalisation this principle and policy was absorbed by the British Electricity Authority, which expanded Edmundsons' small unit into their Agricultural Electrification Section, which has survived through the various changes of organisation to the present days of the Electricity Council.

The same principles and policies were recognised and applied by the Electricity Boards—not least the Scottish Boards—responsible for the development, and day-to-day maintenance, of economic supply in rural areas. While there are *other* users of electricity in rural areas, the farm—and the farmer—has from the first taken pride of place both as a problem and as an absorbing study towards its solution.

Farm electrification is, of course, only part of the wider field of rural electrication generally ; *i.e.*, the extension of supply to premises outwith the more concentrated urban collection of houses, shops, factories, etc., which go to make up by far the majority of the electrifiable premises in England and Wales. I need hardly dwell on the basic, and obvious, difference between the two categories when it comes to considering the respective economic problems presented to the would-be supplier, and deserving some appreciation by the would-be user, of electricity. The denser urban conditions, despite the physical and economic disadvantage of under-pavement cabling and underground cable services, require on a rough average a capital expenditure of some £40 to £50 per consumer supplied. The equivalent *overall* rural figure is some £150 to £200 per consumer ; if we isolate farms, the particular subject of this Paper, their cost is of the overall order of double this figure. For the outstanding 15% of farms—mainly in the more difficult hill areas—still to be supplied, capital expenditure of the order of £500 and more per farm has to be faced, and it is no unusual case to find the cost approaching, or even substantially exceeding, £1,000 for supplying a single farm.

Without going into all the basic details involved, I would say that the capital cost of supplying a farm, as well as the cost of supplying any electricity used, must be met out of the revenue from the farm. Sometimes the Electricity Board will ask for a contribution towards the capital cost, but this rarely meets anything approaching the full outlay. Thus a small part of the cost of each kW.h.—" unit," if you like—goes to meet the capital outlay incurred by the Board in giving supply. By and large, therefore, the more electricity used by the average farmer the less economic liability rests on the shoulders of *other users of electricity.*

Whether or not I have made my point any clearer than it may well have been to you long ago, I am trying to emphasise the urgency, in our supply and tariff system, for the farmer to use as much electricity as possible towards making his supply arrangements *economic to the Electricity Board.*

*My* responsibility, and that of hundreds of my colleagues, many of whom are full-time specialists at the job, is that of evolving and applying methods of enabling the farmer to use as much electricity as possible in ways which are in themselves *economically and operationally attractive to the farmer.*

At the same time, these methods, single or together, must impose the minimum possible load—demand or power—on the supply system as a whole. The significance of this factor in the economics of supply is simplified for the many farmers who are each supplied through an individual transformer. It is, for instance, readily clear to a farmer supplied through his own 15 kVA. transformer (roughly 15-h.p.) that, if he insists on using a 25-h.p. motor for some purpose or other, the transformer will have to be replaced by a larger one and that the overhead costs of supplying him with electricity will be increased. Such increase, too, is reflected—though in diminishing impact through " diversity "—right through the supply system. If, however, this farmer can use a smaller machine, calling for, say, 12·5-h.p., the same transformer can carry this with ease, provided no other simultaneous load, or loads, take the total demand much over the 15 kVA. capacity of the transformer.

Other " fuel " industries have similar problems to consider, as my distinguished predecessor might well remind me, but they each—oil, coal, gas—have an asset which is not available to the electricity supply industry —" storage "—not available to us, at least on the scale involved.

But, if we cannot store *electricity* we can in many cases store the *product of the process*—ground grain, water, heat, CAN be stored and one of our most interesting jobs has been to develop the various techniques involved. Steam sterilising is now very much a thing of the past, but in its heyday we replaced direct steam raisers of up to 30 kW. loading by hot-block and " pressure-storage " steamers of no more than 2 kW. loading. Grain-grinding on the farm is on the up-grade again, but I doubt if any farmer would now install one of the 10, 15 or even 20-h.p. mills so familiar during the 30"s and the modern automatic mill of up to 3 or 5-h.p. is now the accepted tool. The storage of heat in brooding floors and blocks is not, of course, completely in the same line of thought, but rather to take advantage of a lower tariff for night use ; nevertheless, it enables a smaller transformer to be utilised than would be required if the heating load was imposed on top of the normal daytime loads.

All this involves some, and varying, degree of agricultural engineering skill, experience and vision, and the story of the development of electro-farming applications in the United Kingdom stands comparison with that of any other country. Indeed, I have particularly good reason for believing that we are ahead of most if not, indeed, *all* other countries in range and enterprise in the matter of farm electrical processes.

The social and operational value of electricity in rural areas generally, and on farms in particular, is recognised all over the developed world, and different solutions have been applied towards reconciling the economic difficulty of effecting rural supplies with the provision of electricity at rates economically viable to both supplier and user.

In particular, there has been an active European " get-together " on this common problem, and since 1952 there has been in existence—and in action—a Rural Electrification Working Party, set up by and reporting to the Electric Power Committee of the Economic Commission for Europe. The Working Party has met annually in Geneva since 1953. While starting as strictly a " domestic body " in the European sense, the Working Party's activities have aroused much wider interest, and for some time now we have had " observer " representatives of U.S.A., E.C.A.F.E. and E.C.L.A. That the same Russian has been Chairman from the start, I having been Vice-Chairman, might be taken as indicating that our Working Party is performing satisfactorily.

I feel, too, that we fully deserve the sometimes anomalous title " Working Party," because we do actually *work* as well as discuss and debate. Since our inception we have prepared each year a technical and statistical report on " The State of Rural Electrification in Europe." In addition, where any one subject seems to call for more detailed study, one of our number is appointed as " rapporteur " to deal with it. Towards doing so he invites, and receives, relevant information from any country having such to give. Over our period of nine years' operation, five volumes of reports have been prepared and presented, comprising in all some 27 Papers on individual subjects ; of these, three have emanated from the United Kingdom, and I make bold to suggest that I have literally " worked my passage " on what has been an interesting and enjoyable association.

Some time after our first meeting in Geneva, it was suggested that " reading and discussion " were but a substitute for " seeing," and it was then arranged that before each annual autumn meeting the Working Party would be the guests of one of the collaborating countries in order to " see " what was being " debated." So started—in Russia in 1955—a succession of most interesting visits to Austria, Italy, France, United Kingdom, Western Germany, in that order ; by the time this Paper is presented, I hope to have taken part in this year's proposed visit to Finland and Sweden.

If I may seem to have dwelt overlong on this committee history, I have done so only to make it quite clear that I am fairly well placed for expressing an opinion on the relative standing of the European countries so far as rural and farm authoritative discussions with those highly knowledgable on relevant conditions elsewhere. And there is no doubt whatsoever that our own country stands well in the picture—I venture to say *well ahead* in many respects !

We are not, I am afraid, so well placed as some countries so far as " percentage of farms connected " is concerned. France, for instance, has been virtually 100% connected for many years. This also applies to certain other European countries where, for historical reasons, the farm buildings are in the actual village itself, thus presenting no such problem as we have, with our quieter history and freedom from invasion having encouraged the dispersal of farm premises. Nor are the returns of connections from different countries capable of direct comparison as relatively few list " farms " separately from other rural premises. We ourselves returned at March, 1962, a figure of 90% for " rural premises," but the percentage of farms connected was some 86·9% ranging from 96·8% for the highest Board to 73·9% for the lowest, due largely to this Board having a high proportion of " hill farms " in the area.

But time, strangely enough, has been in some way on our side. The French, for instance, had largely connected all their farms before the war, but did so on an almost " string and bobbin " basis with long low-voltage distribution lines. Thus, while quite well able to meet the lighting and occasional power loads of pre-war days, they are quite unable to build up the new utilisation techniques—even on the domestic side—which we now take for granted.

In our own country, on the other hand, while we had some interesting and some very enterprising rural schemes as far back as the 'twenties, they were, by and large, limited in extent. Thus the " battle " between the low-voltage distribution people and the high-voltage exponents was being fought on comparatively limited fronts, so that when the eventual general decision came with nationalisation in 1947 to use high-voltage distribution for our rural areas there was no great amount of low-voltage to be changed over.

There was, therefore, some considerable advantage, on technical grounds, in having a comparatively high percentage of virgin country to move into with modern methods of distribution and supply to farms. Thus, while we are still behind some countries in percentage of farms connected, we are behind none in form of service given and flexibility to cope with increasing needs.

I must, of course, remove any possible impression that we suddenly on nationalisation " invented " the high-voltage system of distribution. Far from this being so, there had been going on for possibly 20 years some degree of running battle between the users of low-voltage distribution, mainly urban systems spreading into the surrounding country, and those undertakings—mainly, if not wholly, " companies "—distributing at high-voltage with individual transformers at the farm, or group of smaller premises. Least of all should I allow to be overlooked that the early comprehensive system of rural distribution initiated by the Dumfries County Council in the mid-thirties was planned as a high-voltage scheme—and largely single-phase at that—from the outset.

One of my first jobs, on joining the staff of the Electrical Research Association just before the war, was to " sit in " on a committee under the Chairmanship of H. Willot Taylor (then of Edmundsons and later Chief Engineer of the Southern Electricity Board) to agree on a British Standard for a light high-voltage rural line suitable for rural distribution at 11 kV. This eventually appeared as B.S. 1320 and is now commonly used as our standard rural line. It may be worth mentioning that a significant feature is the horizontal placing of the wires, either two or three, which considerably reduces the impact of the line on the eye—a fact appreciated by C.P.R.E. ! An unfortunate outcome from this endeavour to reduce " noticeability," however, may well be the resultant substantial record of fatalities to swans in full flight and presumably less able to see the " single wire " profile ahead of them.

Much of the vast spread over our countryside of B.S. 1320 eventually reaches the farmer in the shape of two wires, giving him a single-phase supply, the high proportion of which and, I may emphasise, its satisfactory application, has surprised many of my Committee colleagues from E.C.E. who go to great expense to provide the more expensive three-phase supply for circumstances far from calling for it and only necessary because they would find large single-phase loads an embarrassing unbalance on their three-phase low-voltage distribution systems.

I am not, as some of my agricultural friends sometimes think, nor are my engineering colleagues, unaware of certain—and sometimes substantial—disadvantages of single-phase supply. But these apply practically only to *power*—the use of motors—and generally only because the single-phase motor and its control gear costs more to buy. The day of the single large motor on the farm has, however, largely gone with the disappearance of line-shafting and, in particular, with the almost universal adoption of the small automatic hammermill. The extra cost of outlay per process has therefore been considerably reduced. There is not the same difficulty with single-phase in meeting large *heat* requirement—even if this means bringing in a second transformer for the drying season !

In practice, the number of farms to any significant degree inconvenienced by having single-phase instead of three-phase supply must be small indeed, if only from the fact that they would be the larger farms, which are mathematically and statistically in the minority. In any case, where any undue hardship bears on a particular farmer, or group of farmers, some accommodating compromise can often be arrived at. Nor must it be forgotten that the flexibility of *high-voltage* single-phase offers, through change of transformer, the possibility of a 480-volt supply for large single-phase motors, or heaters, leaving the normal 240-volt supply for the smaller appliances and lighting. If the demand from the farm increases, all that is necessary is the fitting of a larger transformer—or even, in certain circumstances, simply the addition of another one.

### The Cost of Electricity for Farming

While the technicalities of rural distribution and supply have advanced steadily, the matter of the cost to the farmer of the product as delivered to him is of prime importance. Here, I am thankful to say, the position has also been encouraging. The average price per kW.h. sold has inevitably increased over the past quarter-century, but, owing to two basic factors, not by any means in proportion to general costs. Indeed, owing to (*a*) improvements in generating and distribution efficiency and (*b*) a fuller use of the product, the resultant average cost to the farmer in England and Wales of 1·678d. per kW.h. is in real terms only *one-fifth* of what it was 30 years ago ; that is to say, compared with retail prices generally, the price of electricity to farmers as a whole has declined by four-fifths. Inevitably as the general economic conditions vary from Board to Board, owing to the terrain and the economic balance of the areas concerned, some farmers are even better off and some not quite so well off in relative terms. But the farmer making reasonably full use of electricity will be by and large in a relatively much better position as compared with pre-war days.

The most favourably situated Board showed for last year an average farm cost of 1·441d. per kW.h., and the least well-placed Board the figure of 1·898d. per kW.h., the two prices being a very clear reflection of the economic and physical difficulties facing the respective executive groups in relation to giving supply to farms.

### How Fully are we Using Electricity on our Farms ?

In judging the fullness of use on farms, an assessment could be based on a comparison between the consumption per farm in our country and in others making returns to E.C.E. reports. Unfortunately, while this was done during the earlier years of E.C.E. reporting, it gradually became realised that there was nothing approaching either a commonly accepted definition of " farm " or a common method of assessing farm consumptions separately from other uses. Thus, our own 7.900 kW.h. per farm in England and Wales for last year looks feeble alongside the 100,000-plus kW.h. of a Russian " collective " farm, although in fact the range of use of electricity on our better-equipped farms far exceeds in range anything I have seen, or heard about, on a Russian farm.

By and large, I have good reason to believe that our average is about on a par with the U.S.A., if we leave out their *very* special irrigation pumping in the far west. We are, I believe, appreciably better than Germany or any other West European country ; we are well ahead of France—some six times, in fact. I am, of course, referring to that rather misleading, and sometimes dangerous, quantity—" the average." In fact, of course, we have in our own country some—indeed, many—of the leading farms in the world in respect of range of use and degree of consumption of electricity.

An outside observer might, if he looked more closely at our own returns, note that while our overall average for England and Wales is 7,900 kW.h. per farm, we can quietly point to the Southern Board with 11,000 kW.h. per farm, South Eastern with 10,500 and Eastern Board with 8,900 kW.h. If I dare trespass (in the electrical sense, though not in an Institutional sense), over the border we have the figure of 11,740 kW.h. per farm for the South of Scotland ; nor is the 9,049 kW.h. per farm of the North of Scotland area to be overlooked, although they do classify " crofts " separately but together with domestic premises and presumably with much more modest returns. In similar fairness to Boards " south of the border," I should make it clear that the figures of 5,200 and 4,600 kW.h. returned by the Merseyside and North Wales Board and the South Wales Board respectively include a large number of hill farms closely approaching highland crofts in meagreness of income and lack of economic outlets for using electricity. The North-Western Board must, too, have quite an element of small-farm users in their more northerly parts, as there is, too, in the South-West.

