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1965–The year of the all-new Fords

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GUEST EDITORIAL

THE ROLE OF THE AGRICULTURAL ENGINEER in the THIRD AGRICULTURAL REVOLUTION

by

IAN J. FLEMING

BSC(AGR), F INST WSP, AMI AGR E, Chairman of the Scottish Branch of the Institution

After graduating from Edinburgh University in 1937, Mr Fleming lectured in agricultural engineering. He served in REME during the war following which he joined Scottish Agricultural Industries Ltd. He has remained with them to this day, his particular interest and responsibility being connected with work study application.

Mr Fleming has been active on the Committee of the Institution's Scottish Branch for some years and was Vice-Chairman for three years prior to becoming Branch Chairman in 1964.

The New Agricultural Revolution

Though we may not be aware of it, we are at this very moment witnessing a third great Agricultural Revolution which is taking place in an increasingly hungry world.

In the early 1800's, with the drift of population to the towns, horses were harnessed to take the drudgery out of manual farm work and to increase the output of those who remained on the land. A century later, the introduction of the internal combustion engine heralded a second revolution. By the end of the 1914-18 war the farm tractor was a reality, with its ever-increasing potential for mechanizing farm operations. The replacement of the horse gathered momentum so that by the end of the 1940's, the change-over was almost complete.

During the 1950's, a third and much more far-reaching revolution began to take place in agriculture as a result of scientific advances, together with the increased application of business management and work study techniques. These have as their aim the maximization of profits in the face of rising costs, almost static farm prices and a constantly dwindling labour force.

Contract Services

Against this economic background and as agricultural techniques become more specialized and more sophisticated, it is evident that on medium sized and small holdings, farmers with limited resources must come to rely more and more on the services of well equipped and experienced contractors.

In Scotland, as in other parts of the U.K., contract services include the mechanization of excavation, drainage and diching work, basic cultivation where it is still necessary, the spreading of lime and slag, and harvesting of cereals and potatoes. In recent years, however, we have witnessed an increasing dependence upon contractors who have been called upon to undertake specialized tasks which demand a high degree of precision, such as the spreading of fertilisers and the spraying of crops to control weeds both before and after emergence.

The amount and scope of contract work is bound to extend as it becomes increasingly uneconomic to keep an extra man on the farm merely to boost output at busy times of the year, and it is surely better that these 'extra' farm workers should have secure and full employment with the contractor for the greater benefit of the community. Thus, it cannot be long before the agricultural contractor becomes a very important customer of the farm machinery industry.

Rethinking in the Design of Farm Machinery

As this trend develops, it is evident that the days of the low output or modified horse drawn equipment are numbered, and the era of the high performance specialist machine in the hands of an experienced operator are upon us. In these conditions, we may expect to see great changes in the conventional farm tractor which has altered little in form in fifty years. Already, developments in bulk fertilizer spreading in Scotland have shown that output can be greatly improved not only by increasing working width, but also by mounting the mechanism on a general purpose chassis having independently sprung wheels, which make possible field working speeds of 10-15 mile/h. As with the tractor, it is unfortunate that in very many instances implement design has failed to keep pace with

Continued on page 99

THE INSTITUTION'S NEW HEADQUARTERS

Penn Place, Rickmansworth, pictured above, is the pleasing modern setting for the Institution's new central offices and secretariat (see 'Institution Notes' on opposite page)

INSTITUTION NOTES

New Premises

The removal of the Institution's central offices and secretariat from 6 Queen Square, London to Penn Place, Rickmansworth, Hertfordshire, in September, represents a giant stride in the Institution's development. During the twenty-seven years since the Institution was founded the organization has been London-based; it is naturally to be expected that the Institution will always have strong administrative ties with the capital but it is equally true that the structure of the Institution is nation-wide and indeed international. This has been aptly reflected in recent years in the development of the Institution's branches in the United Kingdom and the consistent growth of the membership overseas. In taking the bold decision to move the Institution's headquarters away from central London the Council has taken a step which denotes a spirit of looking outwards from the proximity of London while losing none of the advantages of remaining close at hand to it. By taking advantage of a new office development in a county close to London, the Institution is able to create a compact, modern and highly mechanized nerve centre operating with the minimum staff and at a lower cost per unit of work than could have been achieved by continuing operations in central London. The move, in fact, fits neatly into the programme of modernization of the Institution's administration that has been taking place steadily during the past two or three years.

The new premises are so located as to be geographically more accessible by road to the membership of all eight of the Institution's branches; Rickmansworth is only a few miles from motorways M1 and M4 and there are adequate parking facilities at Penn Place. At the same time links with London are fully maintained as Rickmansworth is easily reached by road, British Rail and London Transport bus and underground services. Rickmansworth is also on the GPO London telephone dialling system and as the Institution has two exchange lines at its new premises instead of only one as in London, communications are still further improved. In short, the Institution, in ostensibly 'moving to the country' has taken a step calculated to strengthen and equip it as an international professional body faced with the challenge of growing responsibilities to its own membership and to the industry it serves.

An incidental but by no means unimportant fact is that the Agricultural Machinery and Tractor Dealers' Association have also moved from London to Rickmansworth and are neighbours of the Institution at Penn Place. This confers the advantage of an effective liaison between the two organizations and will particularly facilitate the co-operation that continually takes place between them, especially in the field of education and training.