But if I am asked to reflect honestly and inwardly on these returns, and whether I am really satisfied that farmers are making the fullest practicable use of electricity *on the farm*, I must answer that I am not so satisfied. Indeed, I cannot but consider that we have only just made a penetration into this sphere of using electricity and that there is vast scope for further conquest.

To support me partly in such a reflection, I have to bear in mind that in making annual returns for our E.C.E. report I am asked to give an example of farms " making a good use of electricity." Each year in turn I telephone a different Board and ask for six of their better " electricity-using " farms, and almost by return post I have a list in detail of farms all using from 50,000 to 100,000 kW.h. per annum. There is nothing about the agricultural details given for each farm to suggest any particularly exceptional conditions and many more similarly placed—and sized—farms could well be using as much, although admittedly the farms given to me are generally over the average in size.

Our main task, however, is, I feel, not so much to bring in more of the " super-users " of electricity, the farms up in the 50,000 to 100,000 kW.h. and over, but to bring many more of the smaller farms into the 15,000 to 30,000 kW.h. mark.

**How can we Increase Average Consumptions ?**

One of our sorest setbacks was the practical disappearance of steam-sterilising on dairy farms. With our development of storage steamers charging at off-peak rates, we had a highly competitive proposition which has largely died with the wide acceptance of chemical methods. Admittedly, we have regained most of the lost consumption through the fuller use of hot water, and, of course, the Bulk Milk Tank calls for an appreciable use of electricity. With the more recently developing signs that *some* use of steam is considered to be of advantage, we have in mind—and in hand—simpler and cheaper methods of utilising electricity to the full in the smaller range of dairy farm ; at least, we are working actively towards the improvement of our economic position in supplying farms, more particularly those at the smaller end of the range.

In the sphere of treating and handling feeding-stuffs on the farm, largely calling for power and not such a good revenue earner as *heating* might have been, we have gone through an interesting cycle, or near cycle. Despite the somewhat sceptical acceptance by the farm machinery Press of the day of the idea of a very small hammermill working for long periods under automatic control‡, such a development was an inevitable concomitant to the use of the high-voltage-cum-transformer system of supply. And it has proved successful to an extraordinary degree ; to the degree, indeed, that the more forward-thinking provender firms are seeking, and passing on, knowledge as how best to combine the use and practice of farm feed preparation with some degree of purchased feeding stuffs.

In the sphere of crop drying there have been some particularly interesting developments all giving food for thought as how best, and to what extent, to use electricity. Taking green crops first, we cannot hope with electricity to " dry grass," other than in providing fan-power, because the high evaporations involved would call for very high electrical loadings and cost. If I may, however, classify the remaining processes as " hay drying," where there is indeed wide scope for electricity, we can simplify matters a lot. Perhaps it is better to refer to them as " hay finishing," because all the practicable electrical methods do rely on vast quantities of water disappearing " naturally " in some degree of wilting period.

Cold-blowing of hay—or "barn hay drying," as it is widely called—was the first of our developments in this line and was put into practice following basic work by the Electrical Research Association in 1945**. A rather more " sophisticated " method was later developed to speed up the drying and yet meet the limitations of cost imposed on a method of electrical *heating* by combining a period of preliminary cold-blowing at a high rate of airflow with a " finishing " period of low-rate blowing with air slightly warmed. While the earlier method turned out to be a method of safeguarding the production of hay, and generally of a good standard, the later

‡ E.R.A. Report W/T4 (1940).

** E.R.A. Report, Ref. W/T17 (1948).

produced a very high class of product indeed and well worth the extra cost involved††. The consumption of electricity for the two methods comes out at about 240 kW.h. per ton and 600 kW.h. per ton respectively.

While we considered that we had in these two applications a promising outlet for using electricity and doing something towards reducing the financial leeway in rural electrification, the actual extent of application has been disappointing. It is made the more so by the fact that the Germans and the Dutch, who were late starters, have out-stripped us to a gree which is astonishing. The Germans have over 20,000 cold-blow driers installed, and every resettlement farm under construction in the north-west of Germany has a cold-blow drying loft provided as a matter of course. I have spoken to a number of the farmers so settled and they all seem to consider it a matter of course—and commonsense—to utilise the resources which are, particularly to those from East Germany, the height of technique.

The Dutch work is particularly interesting because there is a severe limitation in their electrical resources and a restriction in the size of motor which can be fitted—electric *heating*, as we know it, is quite out of the question. They have, therefore, cut down on motor power requirements by erecting their hay in drying stacks with a central vertical flue—much on the lines of one of our well-known grain driers—with the air passing horizontally outwards through the hay, so reducing back pressure and load. Furthermore, the drying " sheds " are open-sided, often with a rising top, and the cost of walls is avoided. We are investigating the possibilities of this method here, more particularly in regard to bale drying.

It may be intriguing to some of my contemporaries to note the resemblance to the original, and long discarded, Oxford " stack " method—there is nothing like the " full circle," provided it picks up ideas on the way.

In our search for further farm consumption—and revenue—we have not overlooked irrigation, which might well, like crop drying, become a very substantial user of electrical energy. Electrical pumping for irrigation does not seem to present any particular technical problem at the power end, and possibly the greatest obstacle to this being a substantial revenue earner is the lack of adequate water resources, particularly where most needed, as in East Anglia. We cannot, therefore, but eye with interest the " long term " talk of a " contour canal " from the watery north-west to the under-privileged—in the water sense—East Anglia. This, as a going proposition, would enable the development of very many electrically-pumped irrigation schemes, and offer a welcome contribution to the balancing of the Eastern Electricity Board's rural budget.

We are rather more satisfied—I hope not smugly so—about the part being played by electricity in grain drying, and there is nothing in this field nearly approaching the economic and technical difficulties in putting electricity to revenue-earning account with grass drying. All we really need are some rather fewer Continental summers, particularly again in East Anglia and right up the East Coast. There are no particular problems there, either technical or economic. We are, however, and through the E.R.A., casting an eye on the infra-red method of grain-drying to see whether there is any advantage to be gained, but long-term work on this has not yet brought anything to light. We are, too, casting an exploratory eye on the possibilities of the " heat pump " principle, although we appreciate that per unit of drying done the revenue will be less—perhaps we are being rather too altruistic here !

From crops to consumers—of crops ! It is fairly obvious that electricity should be able to play a reasonable part where animal environment is concerned and more particularly where intensive methods are required and applied. There would seem, therefore, to be no useful purpose in cataloguing the applications of electricity to the producing, rearing and handling of poultry. The incubator, the brooder and the control of environment all offer obvious outlets for using electricity, and there is in this field hardly any problem or doubt. The " broiler," however, has probably given rise to more speculation and electrical exploration than any other similar or related process. In particular, it has offered a very attractive and promising field for speculation and investigation in the matter of taking advantage of " off-peak " rates for raising " broilers," probably the first electro-farming process where the heat requirements are substantial enough to justify the extra and novel problems involved being tackled on a substantial scale.

There is no particular technical problem in using the very successful " block and canopy " method first applied by Gilbert Print in Sussex. The only obstacle to a general use of this method is the necessity for moving the somewhat heavy units at the end of each batch to enable the house to be cleaned out. No such difficulty arises in the case of the rather later idea of the " warmed floor," first applied by Eric Claydon in East Anglia ; I do, however, take their opportunity of putting on long-delayed record the fact that soon after the war the late David Black, at Reading, was successfully rearing successive batches of chicks with an off-peak storage heater consisting of a tank of heated water underneath the chicks, and designed by my then assistant, Ian Dow. Not, perhaps, a practicability for large-scale broiler rearing, but exploding the then widely-held view that brooder heat must be " top-heat."

The " off-peak " warmed floor has, however, presented some technical problems in design and practice towards evolving the optimum combination of heated area, depth and type of cable and method of control. While many such floors are in use, in the main successfully, we are still working and seeking for the very best system. It may well be—and there are indications of this end—that one solution will take the form of a combination, the bulk of the warmth coming from the floor charged at off-peak rates, with a small amount of overhead raditaion " topping up " at normal tariff rates for meeting extremely cold conditions. There is the complication that such " mixed tariffs " are anathema to the tariff purist—but not all would refuse to compromise towards gaining the

†† E.R.A. Report, Ref. W/T34 (1957).

substantial off-peak use mainly involved. At the same time, increasing indication—if not, indeed, evidence—is appearing that a " super-floor," with excess heating surface beyond that basically necessary for brooding, would provide the space heating safety margin, and all be " off-peak."

**Research and Development**

I have, in my attempt to present briefly a picture of the hopes and problems which confront that part of our electricity supply industry concerned with rural electrification in general, and farm electrication in particular, referred to various investigations and trials—I prefer this to " research," a much misused term, as most of what we do is more correctly classed as experimental investigation or that very valuable and almost typically British term, " look-see."

From the earliest days of rural electrification in the United Kingdom there has always been some ingenious soul trying his hand at some new or modified way of using electricity on the farm—or, indeed, on the nursery and market garden. My own efforts while at the pre-war Oxford Institute of Agricultural Engineering were hardly more than " dabblery " ; and similarly, and simultaneously, the late Borlase Matthews was carrying out on his Sussex farm various exploratory trials of electrical techniques. But in 1938 the first attempt was made at co-ordinating investigation in this up-and-coming field for using electricity by the setting up of a Rural Electrification Section of the Electrical Research Association (E.R.A.) and of which I had the honour of being the first leader. This Section has grown and expanded and is now mainly engaged on long-term work.

This has not in any way, however, damped the enthusiasm of the " man on the job " for trying out ideas. In order, therefore, to make it easier for him, and indeed for anyone interested, to put his ideas to the test, the supply industry, through the Electricity Council, has established an " Appliance and Method " Scheme. Through this, and under guidance from small Working Parties, funds are available for relevant investigations to be carried out on farms, market gardens, and by the staff of Agricultural Colleges, University Departments, etc.

Indeed, our A. & M. Scheme is open to consider suggestions from *anybody* with an idea which he considers will widen or improve the use of electricity in agriculture—or, of course, horticulture—and, if approved, to provide funds for exploring the idea experimentally ; I hope I am not outraging the ethics of Presidential addressing by pointing out that there is this solution if any relevant student of the subject lacks funds to explore and develop a promising idea.

It may be part of my racial heritage to pay due respect to the lone student cut off from organised group study and learning—indeed, my colleagues on Education Committees have long become resigned to my pleas for the " lone student in the candlelit bothy," though now undoubtedly lit by electric lamp and heated by electric fire—but the flexibility of our Appliance and Method Scheme for exploratory research would indeed cover a genuine case of a " lone—and isolated—wolf " eager to develop a basically sound idea as well as the more sophisticated need of the University don seeking more power to his probably already well-primed pump.

I hope that I have succeeded in my main endeavour today, which is an attempt to assure all agricultural engineers that while the electricity supply industry is faced with a difficult problem in extending supply to rural areas in general and to farms in particular, it is not itself inactive in a constant endeavour to remedy the position by ensuring that the latest and most economical means of supplying the energy are utilised, while at the same time working actively towards enabling farmers to make a fuller use of electricity in ways which are beneficial to the farmer and at the same time contributing more fully to the costs of rural distribution.

Finally, lest I be accused by my friends of falling into a trap, I would make it clear that while horticulture is properly a branch of farming and while, electrically, it has afforded over the past quarter-century many interesting—some substantial—developments, I have deliberately excluded it from my Paper as having my hands full with farming proper. There is certainly a place one day —even as a future Presidential Address—for a separate treatment of horticultural electrification.

# THE WORK OF THE NATIONAL COLLEGE OF AGRICULTURAL ENGINEERING

by P. C. J. PAYNE,* M.Sc., Ph.D., A.M.I.Agr.E., M.A.S.A.E.

*A Paper presented at an Open Meeting on Tuesday, October 16th, 1962,*

## INTRODUCTION

IT gives me the greatest pleasure to be invited to address members of the Institution only a fortnight after the commencement of the first-ever term in the history of the National College of Agricultural Engineering—an occasion which most certainly would never have come about had it not been for the inspiration and perseverence of our Institution. The Governing Body, my colleagues and I all trust that the College will live up to the professional ideals and standards set by the Institution.

It must be seven years ago that our then President, Mr. D. P. Ransome, first put forward at an Annual Luncheon the idea of a College catering solely for Agricultural Engineers. Since then a succession of Presidents and Councils have all striven to bring the idea to fruition. In 1956 this Institution, under the leadership of Mr. Douglas Bomford and in conjunction with the Agricultural Engineers' Association, presented a Memorandum to Her Majesty's Minister of Education suggesting that a College should be set up, and in 1957 the Treasury gave its consent in principle. By 1959 the Minister of Education announced, again at an Annual Luncheon, that the teaching establishment would have the status of a National College, and a trust deed was signed in 1960 on behalf of the newly-appointed Governing Body by its Chairman, Sir Gilbert Flemming.

Perhaps it would be helpful if I explain that National Colleges began as a result of recommendations made by the Percy Committee in 1947. They are intended to cater for technologies which, though important, do not call for sufficient numbers to justify provision being made at a variety of colleges. They receive their funds direct from the Ministry of Education. There are eight National Colleges, counting ourselves, catering for a variety of subjects, such as Rubber Technology, Food Technology and Aeronautical Engineering.

## EMERGING PATTERN OF EDUCATION IN BRITAIN

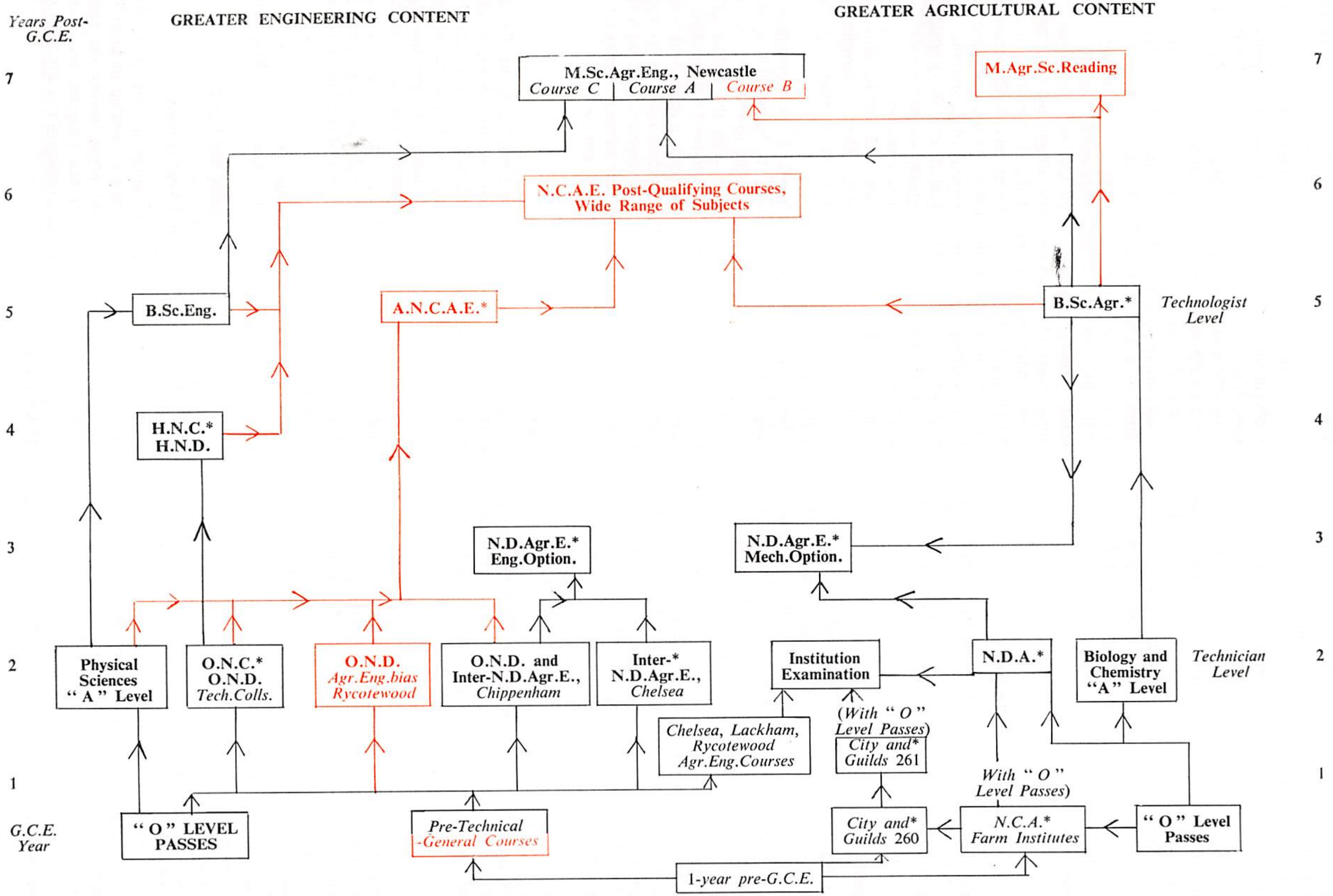
The work of the National College of Agricultural Engineering must not be considered in isolation. I should like, therefore, to describe briefly how the courses already decided upon by the Governors are intended to fit into the emerging pattern of agricultural engineering education.

For some 13 or 14 years we have had at the higher levels two post-qualifying courses in agricultural engineering—the M.Sc. from King's College, Newcastle, and the Institution's N.D.Agr.E. The former is a two-year course for graduates in Engineering or Agriculture, and the latter a one-year course for diploma holders or graduates in either of the same two subjects. Each year seven or eight men have gained their M.Sc. and 20 or 30 their N.D.Agr.E. In practice, on both courses by far the greater number have come from agriculture, and I think it would be fair to say that in their work they have, by and large, remained on the agricultural flank of the industry. The exceptions are some N.D.Agr.E.'s who came up by way of the O.N.D. in mechanical engineering, the very small number of M.Sc. men who have engineering degrees in the first place and a small proportion of the agriculture route M.Sc. men who took naturally to engineering and have since become indistinguishable from other engineers. Nevertheless, when all these exceptions are put together they probably only represent some 15 to 20% of those in the country holding an agricultural engineering qualification. The majority, though making an important contribution and of course coming within the compass of the Institution, are only in the broad sense engineers. Their interest is really in the use of farm machinery, and I believe that they would better be described as practising Agricultural Mechanisation. The use of the words Agricultural Engineer to describe practically all those contributing to the industry has, I think, given rise in this country to the idea that agricultural engineering is a branch of agriculture and, by the same token, not strictly legitimate engineering in the way that mechanical and civil engineering can claim to be.

Since the existing courses are both catering, in the majority of cases, for men going in for mechanisation with a first qualification in agriculture, the Governing Body of the N.C.A.E. has decided that its central course should be a first qualification at degree or technologist level and should truly be a branch of engineering. There is always a chance of a course in a mixed subject such as ours falling between two stools ; so, with this danger in mind, it has been decided that the N.C.A.E.'s Associateship should sit firmly on the engineering stool. Thus it is hoped to fill the most obvious educational gap and to provide the industry with a type of recruit hitherto unobtainable in this country.

* *Principal, National College of Agricultural Engineering.*

THE EMERGING PATTERN OF AGRICULTURAL ENGINEERING EDUCATION




(*a*) Red indicates new courses. Black indicates courses in existence before 1962.
(*b*) * indicates that practical training is an additional requirement.
(*c*) Part-time and block-release courses are expressed as their approximate equivalent in full-time training.

**Fig. I**

Fig. I gives an idea of the educational ladder in Agricultural Engineering as it was a couple of years ago, and as it will be by 1963 or 1964. The vertical scale indicates the number of years the theoretical part of a course takes, starting with the " O " level of the General Certificate of Education. Some of the courses are asterisked to indicate that there are also practical requirements. I have attempted to suggest the relative proportions of the two technologies in the various courses by putting those with a greater engineering content more to the left of the diagram, but I must emphasise that this is a purely personal assessment and others may well disagree with it.

## N.C.A.E. COURSES

I should like now to describe how we are planning the the N.C.A.E.'s two main courses, since these must, at the moment, be the most important unknowns in the picture.

### Associateship Course

The College Associateship is intended to be a basic professional training that will fit a man to move into several alternative spheres of work. In three academic years it is impossible to provide all the theory and practice that is eventually essential and, of the two, it is right that a College should concentrate on the theory. A man will spend the rest of his life in practice and his employer is often far more competent to provide the particular form of practical experience required than an academic institution. Nevertheless, it is essential to have constant contact with real conditions, and we therefore propose to send our students out into industry or farming during the long vacations whenever possible. If they are completely " green " before coming up, we shall insist on their having one pre-college year on a farm or in industry. At the end of their College course we should like to see them all take some form of graduate apprenticeship, and believe that industry will help with this.

The three years of the Associateship are made up as follows :

In the first year approximately 65% of the time is spent on engineering subjects such as Mathematics, Strength of Materials, Workshop Technology and Engineering Drawing, whilst the other 35% is spent on agricultural subjects such as Crop Production, Agricultural Botany and Economics (the last could equally well be termed an engineering subject). I would not for one moment claim that this first year is agricultural engineering ; it is a mixture of the two.

By the second year the engineering subjects have taken a very specific agricultural engineering emphasis. Strength of Materials, for instance, includes Soil Mechanics ; Thermodynamics emphasises Psychrometry, Heat Transfer and Air Conditioning for crop storage rather than internal combustion engine design. Some of the time occupied in the first year by fairly general agriculture and botany is now occupied by Farm Machinery and Soil Physics, and more time is devoted to seminars and visits.

In the third year, 70% of the time will be devoted to applying the earlier work in situations quite peculiar to agricultural engineering, and much of this will involve both field and laboratory experiments. The Governors have purchased 37 acres of farm land which is well suited to the demonstration of, for example, various soil conservation and irrigation practices and to the provision of a field test track. In the laboratory we are planning many experimental rigs such as a crop drier, tanks for soil/vehicle and implement mechanics and plant growth cabinets. Students will be given the opportunity of designing a few simple pieces of equipment under supervision. This, I would claim, is Agricultural Engineering without any doubt whatever. The remaining time is devoted to Tropical Agriculture, Farm Buildings and applied aspects of Economics, such as Business and Farm Management and Work Study.

I should stress that throughout we mean to take a world-wide view and not confine ourselves to temperate conditions. For example, rice will figure alongside wheat in Agricultural Botany. The Governors are attaching considerable importance to overseas experience in the selection of staff.

Since there is no yardstick by which the course may be judged at present, it may, I think, be helpful if I say that we expect our Associates to be able to compete on any mechanical engineering problem with the holder of a Higher National Diploma in Mechanical Engineering of equal experience and, of course, to be a great deal better when it comes to applying their knowledge in agriculture. I do not mean to imply by this statement that, with the exception of some of the first year subjects, the syllabus has been modelled on any existing course.

### Post-Qualifying Course

The main effort has been, and must continue for the next year to be, concentrated on the Associateship course, but by the end of 1963 we hope to be able to provide a small number of tailor-made courses of one year's duration for men with appropriate qualifications at Technologist level. These courses may differ widely from each other and may, I hope, often be attended by men who have already had several years' experience in the industry. Examples of the sort of specialisations we are thinking of are :

- Glasshouse heating and design.
- Field Engineering (soil conservation, irrigation, drainage, etc.).
- Design of Crop Processing Machinery.
- Design of Field Machinery.
- Buildings, Heating and Ventilating.

Our ability to provide a course in any particular subject will depend upon having a suitable member of staff to act as supervisor and upon having the right equipment available. As you can imagine, we count particularly on the N.I.A.E.'s co-operation for help in our post-qualifying work.

## AGRICULTURAL ENGINEERING EDUCATION IN AMERICA

### Professional Recognition

American agricultural engineers had to fight for their right to be accepted as practising a legitimate branch of engineering, just as we have had to do in Britain. The difference is that a greater variety of specialisations is traditionally accepted in the U.S.A. They therefore won their battle 30 or 40 years ago, while we are still fighting ours.* The American Society of Agricultural Engineers was founded in 1907, and there have been undergraduate courses at most of the main university centres catering for engineers since between 1920 and 1930.

An organisation known as the Engineers' Council for Professional Development accredits all engineering curricula in the United States if it considers them suitable. In 1961, 844 curricula received this recognition, and the 10 branches of engineering with the greatest number of accredited courses are set out in descending order in Fig. II.

Fig. II

| *Branch of Engineering* | | *Number Accredited in* 1961 |
|---|---|---|
| Electrical Engineering | .. | 144 |
| Civil Engineering | .. | 143 |
| Mechanical Engineering | .. | 142 |
| Chemical Engineering | .. | 102 |
| Industrial Engineering | .. | 52 |
| Metallurgical Engineering | .. | 43 |
| Aeronautical Engineering | .. | 36 |
| AGRICULTURAL ENGINEERING | .. | 33 |
| Mining Engineering | .. | 26 |
| Petroleum Engineering | .. | 22 |
| All others | .. | 101 |
| | | 844 |

* Better Opportunities in Technical Education, Cmnd. 1254, H.M.S.O.

On this basis, agricultural engineering is the eighth most important out of 36 acknowledged branches. There is in fact more than one accredited course in our profession for each five in the senior branches—civil, mechanical or electrical engineering.

I very much enjoyed being sent to the U.S.A. by the College Governors in May of this year and was treated in the kindest possible way by my many hosts. Representatives of manufacturers and Universities all assured me that graduates in agricultural engineering were in great demand both for the design and the sales side of the industry. One of the largest full-line manufacturers in the U.S.A. is aiming at an engineering staff split 50 : 50 between agricultural and other engineering graduates ; such a ratio is no exception. A number of the chief engineers whom I met were themselves qualified in agricultural engineering and University staffs and complained both of insufficient recruits for their courses and difficulty in keeping their graduates from being attracted into other branches of engineering.