Regional Activities

The removal of Head Office to Rickmansworth is consistent with the pattern of mobility which is emerging in the arrangements of Institutional activities in South East England. This is exemplified by the growing tendency to hold major open meetings around London rather than always at its centre. A measure of the success of this policy is to be seen in the attendance of some 170 members and guests at the first open meeting of the Institution's national winter session programme 1965-66 which was held in the National College of Agricultural Engineering, Silsoe on 28 September and which replaced the open meeting customarily held in central London at about that time of the year. Dr P. C. J. Payne, speaking in his capacity both as Principal of the College and a member of the Institution Council, drew attention to the fact that this was the first Institution open meeting to be held at the National College and was a visible expression of the close ties that had always subsisted between the two organizations. Dr Payne then introduced Mr J. H. W. Wilder, BA, MI AGR E, President of the Institution, who proceeded to give his Presidential Address entitled 'An Analysis of Career Opportunities for Professional Agricultural Engineers'. The remainder of the day was then given over to the presentation of three papers each dealing with a different aspect of 'Power Utilization'; these were:

(*a*) 'A Review of Power Transmission in Farm Machinery'
by T. Sherwen, MI MECH E, MSAE, MI AGR E, Consultant Engineer

(*b*) 'Transmission of Power by Power Take-off'
by J. A. Howard, AMI AGR E of Howard Rotavator Co. Ltd.

(*c*) 'Tyres Mobility and the Tractor'
by W. Wortley and E. G. Dean of Dunlop Rubber Co Ltd

At the conclusion of the day's proceedings the Immediate Past President, Mr W. J. Priest, MI AGR E, presented a Certificate of Honorary Membership and Formal Citation to Mr Douglas R. Bomford (details of the election of Mr Bomford to Honorary Membership appear in 'Institution Notes' in the July 1965 issue of the *Journal*).

The Presidential Address is to be published in the *Journal* in December 1965 and the three papers on power utilization, together with part of the discussions thereto, will appear in the March 1966 issue.

Continuing the process of 'regionalizing' the Institution's national programme, another major open meeting is to be held outside London during the current session. This will take place in Swanley Hall, Wye College (University of London) near Ashford, Kent, on Thursday, 24 March 1966. The subject-theme will be 'Fruit Husbandry'.

Annual Conference and Annual Dinner

One consequence of conducting major open meetings in Bedfordshire and Kent rather than in London is that the Annual Conference and Annual Dinner will stand alone as the Institution's London activities during the session 1965-66. Both events will take place on Thursday 12 May. The Conference will be held in the hall of the Institution of Mechanical Engineers, London and will present a series of papers and discussions on the theme 'Vegetable Harvesting and Handling'. The Annual Dinner will be held at St Ermin's Hotel, London.

Branch News

As announced in the *Journal* some time ago, it is the intention to give increasing prominence in these pages to reporting the activities of the Institution's eight branches. This issue features 'News from Branches' for the first time and as well as containing reports of one or two meetings already held, details will be found of branch programmes for 1965-66 so far as these are known at the time of going to press. Where branch programmes are still incomplete the opportunity will be taken in succeeding issues of the *Journal* of publishing details of fresh information.

Examinations

The 1965 examination for the National Diploma in Agricultural Engineering was held last July at the Essex Institute of Agriculture, Writtle, Chelsmford and at the West of Scotland Agricultural College, Blythswood Square, Glasgow. Out of the 56 entries for the examination 40 candidates passed and 7 candidates were referred in a single subject of the examination. The 1965 Institution Examination was held at the Essex Institute of Agriculture and at Rycotewood College, Thame, Oxon. There were 36 entries received for this examination; 13 candidates passed and 8 were referred in one subject only.

Detailed results for both examinations appear on pages 105, 106 of this issue of the *Journal*. Council expresses its appreciation for the examination facilities made available by the centres concerned.

Candidates referred in one subject of either one examination will be eligible to resit that subject next year. For the majority of candidates for the 1966 examinations however, new examination regulations and syllabuses will become operative. Major changes are the limitation of the Institution Examination to candidates of 30 years and over with not less than 3 years practical experience, and the award of the ND AGR E by the Examination Board on the basis of external assessment of examinations arranged by recognised training centres for the ND AGR E. Many members will recognize the latter system of examination and award as similar to the scheme for the award of Ordinary and Higher National Certificates and Diplomas in Engineering.

Award of Johnson Medal

Council is pleased to announce the award of the Johnson Medal, commemorating the foundation of the Institution in 1938 by Lt-Col Philip Johnson, CBE, DSO, MI MECH E, HON MI AGR E, to Stephen Bradford as the outstanding candidate in the 1965 Examination for the National Diploma in Agricultural Engineering.

Mr Bradford recently completed a three-year course of training at the Essex Institute of Agriculture leading to the National Diploma in Agriculture and subsequently to the ND AGR E. He returns to the family agricultural engineering firm in Yeovil, Somerset.

The Johnson Medal was presented to Mr Bradford at the 1965 Presentation Day of the Essex Institute of Agriculture held on 29 October. Mr Claude Culpin, OBE, MA, MI AGR E, a Vice-President of the Institution, attended the function as a guest of the Essex Institute.

New Courses

1965 has been a memorable year in regard to advancements in Agricultural Engineering Education. July saw the emergence of the first graduates of the National College of Agricultural Engineering (see page 103 of this issue of the *Journal*) and the award of the first Master's Degree in Agricultural Science, Farm Mechanization option, at the University of Reading. The Senate of the University of Newcastle (where a Master's Degree Course in Agricultural Engineering has been available for some years) has approved the introduction of a first degree course in Agricultural Engineering. This new honours degree course will be of four years duration, including a preliminary year, from which students with suitable G.C.E. 'A' Level qualifications will be exempt. The first intake of 20 students will be accepted in October 1966.

Yearbook

As announced in earlier issues of the *Journal*, the **Yearbook** which is shortly due to make its appearance will be very different in form from that of previous years. The tremendous amount of editorial work entailed, coupled with the Institution's recent change of premises, means that publication has unfortunately been delayed; work is, however, well advanced and copies should be in the hands of all members by the end of the year. In 1966 and subsequent years the **Yearbook** will revert to the scheduled publication date of September.