One University Department of Agricultural Engineering was kind enough to supply me with copies of their records of old students from 1913 onwards. Not surprisingly, the data were incomplete, but I have analysed them for the last 21 years and set the results out in semi-graphical form in Fig. III. The lean years

Fig. III

ANALYSIS OF POSTS OCCUPIED BY OLD STUDENTS OF AN AMERICAN UNIVERSITY DEPARTMENT OF AGRICULTURAL ENGINEERING

| *Year* | *Industry (Farm Machinery Co.)* | *Teaching/Research* | *Farming* | *Extension* | *Post Unknown* | *Non-A.E. Posts* | *Total* |
|---|---|---|---|---|---|---|---|
| 1961 | ******* ( 7) | * ( 1) | * (1) | *** (3) | ***** ( 5) | | 17 |
| 60 | ******* ( 7) | ********* ( 9) | | * (1) | ********** (10) | ** ( 2) | 29 |
| 59 | ****** ( 6) | ****** ( 6) | | *** (3) | ********** (10) | ******** ( 8) | 33 |
| 58 | ************ (12) | * ( 1) | | * (1) | ****** ( 6) | ** ( 2) | 22 |
| 57 | ***** ( 5) | ******** ( 8) | | *** (3) | ***** ( 5) | ***** ( 5) | 26 |
| 56 | ************* (13) | ** ( 2) | | * (1) | ******* ( 7) | | 24 |
| 55 | ******* ( 7) | *** ( 3) | | | *** ( 3) | *** ( 3) | 16 |
| 54 | **** ( 4) | ** ( 2) | * (1) | * (1) | ****** ( 6) | * ( 1) | 15 |
| 53 | ******** ( 8) | ***** ( 5) | | * (1) | **** ( 4) | * ( 1) | 19 |
| 52 | ************** (14) | *** ( 3) | *** (3) | ** (2) | ********** (10) | * ( 1) | 33 |
| 51 | ***************** (17) | **** ( 4) | * (1) | **** (4) | ******** ( 8) | *********** (11) | 46 |
| 50 | ************** (14) | ******* ( 7) | * (1) | ****** (6) | ************* (13) | *** ( 3) | 45 |
| 49 | **************** (16) | ************* (13) | *** (3) | **** (4) | ********** (10) | ****** ( 6) | 52 |
| 48 | ************ (12) | **** ( 4) | ** (2) | | ******* ( 7) | | 26 |
| 47 | ******* ( 7) | **** ( 4) | | | ** ( 2) | **** ( 4) | 17 |
| 46 | ** ( 2) | | | * (1) | * ( 1) | | 4 |
| 45 | | | | | * ( 1) | | 1 |
| 44 | *** ( 3) | * ( 1) | | | * ( 1) | | 5 |
| 43 | * ( 1) | *** ( 3) | * (1) | * (1) | * ( 1) | ** ( 2) | 9 |
| 42 | ******** ( 8) | **** ( 4) | *** (3) | | *** ( 3) | | 18 |
| 41 | ************ (12) | * ( 1) | * (1) | | ***** ( 5) | | 19 |
| 40 | ********** (10) | ********* ( 9) | ** (2) | ** (2) | ** ( 2) | ** ( 2) | 27 |

from 1943 to 1947, followed by a flush for five years, was presumably the result of the war. The apparent fall in numbers in 1961 is, I think, merely because the records are not up to date.

It is interesting to note that industry and teaching/research vie with each other for first place, while a high proportion find posts outside agricultural engineering.

### Numbers Qualifying

No exact records of the number of men qualifying as Agricultural Engineers appear to be available for the United States, but several alternative methods of assessing them give approximately similar answers. Taking only the accredited courses (I believe there are almost as many unaccredited) and putting the average number qualifying from each as 10 per annum would give 330. The figure of three agricultural engineering graduates per annum per million of population was suggested to me as a sensible approximation. This would give a figure of 500. Baldwin† suggests a figure of over 300 per annum. Putting these figures side by side, we may safely assume that there are more than 300 qualified men coming into the American industry each year, and I was told by a number of University men that they had five jobs on their books for every candidate. The American Society of Agricultural Engineers has a membership of over 6,000.

On this basis, even if agricultural engineering were no more important to the British economy than it is to the American, which, in view of our exports, is excessively pessimistic, it would appear that we could easily absorb 100 men into the industry at technologist level each year. Without a tradition of seeking qualified agricultural engineers for design or overseas field engineering posts, and with their value in sales and advisory work only just becoming established, this figure will take time to reach. Nevertheless, once these men have proved their worth, the demand must grow and I believe that within a decade the demand throughout the world for British agricultural engineers will have exceeded my estimate of 100 per annum.

### Content of Courses

It is difficult to compare the content of undergraduate courses at different Colleges even within one country.

**Fig. IV**

**COMPARISON OF UNDERGRADUATE COURSE AT N.C.A.E. AND IOWA STATE UNIVERSITY**

| | **National College of Agricultural Engineering** | | | | **Iowa State University** | | | |
|---|---|---|---|---|---|---|---|---|
| *Subject* | *6th Form* | 1st *Year* | *2nd Year* | *3rd Year* | *Freshman* | *Sophomore* | *Junior* | *Senior* |
| Mathematics .. .. .. | ■■■ | ■■■ | ■■■ | — | ■■■ | ■■■ | — | — |
| Mechanics or Applied Mathematics | ■■■ | ■■■ | ■■■ | — | ■■■ | ■■■ | ■■■ | — |
| Physics .. .. .. | ■■■ | ■■■ | — | — | ■■■ | ■■■ | — | — |
| Properties and Strength of Materials | — | ■■■ | ■■■ | — | — | ■■■ | ■■■ | — |
| Thermodynamics .. .. | — | ■■■ | ■■■ | — | — | — | ■■■ | — |
| Fluid Mechanics .. .. | — | ■■■ | ■■■ | — | — | — | ■■■ | — |
| Engineering Drawing .. .. | — | ■■■ | ■■■ | — | ■■■ | — | — | — |
| Workshop Technology .. .. | — | ■■■ | — | — | — | — | — | — |
| Environmental Control .. .. | — | — | — | ■■■ | — | — | — | ■■■ |
| Economics and Business Management .. .. .. | — | ■■■ | ■■■ | ■■■ | — | — | — | ■■■ |
| Biology .. .. .. | — | ■■■ | — | — | — | — | — | — |
| Chemistry .. .. .. | School " O " Level | — | — | — | ■■■ | — | — | — |
| Soil Science .. .. .. | — | — | ■■■ | — | — | ■■■ | — | — |
| Electrical Engineering .. .. | — | ■■■ | ■■■ | — | — | — | ■■■ | ■■■ |
| Agriculture .. .. .. | — | ■■■ | — | — | — | — | — | — |
| Buildings .. .. .. | — | — | — | ■■■ | — | — | — | ■■■ |
| Field Engineering .. .. | — | — | — | ■■■ | — | — | — | ■■■ |
| Soil/Vehicle/Implement Mechanics | — | — | — | ■■■ | — | — | — | — |
| Surveying .. .. .. | — | — | — | ■■■ | — | ■■■ | — | — |
| Farm Machinery .. .. | — | — | ■■■ | — | — | ■■■ | — | — |
| Crop Conditioning and Storing .. | — | — | — | ■■■ | — | — | — | ■■■ |
| Design Projects .. .. | — | — | — | ■■■ | — | — | ■■■ | — |
| Tropical Agriculture .. .. | — | — | — | ■■■ | — | — | — | — |
| Military Science .. .. | — | — | — | — | ■■■ | ■■■ | — | — |
| Physical Education .. .. | (Treated as an extra curricular activity) | | | | ■■■ | ■■■ | — | — |
| Humanities and English.. .. | (Treated as an extra curricular activity) | | | | ■■■ | ■■■ | ■■■ | ■■■ |
| Speech Making .. .. | (Seminars intended to help with this) | | | | — | — | ■■■ | — |
| Civics .. .. .. | (Part of College life) | | | | — | — | — | ■■■ |
| Seminars .. .. .. | — | — | ■■■ | ■■■ | — | — | ■■■ | ■■■ |

When the comparison is attempted between countries, the added difficulty of different school-leaving levels and different names for subjects makes the task nigh on impossible. Nevertheless, I have attempted just this in Fig. IV for the National College's Associateship and Iowa State University's first degree, because I believe members will be interested to see an assessment of the similarities and differencies, even if that assessment be subjective. Two basic assumptions were necessary. First of all, the preliminary year at an American University is assumed to be the equivalent of two years in the sixth form of an English school. Secondly, the number of years in which a subject is studied is taken as indicating the level which is reached. Both of these assumptions are suspect, but I trust that there is enough truth in them not to distort the overall picture too grossly. I have attempted to employ English subject titles where possible.

My first impression is of the striking similarity between the pictures. On closer inspection, one realises that the British student will have a larger dose of Agriculture, Biology, Economics and Business Management, while the American spends a higher proportion of his time on activities which we either ignore altogether or encourage as extra-curricular, but do not teach formally. Though it does not come out in Fig. IV, I believe also that the study of environmental control for animals through building design is more advanced in the States. This is a matter we must put to rights.

Being taught at a University instead of a " one-faculty " College, the American student of agricultural engineering takes many of his subjects along with large numbers of students reading other technologies. This has the advantage of a common standard, but offers less opportunity for lecturers to integrate their courses. No single American department of agricultural engineering can support a research programme to the extent that the N.I.A.E. is able to do here on a national scale ; so our students, though isolated from other faculties, will have close contact with a greater variety of agricultural engineering research than is possible at any American department.

## JOBS AND RECRUITMENT

It is only comparatively recently that men with any formal agricultural engineering training have been available in this country. Even now the supply is small and the emphasis strongly on Agricultural Mechanisation. It is not surprising, therefore, that employers often fail to advertise specifically for agricultural engineers when seeking to fill vacancies. To help show the type of work for which the various qualifications, both established and new, should prove suitable, I have prepared Fig. V. I must, however, emphasise the following points :

1. In pairing a job and a qualification, I am in no sense implying that there are not plenty of other ways of preparing for the job. My intention is merely to suggest what I believe will in the future be the most direct route.

2. In most cases the chart is not concerned with the first two years after a man leaves College when he is being trained by his employer, nor with how far he gets after he is, say, 30, because, after that, what he makes of his career is almost entirely dependent on his personal qualities.

3. The diagram makes no attempt to take account of numbers employed. In one case there may not be more than a couple of posts coming vacant each year, while in another a couple of hundred may be available.

I should explain that the classification " Advisory," sub-division " Manufacturers," is an invention of my own. I am convinced that it would pay the larger manufacturers to set up a more official farm mechanisation advisory service than they have at present. At home I picture specialists being called in regularly by distributors to advise individual farmers on their mechanisation problems, including things like irrigation and work study which might well be outside their firm's direct interests. The system, which works well for fertilizers and chemicals, does not appear to me to clash with the work of the National Agricultural Advisory Service, whose approach must be broader.

In export areas I imagine the advisory man, as well as being a technical expert, would need to concern himself with the intimate details of his district, the distributor network not being so widespread.

If I may continue with my " pet " schemes, another function I see for my " Manufacturers' Overseas Advisory Officers " is reporting back on the " credit worthiness " of his farmers. This is working round to suggesting hire purchase of farm machinery. I am not an economist, but I have always supposed that there is no difficulty in financing hire purchase, provided the customer is known to be sound ; who better to provide this assessment than the manufacturer's own advisory officer who is operating in the area and knows the farmer ? If we don't provide this service, is it not likely that our competitors from other countries will ?

Britain has played a leading role in mechanising the farms of the world right from the days of steam ploughing and before. She still holds this lead, but competition and technical development increase daily. If we are to improve our position, we must both recruit and train greater numbers of men of the highest possible calibre. This Institution is already the acknowledged authority in both recruitment and training.

May I end by saying that the National College looks to the Institution to continue and intensify its recruitment campaign and that the Institution can rely on the National College to support its work in every field to the utmost of its ability.

## REFERENCES

* PAYNE, P. C. J., and OSMAN, M. S., 1961, " Agricultural Engineering as a Technology," *Research*, 14, 405–8.

† BALDWIN, G. G., 1960, " The Role of the National College," *Farm Mechanisation*, 310–12.

Fig. V.

SUGGESTIONS FOR BEST USE OF AVAILABLE COURSES

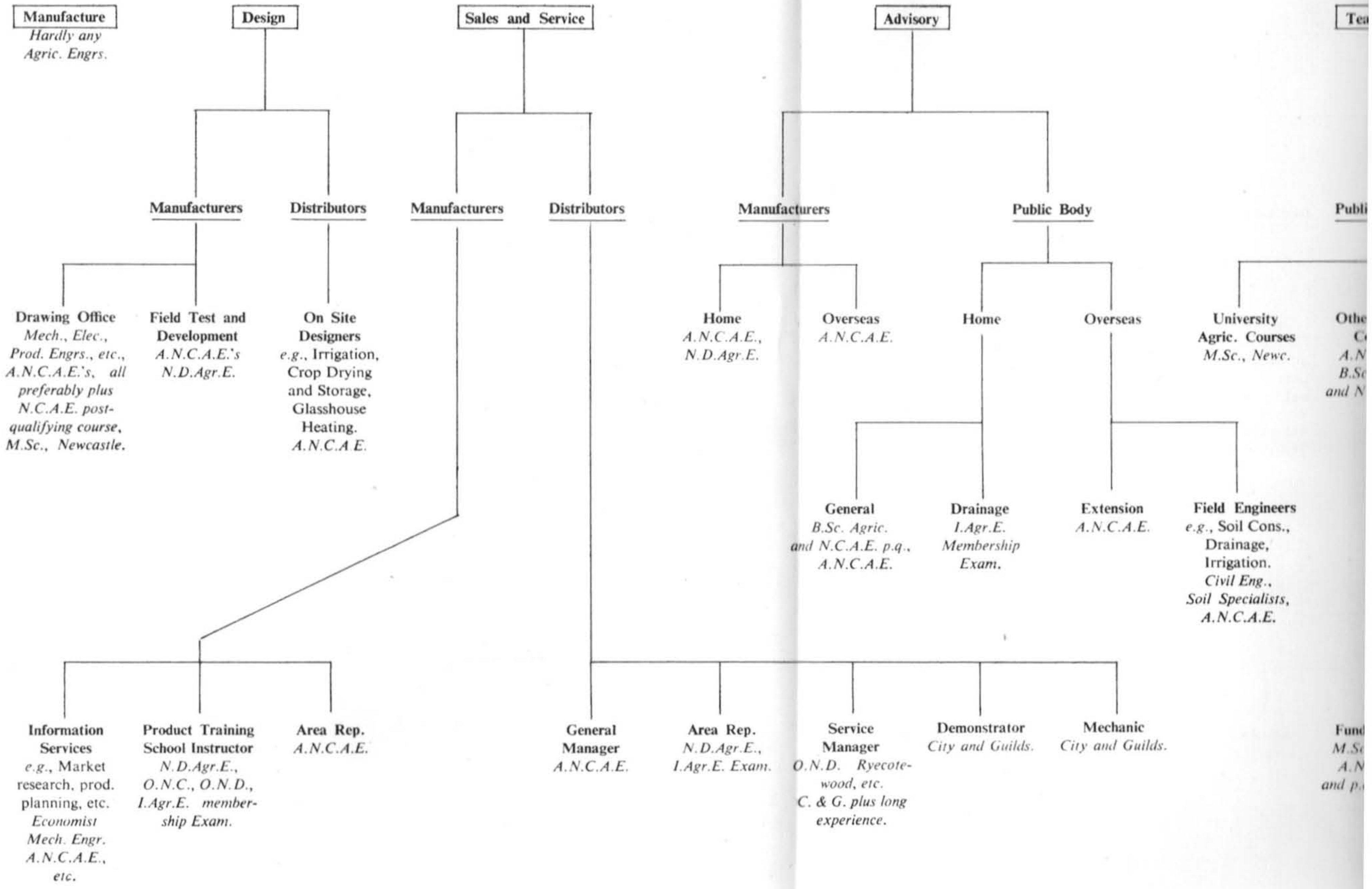
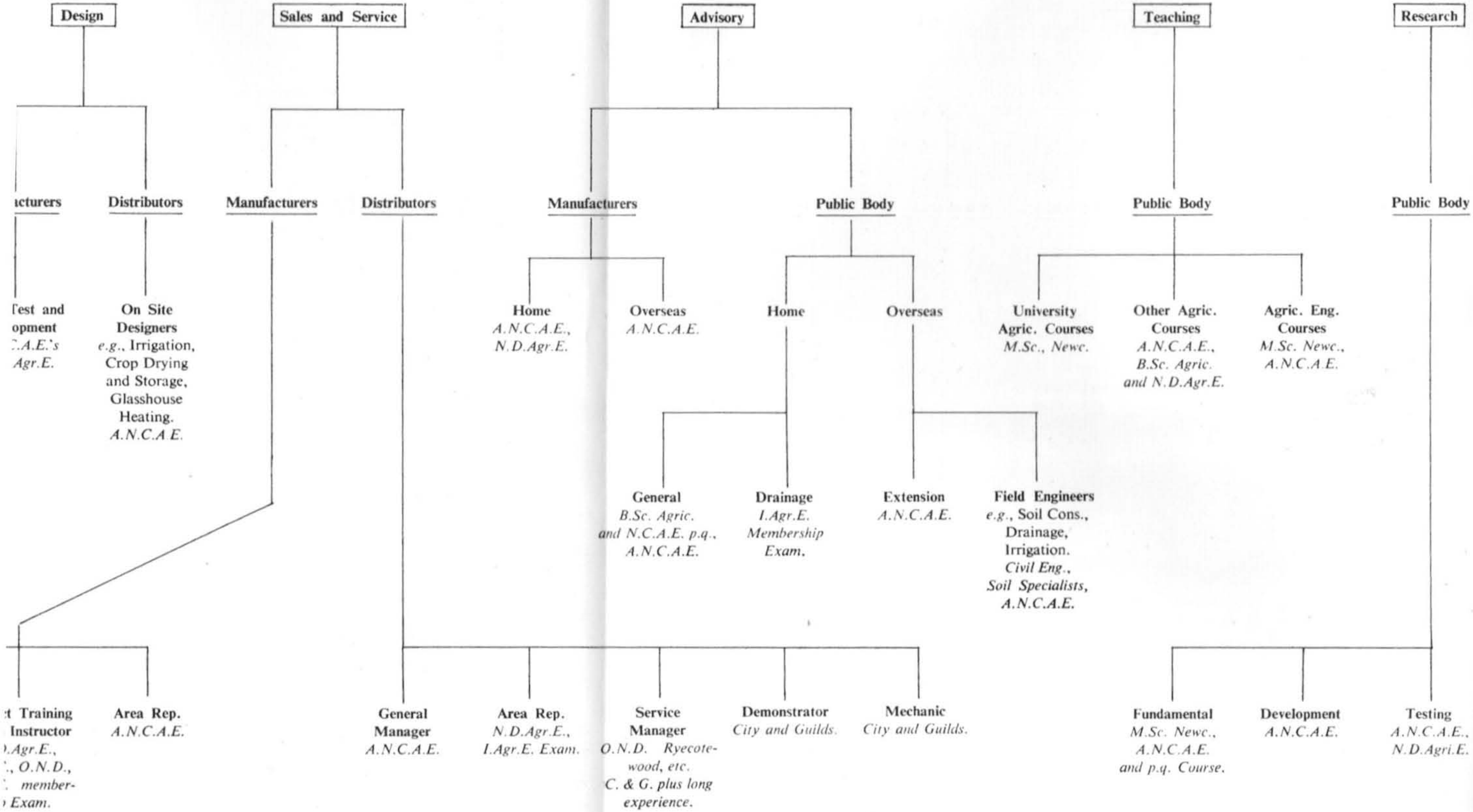


Fig. V.

SUGGESTIONS FOR BEST USE OF AVAILABLE COURSES



# DISCUSSION

MR. J. H. W. WILDER (Director, John Wilder Ltd.) said that the Institution was specially proud of the part it had played in the formation of the National College. He thought of the College as a ship, planned by the Institution and launched by the Ministry of Education. Today they had heard the first captain outlining the course he would take. Dr. Payne had had a very difficult task in presenting his Paper to an audience which was bound to be extremely critical. He had made a wonderful case for his proposals, and Mr. Wilder did not want to make any criticism without first thanking Dr. Payne enormously for the care he had taken to inform the meeting about the work of the National College.

His first criticism concerned the " Associateship " of the College, which Dr. Payne had first stated to be of degree or technologist level, and later that it was equivalent to a Higher National Diploma. Mr. Wilder was certain that the Institution would not wish this qualification to be lower than degree level.

He asked why it was necessary to call the qualification " Associateship of the National College "—he would have preferred some more easily recognisable title for it. The agricultural engineer should be quite as well qualified as his counterpart in mechanical, electrical or civil engineering. He would be different from them in that he had concentrated from the beginning on engineering as applied to agriculture, but would still have advanced knowledge of calculus and other relevant subjects.

Many aspects of mechanical, electrical and civil engineering would, of course, have to be omitted from the agricultural engineer's training, and some agriculture would be included. Mr. Wilder would like a straight answer on the question of the standard of the Associateship. Was it to be of degree level, or of Higher National Diploma standard ? If it was the latter, he hoped it would be possible to raise it eventually to degree level.

Mr. Wilder felt that it would be a considerable time before agricultural engineering firms would wish their area representatives and similar staff to be qualified people of the sort to be trained at the National College. He also thought it was wrong to assume that the tractor manufacturer should be an automobile engineer—he felt strongly that agricultural engineers were very much concerned with tractor design.

MR. F. H. GARNER (Principal, Royal Agricultural College) expressed his thanks for being invited to attend. He had two or three points to raise, first of all, on the academic and other entry requirements. He said that he found it essential to make contact with careers masters in schools to make any satisfactory impact on recruitment. In doing this it was most important to make clear what opportunities existed for training and what posts were available subsequently. One of the first questions to be asked was always on the subject of salaries in such posts. He felt it was important to tackle this matter very quickly, in order to influence boys of 12 to 14 who would quite soon be starting to specialise for specific careers.

MR. P. HEBBLETHWAITE (N.I.A.E.) said that he felt one of the most important functions of the College was in its contacts with countries overseas. Not only would it be concerned with the training of students from this country to work overseas, but also the training of students from overseas. It had been said that the College should aim at degree *standard*, but he would like to put on record the suggestion that the College should aim as quickly as possible at affiliation with a university, thus enabling it actually to award degrees. Put in basic terms, for many overseas students the issue was simple —if they obtained a degree they would enter salary scales in their own country at one level ; if they did not obtain a degree their salary scales would be much lower. Until this country could offer a degree which would enable such students to get good jobs on their return home, we would be at a considerable disadvantage, especially in relation to countries such as the United States.

LT.-COL. W. N. BATES (Kent) asked if Dr. Payne would elaborate on the " tailor-made " post-qualifying courses he had referred to.

DR. PAYNE, in reply, said that in using the word " technologist " he was following the terminology of the Government White Paper*q*, which recognised at least four levels of qualification—operative, craft, technician, and technologist. The technologist could well be compared with the degree-holder in ability and training and every other respect, but would probably be more suitable for applied work. The classic example was the Dip.Tech. from the Colleges of Advanced Technology, which was intended to be comparable with an Honours degree, not just a pass degree. In referring to the Higher National Diploma, which he believed many people in industry regard as at least as valuable to them for the more applied type of work as a degree, Dr. Payne said he had not wished to imply that its academic standard was as high as that of the National College Associateship. Mr. Wilder had pointed out that it would be necessary to omit a certain amount of mechanical engineering, etc., from the Associateship course to make room for the highly specialised agricultural engineering subjects, and what Dr. Payne had wished to convey was that Associates of the National College would be as good as H.N.D. holders at dealing with problems of mechanical or electrical engineering, as well as being far in advance of them in dealing with problems of agricultural engineering, such as the design of a growth cabinet or a glasshouse heating system.

An Associate would not be expected to design a tractor, and in order to accommodate in the Associateship course the great amount of extra material the " simple " mechanical engineers did not require, the National College syllabus had cut out some internal combustion engine aspects and the whole of steam engines. In fact, the normal heat engines syllabus had been drastically reduced, to be replaced by at least as much woık on the adiabatic saturation process at low temperatures—low-temperature steam, in effect.

Dr. Payne regretted that he had appeared to suggest that tractor design did not involve agricultural engineers —they were, indeed, essential for such design aspects as ground drive components, and for deciding what types of tractors should be produced, and with what fittings. The design of engines and gearboxes, on the other hand, was for mechanical engineers to tackle.

Both Mr. Wilder and Mr. Hebblethwaite had referred to degrees, and Dr. Payne fully recognised this problem. For some overseas candidates, undertaking a course of study was to some extent more a case of increasing their salaries than gaining knowledge. The question "Is your Associateship as good as a degree?" was constantly being asked. The answer must be that the Associateship takes the place of a first degree in agricultural engineering because, in Britain, the latter does not exist.

The reason that the National College existed at all, as Dr. Payne understood it, was that no university had been willing to accept the responsibility for providing a degree course in Agricultural Engineering. Affiliation to a University—which would be necessary before degrees could be awarded—was a very difficult business, and he thought the College would have to operate for at least ten years before they could even talk about it. This was a matter of policy for the College Governors to deal with, and it was one of which they were well aware.

Summing up his replies to the points raised so far, Dr. Payne claimed that his Associates would be qualified to the level of H.N.D. plus. The plus would approximate to their third year—the year which they would spend over and above the two years necessary for an H.N.D., which would bring them to technologist level —technologist rather than degree because it was an applied subject in which they had been trained.

The pre-entry requirements about which Mr. Garner had asked were roughly Advanced levels in the General Certificate of Education in Mathematics and Physics, with some latitude over the second subject. This was the school sixth-former entry. Alternatively, there was the engineer entry for candidates with the Ordinary National Certificate (O.N.C.) or Ordinary National Diploma (O.N.D.), which could be obtained by three or four years' part-time study or two years' full-time study respectively at a technical college after obtaining Ordinary-level G.C.E.

Dr. Payne agreed with Mr. Garner about the need to make contact with careers masters at schools. In passing, he mentioned that the College was full this year, and that he was not worried about short-term recruitment. He was more concerned with the long-term objective of establishing agricultural engineering as a definite and obvious career with a reasonably clear path for people to take. He thought very few young men of 18 or 19 had a strong sense of vocation, and that was why a film of the kind shown could catch their imagination. He believed agricultural engineering could have a strong romantic appeal.

Regarding the qualifications to be obtained at the National College, Dr. Payne stressed that the one course now in existence was a three-year course leading to Associateship of the National College of Agricultural Engineering (A.N.C.Agr.E.). The post-qualifying course which would be offered in the next couple of years was intended to be in most cases a one-year course in some special subject for men who were already qualified to tackle such a subject. If a man wished to study, for example, mechanisation of the sugar crop, the College would try to arrange for one of the men at the N.I.A.E. who had a lot of experience in that particular field to be his supervisor. The candidate would also be given courses in economics, farm mechanisation and tropical botany. In this way the post-qualifying course could be tailored to individual requirements.

While the College could not teach tropical agriculture in its entirety, nevertheless two of the four members of staff had 17 years of tropical experience between them, and Dr. Payne hoped it would be possible to maintain a balance among his colleagues between men with good experience in the tropics and at home.

In reply to a question from COL. BATES on the teaching of tropical agriculture, Dr. Payne mentioned that the lecturer in Botany at the College was, in fact, the ex-Director of Horticulture in Sierra Leone.

MR. J. A. C. WILLIAMS (Principal, College of Aeronautical, Automobile & Agricultural Engineering, Chelsea) said that in training engineers one must have the practical and theoretical sides integrated; Dr. Payne had said that the practical training of his students would be left to the manufacturers. It was his (Mr. William's) experience that the practical training provided for students was often at a very low level, and he was not happy that practical training with manufacturers would satisfactorily form part of an integrated system of training. Dr. Payne had not referred to the work of the City and Guilds of London Institute, although in the Chelsea course agricultural engineering students did go on from City and Guilds and the Institution's Graduateship courses to take Part I and II of the Institution of Mechanical Engineers examinations, and afterwards take the National Diploma in Agricultural Engineering. This, he presumed, would qualify them at technologist level. It was also his experience that some academically brilliant students were not suitable for employment as managers —in the kinds of post which Dr. Payne had illustrated in one of his slides. In fact, Mr. Williams was prepared to say that a large number of his students who might be considered educational failures at so-called technologist level, on getting into business, had reached director level. He thought that in order to provide a realistic scheme of education and training a scientific job analysis was first needed; very often the requirements of engineering jobs could be satisfied at a much lower academic level than some people thought necessary.

Mr. Williams felt that a large number of boys at school might be misled into a quest for academic qualifications. He could not recognise, in the general agricultural engineering industry, the difference between jobs which now educationalists labelled " technologist " or " technician." So far as overseas students were concerned, in his opinion the impression had been created in many Commonwealth countries that all a man had to do to become an engineer was to get G.C.E. " A " levels in mathematics, physics, etc., and then go on to a H.N.C. or a degree course. The emphasis was on the academic side, and there was a great tendency to neglect the practical training which we in this country thought necessary. He would like to know what Dr. Payne's attitude would be to entry into the Associateship course of a person coming from overseas having the necessary two " A " levels with practical experience on a farm where the mechanisation was rudimentary or virtually non-existent. He hoped that such a man would not be accepted for a course at the National College until he had had a thoroughly integrated course of practical and theoretical training.