GUEST EDITORIAL *(continued)*

new techniques. For 150 years the mouldboard plough has reigned supreme as the basic tillage implement, and only very recently have promising experiments been carried out with alternative designs to produce a better tilth and to reduce draught. Similarly, the basic style of fertilizer distributing mechanisms has altered little in fifty years, in spite of the fact that concentration has more than trebled during that period. Thus today, variations of 20% on either side of the mean application rate, when they represent as much as 40 units of nitrogen, are no longer acceptable. In handling farm materials we have for too long failed to recognize the very important fact that too many farm products are handled too often in man-sized bundles such as the bag and bale, and that most agricultural produce has its greatest value at the time of harvesting. Every subsequent handling operation adds to cost without increasing value, a truism which applies particularly to products such as potatoes which are easily damaged and even decrease in value as a result of most handling operations.

The Future

These are but a few examples of the opportunities which exist for fundamental rethinking in the design of farm machinery. Improvement of existing equipment by modification is a practice which has been with us for too long; it may be easy and inexpensive, but it can never be more than a stop-gap measure. Thus it seems to me that a great responsibility rests upon the members of this Institution, for if the British Agricultural Engineering industry is to prosper, it must continue to look for outlets for its products beyond these shores where extensive areas are eagerly awaiting development by suitable high capacity equipment. It may well be that the high output specialist machines which are being developed to equip the British agricultural contractor are those upon which our future export business will depend.

INSTITUTION NOTES *(continued)*

Institution Journal

The difficulties referred to have also caused some delay in publishing issues of the *Journal* this year and it was for this reason that the issue which should have appeared in June was actually published in July and this current issue, which should normally have been circulated in September will actually arrive in the hands of most members during November. The publishers regret any inconvenience to which this may have given rise and it can be reported that the final issue for 1965 (Volume 21, No. 4) will appear in December, in accordance with the normal schedule.

Forthcoming Conferences and Exhibitions

Smithfield Show
This event will be held as usual at Earls Court, London and will take place during the period 6-10 December.

Post Graduate Training Programme in Soils Science
Organized by the International Agricultural Centre, in co-operation with the Agricultural University and the Netherlands Soils Survey Institute, a post graduate training programme 'Soils Science' is to be held at Wageningen, the Netherlands, from January to July/September, 1966. This course will be conducted in English and applications should be received at The International Agricultural Centre, 1 Generaal Foulkesweg, Wageningen, the Netherlands, not later than 30 November 1965. Further particulars can be obtained from the Agricultural Attaché, Royal Netherlands Embassy, 38 Hyde Park Gate, London S.W.7.

The World Fair of Rural Equipment (SIMA, Paris)
The 37th Salon International de la Machine Agricole, will be held at Porte de Versailles during the period 8-13 March 1966. Those wishing to have further particulars either as exhibitors or visitors should apply to the Salon International de la Machine Agricole, 95 Rue Saint-Lazare, Paris 9, France.

In the July 1965 issue of the Journal *the announcement of the CIGR Section II Seminar on Farm Structures under 'Forthcoming Conferences and Exhibitions' listed a number of bodies represented on the organizing committee. One of these was named as 'The Electrical Department Association'. This is incorrect and it should have read* The Electrical Development Association.

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UBLICATIONS AND REVIEWS

Advanced Applied Mechanics
by J. Stoney:
Machinery Publishing Co; 1964; 45*s.*

Mr Stoney has written this book specially to cover the Fourth Year or the A1 Grade of the Higher National Certificate in Engineering. The work consists of two parts, the first dealing with Strength of Materials and the second with Machines which includes a chapter on Hydraulics.

The theory is set out concisely and includes worked examples. At the end of each chapter there are examples for the student to work himself to help him to understand the subject. These examples are taken from examination papers of the main examining bodies and are supplied with answers.

Although this book is written for the specific purpose mentioned I am sure it will be of use to any student who wishes to study these subjects to this standard. J.K.

Farm Machinery
by A. G. Harris, T. B. Muckle and J. A. Shaw:
Oxford University Press; 1965; 25*s.*

This book has been written on the principles of farm machinery and in its present form meets most of the requirements of the syllabus for City and Guilds course No. 267, entitled Farm Machinery (Introductory).

The first three chapters deal with many of the scientific principles of machinery and if read under the direction of the teacher could supplement practical and demonstration work, but it is felt that students on the above-mentioned course may find parts of this section a little difficult to follow on their own. The section on science is open to criticism; it would have been greatly improved if greater stress had been placed on the application of the science principles.

The section on materials begins with a clear and simple treatment of the properties of materials, which can be a mystifying subject for the younger reader. It is regretted that plastics and some of the newer materials now being used have not received a fuller treatment.

Chapter five deals adequately with tools and parts of machines except for some unrealistic illustrations. The use of the word wrench for spanner is regretted.

Chapters six to ten are devoted to engines and tractors. The subject receives only fair but rather general coverage. Many of the illustrations are not complementary to the text.

The last section of the book covers a wide range of farm machinery and equipment and, although there are some omissions from the City and Guilds Stage I and II Farm Machinery Syllabuses, the content and the writing are good.

The book is a welcome addition to the range of books available on farm machinery. It is particularly suited to the student gaining his first few years of experience of mechanized farming. It is regretted that the maintenance requirements of machines and practical hints and tips were not developed further. K.M.

PUBLICATIONS RECEIVED

British Standard 2053:/1965 (revised standard): General Purpose Farm Buildings of Framed Construction.

British Standard 2505:/1965 (revised standard): Fixed Equipment for Cowhouses.

British Standard 3854: 1965 (new standard): Farm Stock Fences.

British Standard 3859: 1965 (new standard): Topping Knives for Sugar Beet Harvesters.

British Standard 3872: 1965 (new standard): Poultry Watering Appliances.

British Standard 3885: 1965 (new standard): Tolerances for Hot Brass Stampings.

British Standard 3904: 1965 (new standard): Recommendations for the Location and Direction of Motion of Operator's Controls for self-propelled Agricultural Machines.

British Standard 3926: 1965 (new standard): Recommendations for the Use and Maintenance of Engine Coolant solutions.

British Standard CP 11: 1965 (new code): Design and Construction of Dairy Buildings.

British Standard CP 326: 1965 (new code): Protection of Structures against Lightning.

Electrical Development Association: Farm Electrification Handbook Number 8: Electricity in the Farm Dairy—A Guide to the Practical Design of Installations: 1965.

All publications reviewed or listed above have been acquired for the Institution Library

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The National College of Agricultural Engineering

Silsoe, 13 July 1965

The President of the Institution, Mr J. H. W. Wilder, BA, MI AGR E, *was Guest of Honour at the first Graduation Ceremony of the National College of Agricultural Engineering, Silsoe, on 13 July. He presented awards to 9 college students who had successfully completed the three-year Associateship course and also presented post-qualifying certificates to a further 12 students who had undergone one-year specialist courses at the National College. Prior to making these presentations, Mr Wilder gave the Graduation Address of which the following is a summary.*

Mr Wilder began by saying that Presidents of Professional Institutions should be at their happiest when presenting Degrees and Associateships as the recipients would almost certainly become members and mainstays of their Professional Institutions. He was, he said, quite certain that no duty which might fall to his lot while President of the Institution of Agricultural Engineers, would give him more satisfaction or be considered by the Institution members more worthwhile, than the presentation of these awards.

The President said he could remember the discussions which took place at the Council Meetings of the Institution during the early 1950's and the growing awareness amongst the leading professional agricultural engineers of the day that the provision of college training for agricultural engineers, as such, was of vital importance to this country. This College could therefore be said to be largely the 'brain-child' of the Institution of Agricultural Engineers but in saying this, he would hasten to add that it could never have come into being without the help of many other bodies, particularly the Agricultural Engineers Association and the Agricultural Machinery and Tractor Dealers Association. The Agricultural Engineering industry's promise to the Minister of Education to make a substantial contribution to the College in terms of equipment, had probably been a major factor in obtaining Government approval.

This gathering was therefore a celebration, an occasion for rejoicing because for the very first time in this country, nine men were graduating at the end of a three-year course specifically designed to train agricultural engineers. The President said he wanted to be careful not to belittle the other courses already available for training agricultural engineers but whereas these courses took men already with qualifications in agriculture or engineering and gave them the necessary training to make them agricultural engineers, the Associateship course of this College was complete in itself, tailor-made for the one purpose of producing Agricultural Engineers. It was probably nearly unique in that the industry concerned had been consulted and had had considerable influence in the preparation of the syllabus of the course. This was a typical example of the happy co-operation between so many bodies and individuals which had brought about the successful establishment of this College and the graduation of the first course of Associateship students.

Those who had been watching the progress of this College from the outside, had been very happy at the way things had gone. In particular, the announcement that the Associateship had been designated comparable to a first degree was a cause for great delight. It was the standard which had been hoped for from this College and the Principal and his staff must be congratulated on this great achievement. May it not be too long, said Mr Wilder, before a way could be found whereby a Degree itself could be conferred, a step which would merely seem to confirm a standard which already existed. One was impressed at the growth of these buildings and at the creation of a college campus, pleasing to look at and providing the facilities not only for satisfactory tuition but also for fostering the growth of the 'complete man', by providing for his leisure, sport, living accommodation and sustenance. One sensed that the Principal had been very fortunate in the support given by the Registrar and the administrative staff and they should also be congratulated on their contribution to the successful series of events leading up to this day's celebrations.

There was one more body to be mentioned, namely, those unpaid advisers who had given of their time to make the policy decisions and provide the guidance, the Board of Governors under their Chairman, Sir Gilbert Fleming. On this day of rejoicing, the invaluable contribution of the Chairman and his Board of Governors must not be forgotten.

The President went on to say a word about the Post-graduates. Of the twelve receiving Post-graduate certificates, ten were from six different countries overseas. He was glad that they should have come here for Post-graduate training and hoped that they would return to their own countries better equipped to tackle the various problems ahead of them. One of the arguments put forward to justify the creation of this college was that it would provide a centre for students and graduates from overseas. At present, about one out of every six receiving tuition there came from abroad, the majority of them taking a post-graduate course. It was good to know that the need foreseen when planning the college, had been confirmed in practice.

The Chairman, the Board of Governors and the Staff of this College must be very pleased to know that those of the men receiving awards today who wished to obtain jobs in industry, had all been offered Graduate apprenticeships or the equivalent, many with the leading agricultural engineering firms in this country. This ready acceptance of the product of this college by industry was most encouraging and completed the College's cycle of responsibilities towards the first intake of students in a most satisfying manner.

Thus, said Mr Wilder, the first pudding had been cooked, the pudding being, metaphorically speaking, the students who were about to receive their awards. From all external appearances, the recipe had been carefully followed, the ingredients had been of good material and the cooking had been according to plan. But the proof of the pudding would be in the eating and it would be three years or more before judgement could be made, before the digestive system of industry produced the smile caused by a satisfying repast or the scowl resulting from internal discomfort. The President said he thought it was therefore only right that he should try to give some guidance as to what industry was looking for in its graduate apprentice engineers.

The first thing to remember was that while professional agricultural engineers and leaders in the industry appreciated the need for college-trained agricultural engineers, the men to whom these graduates would be immediately responsible, would probably be completely ignorant of this College and even less interested in its objectives.