A factor which might have relevance for students seeking entry to the National College was the idealistic view schoolboys have of what an engineer does and what training he required. Entry of students direct into the National College course, unless a fair amount of practical training had first been obtained, might produce eventual wastage from the industry.

DR. PAYNE, in reply, said that on the whole he agreed with Mr. Williams' remarks, but not with his conclusions. One solution to the problem of integrating practical and theoretical training was the sandwich course in which the student spent roughly six months in industry and six months at College doing academic work. He thought that the governors of the N.C.A.E. would have liked the Associateship to have been arranged like that, but it required a lot of organisation and would probably take several years for the industry to adapt itself to having people in employment for six months and then losing them—in effect, it would have to employ twice as many people.

Mr. Williams had referred to the City and Guilds courses, for which the College had the highest admiration. But, in his talk, he had been concerned with what he hesitated to call " the higher levels." In saying this, he emphasised that no one thought the technician or technologist was better than other people contributing to the industry, but they were different and required different skills. He had just been given a definition which he would like to read : " A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility in the development and application of engineering science and knowledge, notably in research, design and construction, manufacture, superintending, managing and in the education of the engineer." There was more about the professional engineer, but he wanted to go on to the definition of the technician in contrast : " An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in advanced engineering or those techniques specifically prescribed by professional engineers."

This problem was very difficult—one might say it was almost a matter of snobbery, but one had to draw a distinction, and in his talk he was referring only to those courses which he thought would count as technologist and above. He was well aware of the courses below this level. They must try to provide the best educational facilities, and to see that those who did not have such initial advantages could still get to the top if they had the ability. In presenting his chart, he was trying to bring some order into the discussion of courses and opportunities.

In reply to a question by MR. G. B. H. SPEAR (N.A.A.S.) on farm building layout, Dr. Payne said he did not think that it could be taught at the College as a standard course. It could, however, be tackled as one of the so-called " tailor-made " courses.

MRS. O. M. FOSS (City and Guilds of London Institute) agreed that it was important to bring the National College courses to the attention of careers masters. It was also a matter for the members of the professional institutions and firms concerned, who could give support by guaranteeing to send some of their own employees to the College.

In concluding the session, the PRESIDENT referred to the construction of the new College buildings at Silsoe and assured Dr. Payne of the support and interest of the Institution. He was very grateful to Dr. Payne for his address and for dealing so admirably with the questions raised in the discussion.

## OBITUARY

### Lt.-Col. W. T. Cook

It is with great regret that we report the death of Lt.-Col. W. T. Cook, M.I.Agr.E., Senior Director of William Cook (Engineers), Ltd., of Yaxley, Peterborough. Colonel Cook was the fourth generation head of a family agricultural engineering concern founded in 1820. His was an ingenious, fertile mind and he produced many machinery designs and modifications. In addition to his exacting business duties, he was a Deputy Lieutenant of Huntingdonshire and took a keen interest in local affairs. He had been a member of the Institution since 1949.

### M. et Mme. Armand Blanc

We have learned with regret and shock of the deaths of M. et Mme. Armand Blanc due to an accident.

Monsieur Blanc was well known in international agricultural engineering and agricultural circles as President of the Commission Internationale du Génie Rural and Vice-President of l'Académie d'Agriculture de France. In addition to these offices, he was Commandeur de la Légion d'Honneur—Croix de Guerre 1914–18, Commandeur du Mérite Agricole and Directeur Général Honoraire du Génie Rural et l'Hydraulique Agricole. His death has left a gap that will be difficult to fill.

# RESEARCH AND DEVELOPMENT TOWARDS IMPROVED FARM IMPLEMENTS FOR PEASANT FARMERS IN THE TROPICS

by I. CONSTANTINESCO,* B.Sc., N.D.Agr.E., M.I.Agr.E.

*A Paper presented on behalf of the author by T. C. D. Manby (N.I.A.E.) at an Open Meeting on Tuesday, October 16th, 1962.*

THE object of this Paper is to review some of the problems associated with the need to increase agricultural production of peasant farms in the tropics, and to give examples of how research and development in farm machinery is helping towards solving some of these problems.

The author had the opportunity during 1961 to visit a number of countries in the Far East, including India and Japan, in order to study the development of machinery for peasant farms there. This visit brought home the close relationship of problems of agricultural production among peasant farming communities in the whole of the Afro-Asian group and how the evolution and development of farm machinery in the Asian group is of particular application to countries with similar conditions in Africa.

In spite of the great advances of our time in farm mechanisation in the developed countries of the West, it is startling to realise that 80% of the world's crops are still cultivated by hand or primitive animal-drawn implements. In countries of the tropics where industrialisation is either completely absent or only just beginning, the majority of the people earn their living from the land. The bulk of the agricultural produce, some of which is exported to earn foreign exchange, comes from a large number of very small family holdings, each one contributing a small share of the whole. In many cases this contribution provides only a subsistence standard of living to the producer and in bad years can lead to famine conditions. An important factor influencing these conditions is low yields, resulting in an inadequate return to the producer. There are a number of factors responsible for low yields, such as insufficient or erratic rainfall, too much of it at the wrong time, poor soil conditions, lack of water for irrigation or good seed, lack of fertilisers, or lack of knowledge how best to grow a crop or even what crop to grow.

Agricultural research and extension workers have been concerned with all these problems for a long time in tropical countries and great strides have been made, but very often the increase in production possible by know-how has been limited by the capacity of the primitive farm implements available, in many cases nothing more than a hand hoe.

In some instances attempts have been made to overcome the limitation of primitive implements by the sudden introduction of mechanisation with tractors. This line of approach has not always met with the success that was anticipated. Apart from technical difficulties of operating tractors and machinery under conditions for which they were not designed, but which may be overcome by adaption of existing machines or the design of new ones, the social and economic problems involved may not be so easily solved. If success in this field is to be achieved, certain conditions must be met in the farming community in question, whether the operation of tractors is to be done on a contract, communal or co-operative basis. Individual operation is out of the question, except for the larger farmer, on economic grounds, though individual ownership is possible where the owner can employ his tractor on contract work for neighbours up to an economic acreage, provided that the conditions necessary for the mechanisation of the peasant community hold good. Broadly speaking, the required conditions are (*a*) the area of small holdings to be mechanised must be aggregated and contiguous in one block ; (*b*) all the farmers in question must be willing to participate in the scheme ; (*c*) the yield and price of the crops to be mechanised must be high enough to carry the costs of production ; (*d*) the machinery used must be suitable for the job it has to do ; (*e*) there must be adequate maintenance and servicing facilities, and spare parts available in the area concerned ; (*f*) there must be an adequate number of trained operators and mechanics available ; (*g*) the general standard of development and education in the community concerned must be sufficiently high for them to appreciate the conditions necessary for the successful operation of tractors and their income high enough to pay for the costs of operation. The alternative to this last point is subsidisation by a Government, quasi Government organisation or corporation, but this can only be done where the scheme shows definite signs of being an economic proposition, and the organisation concerned has sufficient finance at its disposal for capital and recurrent charges and for meeting unexpected setbacks over a number of years.

It will be seen, therefore, that the conditions necessary

* *Department of Agriculture, Government of Tanganyika.*

for successful tractor mechanisation of peasant farms are quite formidable and have been learnt from practical experience and investigation and often at considerable cost. The final point to be made on the question of tractor mechanisation of small farms in the tropics is that it is limited to areas suitable for it and, therefore, to a small proportion of the farming community as a whole. For the majority, experience has shown that more overall good can be done by the introduction of improved hand and animal-operated equipment, small processing machinery and extending the use of animal power.

In countries like India and Pakistan, animal power has been used for many centuries, but the implements used have been very primitive. In India the main power unit is still a pair of bullocks and the main cultivating implement a wooden plough. Improved and more efficient implements have been evolved over a long period of time and introduced in areas where they are needed, and this is coupled with research and development of more modern and efficient implements and machines for use with animal power. In the rice lands of Malaya the power unit is the water buffalo, and implements have been evolved to suit that animal. In Japan, a highly industrialised country, there is still 60% of the population on the land on very small farms of 2½ to 3 acres, and there the domestic cow is still used extensively as a draft animal, often in addition to a low-powered two-wheeled tractor. Again, development of machinery in Japan has been directed towards the production of large numbers of efficient implements for use with low-powered tractors and animal power, and this has meant the development of implements with the lowest possible draft.

As far as Tanganyika is concerned, there are no indigenous implements to use as a basis for improvement other than the hand hoe. There is, however, a large potential of oxen power which is being gradually trained and harnessed, and the pace is being accelerated. There is, however, a lack of suitable implements for use with them, and thus note is being taken of work in other countries, particularly the Far East, of the developmet of farm implements for animal draft with a view to the introduction and development of suitable implements in Tanganyika. The function of the Tanganyika Agricultural Machinery Testing Unit is to test and adapt machinery suitable for use on peasant farms in the country and, if necessary, develop machinery not available elsewhere for specific purposes. It has also in the past, under its former title of the Farm Machinery Experimental Section, investigated problems of tractor mechanisation particularly in the cotton-growing areas of the Lake Province.

The writer has recorded some of this work elsewhere and is therefore in this Paper confining himself to the more general problem of developing suitable farm implements and machines for the vast majority of small peasant farms in need of them. This particular problem has been given only little attention in the industrialised countries of the West, with the result that much of the earlier equipment imported has been expensive and unsuitable. The point to be stressed is that the annual income of these peasant farms is so low (often less than £30 per annum) that they cannot afford to buy much of the kind of machinery that has been sent out to them. An example of this would be single-row seeders of the tractor type modified slightly and fixed to a frame so that it can be drawn by oxen, costing £25 to £30 for one row of seed. By stretching himself, such a farmer can, and often does, buy a plough costing £6 or £7, but he can rarely afford to buy anything else. The result is he tends to plough up more land than he was able with a hoe and then finds that he cannot cope with the increased weeding and harvesting necessary by hand. What is wanted is not so much an increase in the area of land under cultivation or an increase in the output per man, but an increase in the yield per acre, with simple, robust and cheap implements with which to carry out all the necessary operations of initial ploughing, seeding and subsequent weeding. The need is, in fact, for an efficient but cheap multi-purpose tool for use with animal power. Modern tractors are made and supplied with a full range of equipment for all the operations required on a farm using the same power unit. The same principle should apply where the power unit happens to be a pair of bullocks. In the following section, ways in which this idea has developed and the stage it has reached is described.

**Development of Ploughs and the Multi-Purpose Implement**

In countries of Asia and the Middle East the indigenous plough, known as an Ard, consists of a wedge-shaped piece of wood attached to a long beam. There are variations in the shape and size for different soil conditions and depth of cultivation, requiring a draft of from two to six or more pairs of bullocks (approx. 200 to 600 lb.), but basically they are all wedges, the action of which is to shear the soil without inversion. They are made by the local village carpenter or farmer himself and cost only a few shillings. The first improvement was the addition of an iron share or point which gave better penetration and prolonged wear. This implement works more like a one-tined cultivator than a plough. Its main objection is the slow rate of work and high draft compared to a medium type of plough. It has, however, certain important advantages, the main being that it is a multi-purpose implement, as it can be used for primary cultivation or ploughing, as a cultivator between rows of crops and as a seeder or drill by attaching a funnel and tube at the rear down which the operator drops seed as he proceeds.

In India and Pakistan early attempts were made to improve this plough by cutting off the pointed part of the wedge and fitting a soil-inverting body in its place, an example of which is the Indian melur plough, but this merely increased the draft without a substantial improvement in the quality of the work done. Another approach was a look towards western types of mould board ploughs to replace the wooden indigenous types. A number were imported and copied, but never proved very popular. They were short-beam types with two handles, heavy and unwieldy compared to the indigenous types and the method of hitching to the bullocks was unfamiliar.

At the same time, various research workers and Institutions were working on the idea of fixing a mould board type of body to a long beam, examples being the Punjab Agricultural College and Research Institute at Lyallpur, West Pakistan, and the Agricultural Colleges at Kanpur and Allahabad in India. There are no doubt others, but the author found evidence of this work at these Institutions which he visited.

One of the earlier ploughs in this category is called the " Hindustan." The body is made of chilled cast iron with a cast steel share and it is fixed to a long beam. It weighs about 50 lb. and has a draft of about 150 lb. at 6 in. depth. A lighter plough developed is called the " Meston " for ploughing light soils, weighs about 35 lb. and has a draft of about 120 lb. under the same conditions and derives its name from Sir George Meston, a former Principal of the Agricultural College of Kanpur in India. Both ploughs are reckoned to cover ¾ to 1 acre in an 8-hour day, and need only one pair of bullocks. The alternative imported short-beam type ploughs carried out the same amount of work in an 8-hour day, but needed a pull of nearly 400 lb. under the same conditions—beyond the capacity of one pair of bullocks.

The disadvantage of these earlier improved ploughs is that there is insufficient clearance between the ground and the beam in weedy conditions, resulting in frequent chocking. This defect has now been largely overcome in more recent designs such as the " Shabash " and " Care " ploughs. These are also light ploughs with a general-purpose body made of steel with a hard-wearing high-carbon steel share that can be sharpened by a village blacksmith. They also have provision for varying the pitch in relation to the beam.

Although these implements are more efficient than the indigenous types, as ploughs a serious disadvantage becomes apparent. *The indigenous ploughs, though inefficient for modern conditions, provided a full cultivation system for a small farmer with one pair of bullocks. In the improved ploughs the multi-purpose nature of the indigenous implements was lost.*

Research workers then embarked on the development of a more efficient multi-purpose implement. In Pakistan this resulted in the " Pakistan " ploughs, types A and B, developed at the Punjab Agricultural College. These ploughs are made with various bodies and shares which are interchangeable, and thus various soil conditions can be dealt with by fixing alternative bodies and shares. They can also be turned into cultivators and be used as seed drills by attaching a seed tube and funnel.

Somewhat more advanced examples of this theme have been developed in India by the Agricultural Development Society at Allahabad and the Agricultural College and Government workshops at Lucknow. At Allahabad the implement is called the " Wah-Wah " cultivator, and at Lucknow the " Lucknow Cultivator." It is also being produced commercially by one of the larger machinery manufacturers in India. It is designed to meet all the cultivation needs of a small peasant farmer controlling up to 10 acres of land with a pair of medium-sized bullocks. In addition to the provision of alternative plough bodies, it may be fitted with a ridging body, a sweep, and a tool bar carrying up to five cultivator tines and seeding tubes. The outfit is available commercially in India at a cost of only £8 15s. 0d. A further improvement visualised on this idea is the development of a satisfactory seeder for attachment to the tool bar to sow up to three or five rows at a time to replace the rather primitive method of dropping seed by hand into the funnel at the top of the seeding tubes. Though primitive, it is effective in sowing seed in straight lines, and from the extension point of view relatively easy to absorb by the cultivator, as he is familiar with the system on his indigenous implements. In Rhodesia an outfit has been produced to extend the versatility of the western type mould board plough by the provision of alternative plates and shares to turn the plough into an interow cultivator or small ridger and can be fitted with a mechanical seeder. In Japan, the multi-purpose idea is incorporated in an implement of the horse-hoe type, but specially designed for operation with a cow or bullock. The tines of the cultivator may be removed, leaving the central frame or beam, which resembles an ordinary plough beam of western type. This can then be fitted with various plough bodies and a ridging body of remarkably low draft. It has a wheel at the front, whereas the Indian system has no wheels. Tanganyika and Uganda are also investigating the application of the long-beam system to ploughs and the use of the Indian multi-purpose system with the long beam. This should be of particular application to the small farmer controlling up to 10 acres.

There is, however, another class of farmer emerging who farms 30 acres or more of land, but who cannot afford to buy a tractor and, even if he did, would not be able to use it economically. For this category of farmer the idea of a kind of self-propelled tool bar is emerging, but the propulsion is by a pair of bullocks. Provision is also being made in some cases for the eventual replacement of the bullocks by a motorised power unit. Development of this idea has reached the prototype stage by an Indian firm of farm machinery manufacturers and developed from what was previously known as the Voltas Otto frame. A French firm is also producing two machines of similar type which they claim are meeting with success in parts of Africa, while samples are under test by the Special Development Section in Uganda. The ox-drawn toolbar has, in fact, been receiving considerable attention in East Africa within recent years, particularly by Tanganyika and Uganda, and development work has been in progress in conjunction with the N.I.A.E. in the United Kingdom. The N.I.A.E. has now developed and constructed an experimental ox-drawn toolbar to be capable of ploughing, ridging, cultivating and sowing seed, while provision is also made for fixing a cart body for transport, as in the other machines mentioned. Samples of these have recently been sent to Tanganyika and Uganda for test.

As far as Tanganyika is concerned, there are still some design problems to be solved. Many of the crops there are grown at a 36 in. interow spacing, mainly on ridges. For inter-row weeding and cultivation a 36 in. or 72 in. wheel spacing is required, whereas the French and

N.I.A.E. machines have a 48 in. wheel spacing.

The French machine has a straight axle for the wheels which gives insufficient clearance for working high growing crops on ridged land and while the N.I.A.E. main frame is virtually an inserted U more clearance would be desirable under these conditions. In Tanganyika a machine with 72 in. wheel spacing was designed and constructed, but proved too heavy and unwieldy. A second machine with a 36 in. wheel spacing and a high arch axle and toolbar has recently been constructed to test the feasibility of the high arch system for ox-cultivation.

The idea of the high arch toolbar is not new and tractor versions are already available commercially. The Tanganyika experimental machine is, in fact, based on the rear section of a commercially available tractor high arch toolbar manufactured in Australia. A high arch toolbar is also available for the Indian machine as an extra. This is possible because the main frame of the machine is arched and there is no straight-through axle.

The writer is suggesting that with the information now available it should be possible to design an ox-drawn toolbar to meet the needs of as many Afro-Asian countries as possible in one machine. This should enable manufacture of sufficiently large quantities of toolbars at the lowest possible cost and thus be saleable in a wide enough market. In order to meet these conditions, two basic requirements should be met in the design. The first is that the frame itself should be of the high arch type with no straight-through axle to enable the use of a high arch toolbar. The second is that there should be provision for altering the wheel spacings at least from 36 in. to 48 in. A popular attachment also would be the provision of a seat for the operator.

**Seeders and Drills**

Before any system of interow cultivation or weeding can be applied, whether incorporated in a multi-purpose unit or used by itself, the seed must first be sown in straight or at least parallel lines. In primitive systems of cultivation based on the hoe there is no way of turning a hoe into a simple seeding unit, as in the case of the indigenous Ard in Asia, previously described. The first step in mechanisation among peasant farmers in East Africa (and other parts of Africa) has been the purchase of a plough. Sometimes this leads to more land being ploughed up than could previously be done by a hoe, more seed being sown broadcast than before, making it a laborious task to carry out weeding and in some cases impossible.

There is an urgent need, therefore, for simple and cheap seeders and drills. In the absence of suitable machines of this type being available from the developed countries of the West, other than modified tractor types which are far too expensive, a look to the evolution and development of such machines in the Asian group of countries is of particular interest.

In India the simplest drill consists of a tube about 1 in. in diameter with a funnel at the top. It may be fixed to the rear of an indigenous plough, which acts as the opener, and the operator drops seed down the funnel as he proceeds. This may at first sight seem an over-simplification of the problem, but in practice is perfectly effective in getting seed sown in parallel lines so that the crop can be weeded afterwards. It also has the advantage of being very cheap, costing only a few shillings. At the Punjab Agricultural College in Pakistan this idea was improved upon by fixing an iron shoe to a long beam with the tube and funnel at the rear made of galvanised iron sheet by the local tinsmith and a marker. The outfit took on and was put into commercial production at a cost of 25/-, including the beam. Indigenous wooden cultivators with three or more wooden tines with iron points are also fitted with the same number of seed tubes and a common funnel at the top. Operation with more than one seed tube entails a certain amount of skill to distribute the seed evenly down each tube, but the average cultivator in these parts is well accustomed to this method of sowing. As previously described, the same system for seeding has been incorporated in the small multi-purpose cultivator outfits made in India.

At the Agricultural College at Poona a fully mechanical version of the same idea has been developed. It consists basically of an indigenous four-tined wooden cultivator with iron points, which the Indian farmer knows well how to use as a seeder when fitted with the usual tubes and funnel. Instead of the funnel, they have fitted a modern-type four-row force-feed seed box with four polythene seed tubes connecting the seed box with the usual hole in the wooden cultivator shanks. The seeding mechanism is driven from a single peg-type wooden land wheel through bicycle chains and sprockets. The design is important as far as India is concerned from the extension angle, as the conservative farmer only has to accept the idea of changing the original funnel with a mechanical seed box. The application of a similar system to the manufactured cultivator units can be visualised and is receiving attention by development engineers in India. An alternative mechanism using a brush feed turned by hand is under test and development in Uganda.

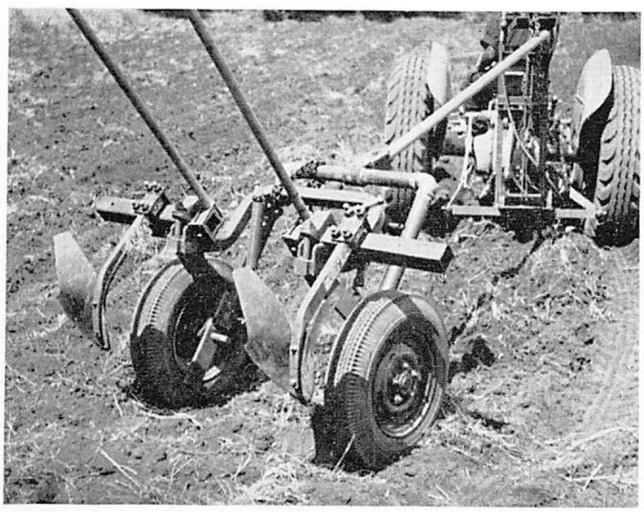
In Pakistan two simple machines for use purely as bullock-drawn drills have been developed at the Punjab Agricultural College and are now in commercial production, one being a cotton drill and the other a cereal drill.

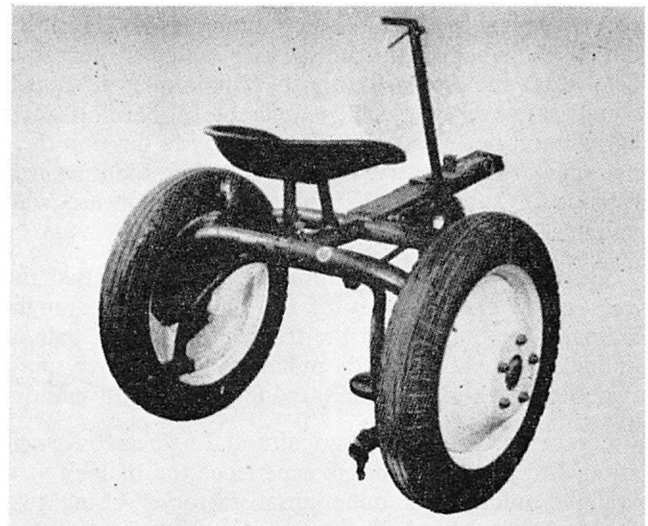
The two-row cotton drill consists of an axle driven by a land wheel which has four short pegs at right-angles spaced 3 ft. or 2 ft. apart. These rotate in the bottom of two seed hoppers and force cotton seed through an aperture in the bottom of the hopper. The seed rate is controlled by varying the size of the aperture by means of a sliding plate. The machine spaces the seed at about 1 ft. intervals, dropping two or three seeds at a time.

The four-row cereal drill is used mainly for sowing wheat. There are two seed boxes. The upper box carries enough seed to sow an acre, which drops by gravity down four telescopic tubes of galvanised sheet into the lower seed box. The level of seed in the bottom box, and also the seed rate, is controlled by the depth at which the telescopic tubes are set. Four cup-type seed wheels rotate and pick up seed in the lower box and deliver it down galvanised sheet spouts fitted with opening shoes, the height of which is adjustable for depth of sowing. A simple clutch engages the driving land wheel to the seed cups for sowing, and when the clutch is disengaged the machine can travel without dropping seed. Various versions of this machine are made from an all-wood model which costs £7 10s. 0d. to an all-steel one costing £17. Multi-row models have also been developed on the same principle for tractor operation.

The Tanganyika Agricultural Machinery Testing Unit and the Special Development Section in Uganda have co-operated with a manufacturer in the United Kingdom in the design of a small seeder unit for African conditions. It is basically of the rolling container type made of two pressed concave circular plates clipped together. The space within the plates contains the seed and an agitator, and there is a rim perforated with holes through which seed drops as the container rotates. There is provision for varying the size of the holes in the rim and the number of holes exposed for different kinds of seeds, seed rates and spacings. This seeder may be used singly in a hand-pushed frame or attached to the rear of a plough or up to any suitable number on an ox-drawn toolbar.

In conclusion, the author would like to point out that this Paper is by no means a full coverage of the subject. There are other problems of mechanisation of small peasant holdings in the tropics which are receiving attention, as, for example, in the case of harvesting and processing machinery, low-powered tractors and power units, utilisation and training of animal power, or improvement of harness and yokes, to mention a few. It is hoped, however, that the examples given in the field of cultivating machinery and seeders will be of interest to members of the Institution and the Agricultural Engineering Industry in general.





# DISCUSSION

MR. B. POTHECARY (Export Sales Manager, Ransomes, Sims & Jefferies, Ltd.), in opening the discussion, congratulated Mr. Constantinesco on his Paper. To those, like himself, who were conditioned to thinking of mechanisation in terms of tractors and other tools of that type, the fact that over 80% of the world's crops were still cultivated by hand or by tools like those described by Mr. Constantinesco was very significant. He thought that too many people had their heads in the clouds when thinking of farm mechanisation, and that not enough attention was being paid to the very real problems still to be solved at lower levels.

He agreed with the basic approach outlined by Mr. Constantinesco to the problems of mechanising smallholdings, which were formidable. Many people present would no doubt wish to discuss the application of machinery on slightly larger holdings, and also the thorny problem of the application of tractors and machinery through a government contracting service.

He was specially interested in one or two technical points, among them the choice of tined implements *versus* ploughs for primary cultivations. Western cultivation practices, together with inversion of the soil by ploughing, had been introduced, but now it seemed that the tined cultivation had re-asserted itself in some circumstances. He was also interested to note that tractor-mounted seed drills had made very little impact in tropical agriculture. There was obviously plenty of room for development in this sphere, since planting the seed at the correct depth and at the correct time was of the greatest importance if yields were to be increased.

Mr. Constantinesco had assumed that bullocks were available widely in the areas under discussion which could be trained to pull implements. This was not always so, often because of the tsetse fly ; then again in these areas there was no tradition of using available animals and harnessing them for draught work. The usefulness of the range of implements described was to that extent reduced. Another problem in many areas was the tremendous political pressure towards tractor mechanisation, whilst wider educational facilities were also emphasising the deficiencies of what Mr. Pothecary called " unenterprising " farming and the poor standard of living it provided for those engaged in it. In saying this, he was painting the other side of the picture so well drawn by Mr. Constantinesco, as in many areas the attractions of bullock farming were insufficient to retain the educated in the country areas where they were so badly needed.

Mr. Pothecary believed that we in this country had a part to play in the development of the countries described, but he did not feel that this was now a very lucrative field for the manufacturers. The under-developed countries were not content merely to develop their agriculture, but were also endeavouring to develop their manufacturing industry, which more often than not was capable of supplying the requisite tools for use with animals.