Therefore, although industry wanted graduate agricultural engineers, it was going to be up to those graduates to prove to industry that they had the qualities required. He hoped that those graduating today would accept the challenge of the tough times which might lie ahead and turn them to their advantage. In engineering terms, it was always advisable to test the strength of a component such as a plough beam, to stand up to extreme stress before fitting it in the plough. The more responsible the position in industry, the greater the probability of having to cope with emergencies under conditions of stress. Failure to cope at that stage might be disastrous to the firm concerned so it was not unreasonable for industry to test the quality of its graduates during the training stage to make sure that they were of sufficiently tough material to stand the racket of the higher executive positions for which they were being trained.

Viewed from the point of view of the graduates, this attitude of industry might seem high and mighty. They may well be saying 'You are not making such a wonderful go of it. Look at the complaints of poor workmanship and design, bad deliveries and high cost'. There would be no hope of improving this situation if graduates did not believe that they could do better, that they had gained new knowledge and had new ideas to offer. College training must give a new vision of what could be achieved and create a discontent with the low level of actual achievement when compared with the possible. If it did not do this, it had little value. It was the way of the world that human achievement fell short of perfection and it was unfortunately only to be expected that the actual performance of our graduates would fall short of their hopes of today. But without those hopes, without this new vision and without a new enthusiasm, our industry would not progress.

Drawing attention to the vital need for the industry to make progress, Mr Wilder said that export performance of British tractor makers had shown the way as to what could be done, with 70 per cent of their production going overseas. The agricultural machinery and implement manufacturers were doing quite well to be exporting about one third of everything they made but there was room for great improvement in the years ahead. This was also the opportunity, in a world in which a large proportion of the existing population was undernourished and in which the predicted increase of population, given a period of comparative peace, was almost too frightening to think about. The world needed more food now and this need would increase as the number of mouths to be fed increased. The agricultural machine had a vital role to play in increasing the world's production of food. Power in all its forms was being made more readily available to the farmers of the world; electric power, engine power and tractor power. This increasing availability of power must be harnessed to the service of farmers to help in the struggle to produce more food. This must surely mean an increase in the size of the world's agricultural machinery industry which would make the present day turnover, on a world basis, seem small by comparison. Britain could continue to be a leading supplier of the world's agricultural machines but she would do so only if her technical skill and know-how kept ahead of her competitors. This rapidly developing and exciting situation meant that her agricultural machinery industry must have the best agricultural engineers to run the various firms, design and develop new machines and organise the technical sales and service required. This was the opportunity and the challenge. The best agricultural engineers should come from amongst college-trained men but these men must realise that their academic qualifications were an addition to, and not a substitute for, practical experience and training in industry itself. Industry did not owe graduates a career but industry would clamour for their services if they proved in practice, that they had the judgement and the technical skill required to keep the industry ahead in the future. New products had to prove their worth before they created a demand for themselves. It would be the tough assignment of the first Associates of this National College, to prove their worth to industry and thereby create a demand for the services of those who would be graduating from this college in future years.

The President said there were two more things he would like to mention. Firstly, at the beginning of this address, he had referred to the delight of Presidents of Professional Institutions at presenting Degrees and Associateships because it potentially increased the membership of their Institutions. He would offer a reminder that Associateship of this College was a suitable qualification to enable members of the Institution of Agricultural Engineers who were now students to transfer to the grade of Graduate and he very much hoped that all College Associates would make this application for transfer as soon as possible. He would also like to hope that anyone, including the Post-graduates, who had not yet applied for membership of the Institution, would do so. Like industry, the future success of the Institution of Agricultural Engineers depended on the college trained men of today. History would be made one day when someone trained at this college became President of the Institution

Secondly and lastly, Mr Wilder said he would like to express what he was sure were the feelings of all present by wishing all the recipients of awards the best of good luck and good fortune in their future careers.

1965 EXAMINATION RESULTS

INSTITUTION EXAMINATION*

Pass

		Training Centre
Baldwin, A. L.	Warwicks	Private Study
Briggs, P. S.	Somerset	Kesteven Farm Institute
Cape, R. ..	Yorks ..	East Riding Institute of Agriculture
Cartland, M. C.	Beds ..	Lackham School of Agriculture
Harty, G. A. N.	Yorks ..	Private Study
Herbert, J. ..	Co. Durham	College of Aeronautical & Automobile Engineering
Hunt, G. P. ..	Worcs ..	Lackham School of Agriculture
James, W. W.	Oxon ..	Private Study
Nkembe, G. S. N.	Cameroon	College of Aeronautical & Automobile Engineering
Nutt, G. J. ..	Oxon ..	Rycotewood College
Shaw, J. G. ..	Dorset	College of Aeronautical & Automobile Engineering
Wainwright, R. P.	Salop ..	Rycotewood College
Waugh, T. ..	Staffs ..	Rycotewood College

** Passes in this examination are not graded*

NATIONAL DIPLOMA IN AGRICULTURAL ENGINEERING

First Class Honours

		Training Centre
Bradford, S. P. J.	Herts ..	Essex Institute of Agriculture
Linton, B. ..	Ches ..	Essex Institute of Agriculture
†Ormiston, L. W.	Surrey	Essex Institute of Agriculture

Second Class Honours

Bartle, J. A. G.	Kent ..	Essex Institute of Agriculture
Clark, J. A. L.	Yorks ..	Essex Institute of Agriculture
‡[1]Coote, D. R.	Sussex	West of Scotland Agricultural College
*Cousins, S. B.	Kent ..	Essex Institute of Agriculture
Earley, J. A. ..	Wilts ..	West of Scotland Agricultural College
Hayward, A. R.	Kent ..	Essex Institute of Agriculture
*[1]Hayes, R. J.	Leics ..	West of Scotland Agricultural College
‡Knight, T. J. M.	Somerset	West of Scotland Agricultural College
Lamin, W. H.	Cumberland	Private Study
‡Minto, B. ..	Co. Durham	West of Scotland Agricultural College
Pickering, J. T.	Co. Durham	West of Scotland Agricultural College
*[1]Thomas, R. J. O.	Wilts ..	West of Scotland Agricultural College
Thomson, S. B.	Glasgow	West of Scotland Agricultural College

† *Holder of Dunlop Scholarship 1964-65*
[1] *Holder of Shell-Mex and BP Bursary 1964-65*
* *Intermediate ND Agr E studied at College of Aeronautical and Automobile Engineering*
‡ *Intermediate ND Agr E studied at North West Wiltshire Area College*

Continued overleaf

1965 EXAMINATION RESULTS *(continued)*

Pass

‡Akinsete, E.	W. Nigeria	West of Scotland Agricultural College
Beadle, E. F. ..	Lincoln	Private Study
Beattie, W. ..	Angus ..	West of Scotland Agricultural College
Cavill, R. A. ..	Beds ..	Essex Institute of Agriculture
*Cutler, F. ..	Co. Durham	West of Scotland Agricultural College
Daniel, J. A. ..	London	West of Scotland Agricultural College
Frost, E. D. ..	Yorks ..	Private Study
*Fru, P. B. F.	W.Cameroon	West of Scotland Agricultural College
Heming, R. G.	Glos ..	West of Scotland Agricultural College
Lees, A. J. ..	Edinburgh	West of Scotland Agricultural College
Low, J. P. ..	Cornwall	Private Study
Lowe, J. C. ..	Yorks ..	Private Study
MacIntyre, M. W.	W. Lothian	West of Scotland Agricultural College
McLatchie, R. J. T.	Glasgow	West of Scotland Agricultural College
Martin, P. ..	Midlothian	West of Scotland Agricultural College
Provan, I. H.	Worcs ..	West of Scotland Agricultural College
*Quansah, E. K.	Ghana	West of Scotland Agricultural College
*Reisner, J. ..	Essex ..	West of Scotland Agricultural College
‡Sarsfield, J. ..	Warwicks	West of Scotland Agricultural College
Smeaton, K. W.	Glasgow	West of Scotland Agricultural College
‡Smith, T. G.	Northants	West of Scotland Agricultural College
*Statham, R. N.	S. Africa	West of Scotland Agricultural College
‡Stewart, D. S.	Kinross	West of Scotland Agricultural College
‡Thurgood, R. J.	Wilts ..	West of Scotland Agricultural College

* *Intermediate ND Agr E Studied at College of Aeronautical and Automobile Engineering*
‡ *Intermediate ND Agr E studied at North West Wiltshire Area College*

NEWS FROM BRANCHES

East Anglian Branch

SESSION PROGRAMME 1965-66

1965

TUESDAY 23 NOVEMBER
At Norwood Rooms, Aylsham Road, Norwich

CONFERENCE (10.30 a.m.— 4.30 p.m.)
Chairman: J. D. Alston (Farmer)

Collection of Slurry in Relation to Farm Buildings by D. S. Soutar, Head of Farm Buildings Department, North of Scotland College of Agriculture.

Tankers and Spreaders by W. K. Hall, National Agricultural Advisory Service

Pipeline Systems by F. G. Ingleton, Wright Rain Limited

Slurry on the Land by P. Bolam, National Agricultural Advisory Service, Norfolk

The Animal Health Aspect of Using Slurry by Dr E. A. Gibron, Veterinary Investigation Centre, Norwich

Other Possible Methods by F. W. Roberts, Pollution Officer, E. Suffolk and Norfolk River Authority

Discussion and Open Forum

East Midlands Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7.30 p.m. unless otherwise indicated

1965

TUESDAY 5 OCTOBER *at Kesteven Farm Institute, Caythorpe Court, GRANTHAM*

The Price of Change by J. L. Gould of Lugg & Gould Ltd

The

INSTITUTION OF AGRICULTURAL ENGINEERS

PROGRAMME OF NATIONAL ACTIVITIES OF THE INSTITUTION 1965-66

WEDNESDAY 17 NOVEMBER 1965

An All-day **Visit** will be organized at the Works of *Perkins Engines Limited, Peterborough*

THURSDAY 24 MARCH 1966

An All-day **Open Meeting** will be held at *Swanley Hall, Wye College, near Ashford, Kent,* and will feature a series of Papers and Discussions on **Fruit Husbandry**

THURSDAY 12 MAY 1966

The Annual Conference will be held in *The Main Hall, The Institution of Mechanical Engineers,* 1 *Birdcage Walk, London S.W.*1 and will feature Papers and Discussions on **Vegetable Harvesting and Handling.** The **Annual General Meeting** will also be held on this date

THURSDAY 12 MAY 1966

The Annual Dinner will be held in *St Ermin's Hotel, London S.W.*1

Further particulars of all the above events will be released in due course

East Midlands Branch *(continued)*

TUESDAY 2 NOVEMBER *at Lindsey Farm Institute, Riseholme, LINCOLN*

Day Conference on Spraying commencing at 9.30 a.m. *Chairman:* H. J. T. Carter, Gedney, Spalding

Aerial Crop Spraying by R. C. Amsden, Chesterford Park Research Station

Safety in Spraying by C. E. Babington, East Midlands Regional Safety Officer

Biological Effects of Spraying by Dr J. P. Dempster, Monks Wood Experimental Station

TUESDAY 30 NOVEMBER *at Allis-Chalmers Canteen, Essendine, STAMFORD*

Prevention of Corrosion by Surface Coatings by E. A. Duligal, B SC (HONS), ARIC, ARTCS, Molecular Metals Ltd

1966

WEDNESDAY 19 JANUARY *at Aveling Barford, New Social Hall, Arnoldfield, North Parade, GRANTHAM*

Water Conservation by H. S. Hawkins, B SC, AMICE, AMIWE, Lincolnshire River Authority

THURSDAY 25 FEBRUARY *at Main Hall, Sutton Bonnington, LOUGHBOROUGH*

Spring Mechanization in Sugar Beet by R. Bond, British Sugar Corporation Ltd

WEDNESDAY 16 MARCH (7 for 7.30 p.m.) *at Peterscourt, PETERBOROUGH*

The Diesel Engine as applied to Agriculture by T. H. L. Parrish, Perkins Engines Ltd

This large party of Officers and members of the South Western Branch visited the works of the Heathcote Group at Tiverton on 30 June 1965. The party was welcomed by the Mayor of Tiverton, Mr. W. P. Authers, seen standing on the right.