MR. D. R. BOMFORD (Bomford Bros., Ltd.) raised the question of the efficiency of the bullock as a draught animal. He understood the tractive effort of a pair of bullocks was about 150 lb. pull at a much slower speed than that of a horse, and he asked for further information.

CDR. F. D. BINGHAM (Agricultural Engineers' Association, Ltd.) said that in his experience the bullock as a draught animal was quite unsatisfactory. Using two 16-oxen teams for half-a-day each, one might plough two acres a day in good conditions, and the performance was largely dependent on how well the beasts had been fed. In these days the bullock was worth more to its owner as a beef animal than as a draught animal.

LT.-COL. W. N. BATES said that he agreed with Commander Bingham so far as African conditions were concerned. In India, however, he thought there was still a place for bullock-drawn implements, and he referred particularly to an iron type of plough made in Bombay Province.

MR. J. A. PATTERSON (New Holland Machine Co., Ltd.) asked the speaker to elaborate on the desirability of pneumatic tyres on the " advanced primitive-type " implements described in the Paper.

MR. G. R. CHALMERS (N.I.A.E.), replying at the request of Mr. Manby, said that while pneumatic tyres had some social significance as status symbols, the major point was that the pneumatic tyre required less draught than steel or wooden wheels in wet or dry soft conditions. It also appeared to shed dust and sand more effectively before top dead-centre than the alternative types, and this resulted in longer wheel-bearing life. When bought in bulk, there was probably little price difference between pneumatic-tyred and steel wheels.

MR. PATTERSON agreed with these points, but said that it was his impression that the majority of pneumatic tyres on the implements in question were running flat.

MR. G. T. MERRYWEATHER (Agricultural Technical Advisor to the Goodyear Tyre & Rubber Company, Ltd.) said that he had not seen tyres being run flat in use. Whilst at this stage it was not possible to prevent punctures, developments had been carried out with this aim. In reply to a question on unpuncturable tyres, Mr. Merryweather went on to say that in the past experimental work had been carried out on liquid fillings which solidified in contact with air, so sealing the hole, and with a sorbo rubber filling, but neither was satisfactory. An alternative was to put a liner in the cover under the tread, but for most purposes the tubeless tyre probably provided the most practical answer at the present time.

Replying to a question on tyre life in the Tropics, Mr. Merryweather said that ultra-violet rays resulted in crazing of the outer surfaces of the rubber, which leads to slightly more rapid wear. Work in the sun was a natural hazard inherent in the use of rubber tyres in the Tropics. When out of work they should be covered if possible, and they should be stored out of the sun.

MR. CHALMERS referred to the fact that 80% of the world's crops were still cultivated by primitive methods, and said that to his mind an even more startling figure, published in 1960, showed that 85% of the total draught power used in agriculture throughout the world was provided by animals, in spite of the fact that the world tractor population had doubled every ten years since 1930. He felt, therefore, that to make the utilisation of animal power more efficient was a well worthwhile aim.

Before describing the N.I.A.E. animal-drawn toolbar equipment, Mr. Chalmers outlined the advantages that this sort of equipment had compared with the multiple separate implement approach. The basic idea behind equipment of this type was to reduce costs and increase productivity by getting people to think in terms of drilling crops in parallel rows and eliminating hand-weeding, which constituted a very high proportion of the cost of producing tropical crops. The other point about the mobile toolbar approach was that it was very simple to combine with this the provision of effective transport. This was probably the next most important requirement after eliminating hand-weeding. He was sure that these underlying points had also governed the work which has been done by M. Nolle, who was responsible for the development of the French equipment shown by Mr. Manby.

At this point Mr. Chalmers showed slides of the N.I.A.E. equipment and described the toolbar in detail. It consisted of a welded square-section frame carrying two stub-axles on which were mounted two 5.00 $\times$ 16 pneumatic-tyred wheels. This gave a minimum ground clearance of 15 ins. Good penetration of the tools was provided by the provision of a simple over-centre lifting device, which locked the toolbar in or out of work. Simple quick-release pins or captive-threaded bolts had been used wherever possible to avoid nuts and bolts, which could be damaged or lost. On the question of ploughing, the equipment provided for mouldboard or chisel-point work.

The equipment was finally shown ploughing, cultivating, ridging, seeding, weeding and fitted with a cheap, simple cart body, which could be readily removed by withdrawing three simple self-locking pins. Although the cart body shown was not capable of being tipped, an arrangement for tipping had been successfully tried.

MR. R. M. CHAMBERS (Massey-Ferguson (U.K.), Ltd.) made the point that where tractors were in use it was economically desirable that they should be working as high a proportion of their available time as possible. He instanced an area in North India where farmers were able to use tractors throughout the year on rice crops, for tilling and hoeing, as well as puddling and other operations. In such circumstances, tractors could be used economically.

MR. J. H. W. WILDER (John Wilder & Sons, Ltd.) said that he thought that a conflict existed between the sophisticated and excellent equipment designed by the N.I.A.E. and the very primitive and low-priced equipment described in Mr. Constantinesco's Paper. Mr. Pothecary had told the meeting that there was a desire, for prestige and status reasons, to jump straight from the primitive to the ultimate in the form of tractor-operated equipment. The N.I.A.E.-designed equipment was probably more expensive than the small farmer could afford, and might not appeal to governments because it lacked the prestige of the tractor. This kind of political consideration was very important.

MR. MERRYWEATHER referred to the point made by Mr. Chalmers of the better dirt-shedding properties of pneumatic tyres as against metal wheels. This was a fundamental attribute of the pneumatic tyre. On meeting the ground the tyre deflected with the result that an arc of the tread became compressed into a chord, gripping the soil in the process. On leaving the ground the air pressure stretched the chord out again to an arc, shedding the soil in the process.

MR. E. ATKINSON (Shell-Mex & B.P., Ltd.) referred to the possibility of adopting the European method of ploughing. He thought the suitability of ploughing was governed mainly by considerations of moisture loss. Ploughing and scarifying tended to encourage loss of moisture, and might therefore be quite undesirable in hot, dry countries where it was important to retain all available moisture.

MR. C. P. WOLTON said that he had carried out some work on cultivations during the last rainy season in West Africa. With proper cultivations carried out before planting, the weed problem was lessened. Certainly weed control in a growing crop was a major difficulty that must be overcome. He emphasised that most tropcial crops were grown on ridges, and not on the flat, and said that the depth of ploughing in the uplands at least was usually limited to 4 ins. or 6 ins. by the available depth of soil. Where a greater depth of soil was available, as in the valleys, deeper ploughing was desirable.

MR. R. D. BELL (Wye College) mentioned that one important argument in favour of mechanised operations was the effect of planting at the optimum time. This was much easier with tractor-drawn equipment than with bullocks, and the resultant increased yields might go a long way towards justifying mechanisation.

MR. MANBY said that in many parts of Tanganyika, where possession of a bicycle was the maximum limit of prestige, improved equipment for bullock draught would be a major step forward. The basic concept of working in straight, parallel lines was something quite foreign to many primitive farmers, and educating them to do so was a major step forward. The same was true in other countries, and one of the functions of the Middle East Training Centre recently set up in Iran was to give students from Pakistan, Iran and Turkey some sense of orderliness in working. Certainly the use of seed drills would be a major improvement.

Mr. Manby went on to say that while there were conditions in which the use of oxen was to be encouraged, there were others in which it was not. He agreed with Mr. Bell that seeding and planting could not always be carried out at the optimum time. This could arise because the physical condition of the bullocks at the end of the dry periods was often unsatisfactory and they were unable to work at a reasonable rate until some considerable time after the rains had commenced, thus producing improved feed for them. In response to Mr. Bomford's query, he agreed that the pace was slower than a horse ; also it was often sporadic. Figures published for the sustained pull of a pair of oxen were of the order of 200–300 lb., and the peak loads, momentarily exerted, could be 500 lb. and up to 800 lb. with animals in excellent condition and when fresh first thing in the morning.*

Bearing in mind these points and also that of prestige, he wanted to suggest a compromised solution for certain types of farming. There might be a need for some machine to bridge the present gap between animal-drawn equipment and conventional present-day tractors. Such a machine, of course, must be a tractor in the most basic form, simplicity, ruggedness and cost being vitally important features. A prototype one-wheel-drive machine had been developed at the N.I.A.E. as representing the simplest possible form of tractor to see whether its practical performance made it an attractive proposition as an intermediate step in mechanisation. It had a single-cylinder air-cooled engine, a working forward speed of about $1\frac{1}{4}$ m.p.h., a transport speed of about 7 m.p.h. and a reverse gear. The drive from engine to transmission was by a flat belt ; a single control lever takes up the drive when it is locked in a forward position,

* "Animal-Drawn Equipment for Tropical Agriculture," by Chalmers and Marsden, *Journal of Agricultural Engineering Research*, Vol. 7, No. 3, 1962.

and releases the drive and applies a brake in its rear position. With the driving belt removed from the transmission, the tractor engine can provide a stationary power source for pumping, grinding, hammer-milling, etc. A very simple tiller steering system is used. The tractor could be used with the tools designed for ox-drawn equipment fitted on to a front-mounted tool-bar. A transport platform or box on the front of the tractor would also be an essential feature, and he emphasised that the use of any form of tractor for transport purposes was important also from the social point of view people in under-developed countries were not always content to go only from hand equipment to ox-drawn equipment, however sophisticated. They wanted something on which they could ride into town, as well as work with, and this was very important in their eyes.

The machine shown has done some field work and this is proceeding. Design has begun on a later version of this tractor, which, it is hoped, will be taken to Africa for full assessment. The use in the areas under discussion of the surplus of second-hand tractors in the Western World was sometimes suggested, and Mr. Manby believed that in some areas this could be useful, if properly organised. If done badly, and without proper organisation, it could be most unsatisfactory and highly undesirable.

Referring to the use of pneumatic tyres, he mentioned the difficulties experienced due to tyre wall breakdown and penetration by thorns. He felt that tougher tyre carcasses were required, and that although there had been some improvements in the last three or four years there was very considerable scope for further development of tyres which did not require to be inflated and would really stand up to complete lack of maintenance.

The PRESIDENT, in closing the session, emphasised that peasant agriculture, and not large acreages, had been under discussion. He thanked Mr. Manby for his most able presentation of Mr. Constantinesco's Paper.

## LETTER TO THE EDITOR

DEAR SIR,

On page 100 of our Paper " Aspects of Combine-Harvester Design " (Journal, Volume 18, No. 3), we refer to the ability or otherwise of self-propelled combines to achieve heads-first feed. We would like to point out that this relates mainly to British practice. A number of Continental machines can, when working in a standing crop, present a high proportion of the crop heads first.

Yours sincerely,

PETER HEBBLETHWAITE,
*Head of Implement Testing Department.*

R. E. ARNOLD,
*Harvesting and Handling Department.*

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# ELECTIONS

*Approved by Council at their Meeting on the 27th September, 1962*

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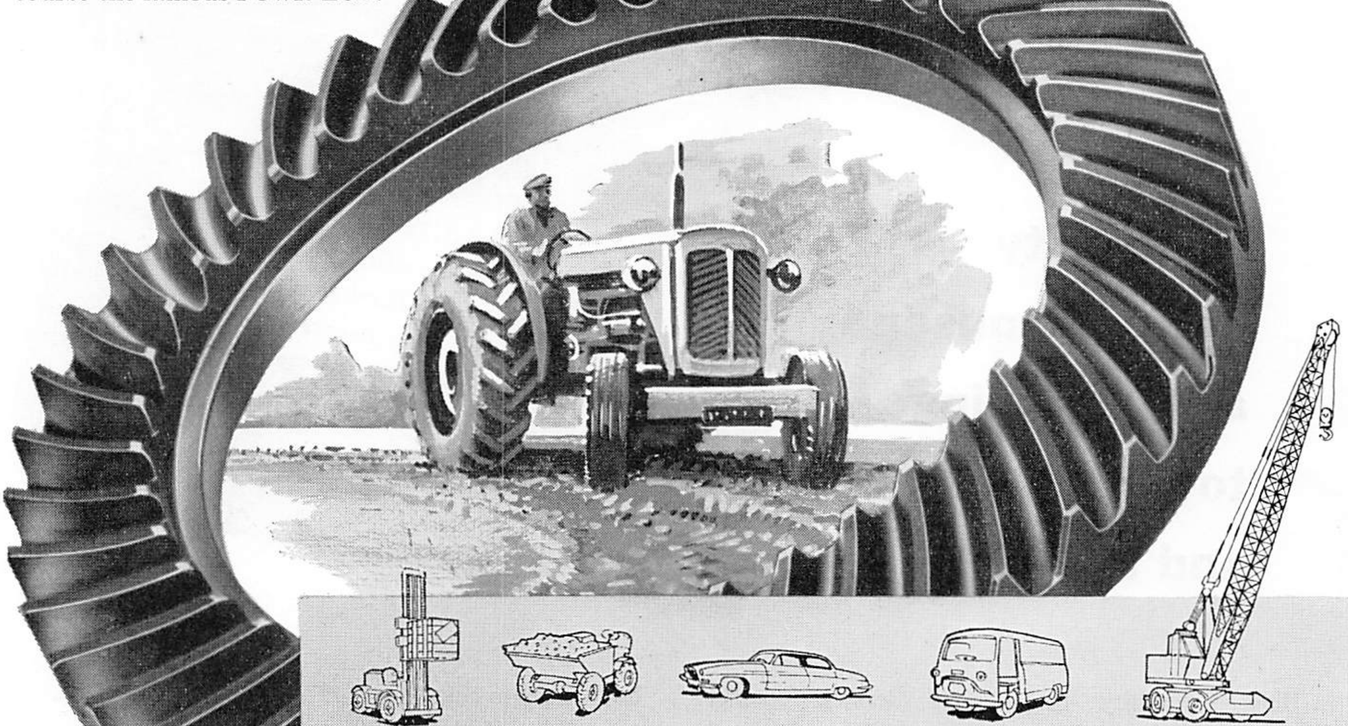

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