Northern Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7 p.m. unless otherwise indicated

1965

MONDAY 6 DECEMBER *at Carliol House, NEWCASTLE*
Farm Buildings for Mechanized Livestock Feeding by David Long, B SC (AGR)

1966

MONDAY 10 JANUARY (*Venue to be arranged*)
Discussion on **Minimum Cultivations.** Leader of discussion: W. E. Hughes, B SC, M SC, Grassland Officer, N.A.A.S.

MONDAY 7 FEBRUARY (*Venue to be arranged*)
Irrigation in the North. Speakers: D. W. Beesley, B SC, Crop Husbandry Officer, N.A.A.S., J. S. Robertson, NDA, ND AGR E, AMI AGR E, Mechanization Adviser, N.A.A.S.

The ANNUAL GENERAL MEETING *of the Branch will be held on Monday 7 March.* (*Time and venue to be announced*)

Scottish Branch

SESSION PROGRAMME 1965-66

WEDNESDAY 2 MARCH 1966
Annual Conference (*further details to be announced*)

South Western Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7.30 p.m. unless otherwise indicated

1965

THURSDAY 11 NOVEMBER *at the Royal Clarence Hotel, EXETER*
Panel on Education in Agricultural Engineering. Speakers: H. R. Jeffrey, AMI AGR E, of H. Nortington & Sons, Axminster; Miss J. P. Housley of the Institution of Agricultural Engineers; Dr P. C. J. Payne, MI AGR E, of the National College of Agricultural Engineering; L. M. Tate of Exeter Technical College

1966

JANUARY (*date and time to be announced*) *at Seale-Hayne Agricultural College, NEWTON ABBOT*
Rotary Cultivations by J. B. Paterson AMI AGR E, of Seale-Hayne College

FEBRUARY (*date, time and venue to be announced*)
Modern Dairy Machinery by A. J. Quick of N.A.A.S. Milk Group, South Western Region

THURSDAY 10 MARCH *commencing at 7 p.m. at The Royal Clarence Hotel, EXETER*
(Joint meeting with the Exeter Panel of the Institution of Mechanical Engineers)
Metallurgy in Relation to Agricultural Machinery Forgings by J. Chousmer of the Ford Motor Company

The ANNUAL GENERAL MEETING *of the Branch will be held on Friday, 25 March* (*venue to be arranged*) *commencing at 6.30 p.m. followed by the* ANNUAL DINNER

The South Western Branch paid a visit to the Tiverton works of the Heathcote Group of factories on 30 June 1965. The party was welcomed at the Lowman Manufacturing works by Mr R. W. H. Lockyer, AMI AGR E, a director of E. V. Twose Ltd, who gave an introductory talk on the engineering activities of the Group.

After being shown a film of Twose machinery at work the party then toured the workshops, foundry, and offices of E. V. Twose, Stenners and the new repair shops and showrooms of Medland, Sanders and Twose, where great interest was shown in the layout of a new store system now in use.

The party then went on to John Heathcote & Co's Textile Factory, where they were shown the various processes in producing fabrics from man-made fibres.

At the conclusion of the visit the party went on to the Town Hall for a civic reception, where the Mayor of Tiverton (Mr W. P. Authers, a former President of the Agricultural Engineers Association) welcomed the visitors and told them something of the history and development of industry in Tiverton.

The Mayor then conducted the party to the Tiverton Folk-Museum where much interest was shown in the collection of early agricultural implements.

Western Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7.45 p.m. unless otherwise indicated

1965

WEDNESDAY 17 NOVEMBER *at the Francis Hotel, Queen Street, BATH*
Developments in Haymaking by G. Shepperson, B SC (AGRIC), MI AGR E, Harvesting and Handling Department, National Institute of Agricultural Engineering

1966

WEDNESDAY 16 FEBRUARY

Annual General Meeting commencing at 6.30 p.m. *at the Bath Arms, WARMINSTER*

7.45 p.m., **Current Trends in Irrigation Equipment** by W. T. A. Rundle, MI AGR E, Wright Rain Ltd

WEDNESDAY 16 March

Visit commencing at 2 p.m. to *British Aircraft Corporation, BRISTOL* (to be confirmed)

Meeting commencing at 7.45 p.m. at *The Bath Arms, WARMINSTER*

Grain Storage in Sealed Silos by D. E. Willows, B SC (AGRIC), AMI AGR E, N.A.A.S. Liaison Unit, National Institute of Agricultural Engineering

Grain Storage by Refrigeration by R. E. Worner, AMI AGR E, Southern Electricity Board

FRIDAY 15 APRIL

The Branch ANNUAL DINNER *will be held at The Bath Arms, Warminster (time to be announced)*

West Midlands Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7.30 p.m. unless otherwise indicated

1965

MONDAY 29 NOVEMBER *at Room 118, The College of Advanced Technology, Gosta Green, BIRMINGHAM 4*

The Layout of Dairy Farm Buildings by P. Clough, National Institute for Research in Dairying

1966

MONDAY 3 JANUARY *at Room 140, Lecture Centre, The College of Advanced Technology, Gosta Green, BIRMINGHAM 4*

Recent Developments in Crop Spraying Methods and Materials by R. F. Norman, AMI AGR E, Fisons Farmwork Ltd

MONDAY 7 FEBRUARY *at Room 118, The College of Advanced Technology, Gosta Green, BIRMINGHAM 4*

Control of Distortion in Welded Structures and Agricultural Implements by W. Archer, British Oxygen Company Ltd

MONDAY 7 MARCH *at Room 118, The College of Advanced Technology, Gosta Green, BIRMINGHAM 4*

Modern Trends in Glasshouse Automation by A. W. Gray, The Electricity Council

FRIDAY 15 APRIL *at The Town Hall, LEAMINGTON SPA*

One Day Conference (Time and further details to be announced)

SATURDAY 14 MAY

Spring Outing to British Rail Engineering Workshops, *DERBY* (Details to be announced)

The ANNUAL GENERAL MEETING *of the Branch is to be held on Friday 15 April followed by the* ANNUAL DINNER *at The Regent Hotel, LEAMINGTON SPA* (Details to be announced)

Yorkshire Branch

SESSION PROGRAMME 1965-66

All meetings will commence at 7.30 p.m. unless otherwise indicated

1965

FRIDAY 12 NOVEMBER *at the Griffin Hotel, Boar Lane, LEEDS*

The History of the British Tractor by C. L. Cawood, AI AGR E, Farmer

1966

FRIDAY 25 FEBRUARY *at the Elm Bank Hotel, YORK*

Potato Harvesting by W. J. West, MI AGR E, Scottish Station, N.I.A.E.

FRIDAY 25 MARCH *at the Griffin Hotel, Boar Lane, LEEDS*

Annual General Meeting and **Presidential Address** by J. H. W. Wilder, BA, MI AGR E.

FRIDAY 29 APRIL *at the Strafford Arms Hotel, WAKEFIELD*

Traction and Farm Soils by Dr A. Reece, PH D, B SC (MECH ENG), M SC (AGR ENG), AMI MECH E, AMI AGR E, of Department of Agricultural Engineering, University of Newcastle-upon-Tyne.

An Open Meeting was held at the Strafford Arms Hotel, Wakefield on 3 September 1965.

Mr L. K. O. Cox of Esso Petroleum Company Ltd spoke on some of the features of oils and their specifications. He considered mainly crankcase, transmission and hydraulic oils, and showed the relationships of certain of their properties. Mr Cox discussed briefly the development of different specifications to meet individual requirements, and mentioned the tests used to achieve this.

The scope and range of additives were mentioned and the effects of these on the different types of oils.

An interesting development recently has been the use of analyses of oil to measure the state of wear in an engine. This is particularly of use in the aircraft industry.

In questions following the Paper a range of further points were discussed. These covered topics including the use of multi-use oils and their limitations; the development of oils for power transmission systems; the data required so that designers could select a suitable oil by calculation—this is not always possible; the causes and effects of lacquering; and the problem of differing oils in overseas countries.

CONTEMPORARY LIVESTOCK HOUSING SYSTEMS

by D. S. SOUTAR, ARIBA, CI AGR E*

A Paper presented at the Scottish Branch Conference of the Institution in Dunblane on 3 March 1965

INTRODUCTION

The ever increasing interest which is being taken in the housing of livestock is further evidence of the current trend towards intensification and specialization in all branches of agriculture. The economic pressure of rising costs is forcing the farmer constantly to seek new ways of increasing production both in quantity and quality while endeavouring to curb labour and other charges. The intensive housing of stock not only permits the provision of the best environment for its thriftiness and the simplification of management chores, but in many instances it frees valuable acres for arable crop production. It is not easy to forecast just how far the trend will continue but continue it undoubtedly will, particularly in the more fertile areas. The rate of increase will largely depend on the skills of the scientist and the development of new management techniques. However, Mother Nature will only stand so much pressure and when advances are too rapid she has the knack of handing out an awkward blow which enforces a breathing space until scientific knowledge has reorganized its forces for another advance.

Evidence of the trend towards larger units can be seen everywhere but current developments in intensive housing can be just as important to the small producer as the large scale operator. The pioneer of the cubicle system for the dairy cow, one of the most notable innovations of recent years, farmed only some thirty acres!

The way ahead, however, is not easy. Whereas the industrialist when promoting a production process can draw up a precise set of requirements with a definite output prediction, the variations in management practices in agriculture are so great that in many instances the agriculturalist must pioneer his own salvation. In industry the scale of production organizations is such that vast sums can be spent on research and development work. Probably the only comparable case in agriculture can be seen in poultry production wherein the progress and efficiency achieved in recent years has been quite outstanding. Here the large scale organization of the main stock producing units and the very nature of the product has permitted the rapid genetical improvement of stock performance while the standardization of management practices permits of the large scale prefabrication of highly efficient low cost housing and equipment.

In pig production management practices are becoming more standardized, permitting to an increasing degree the benefits of mass production in housing and equipment, and this trend will surely continue. As in poultry production, the nature of the stock and management practices as well as the return on capital encourages investment in specialist buildings of high efficiency. In cattle production, however, the variations in management practices are much greater, the environmental requirements of the stock are far from being clearly defined and the return on invested capital is less.

The Health of the Stock

Whatever class of stock is involved the maintenance of health so as to ensure maximum production is a first essential. Of late there has been a public outcry of the type cherished by the 'yellow press' against some contemporary housing practices but, for the most part, the protagonists have been ill-informed and largely prompted by sentiment rather than reason. Where bad management is involved stress amounting to cruelty can occur irrespective of the housing system. In contemporary housing the number of animals per unit is greatly increased and, therefore, if the management is bad more animals are affected. However, economic success in contemporary systems requires a higher standard of management than ever before and this factor alone is a worthwhile guarantee against cruel practices. To give a practical example, far more pigs suffer excessive stress in cold damp draughty 'traditional piggeries' than in modern housing—including the high-humidity system. Positive health must be the aim of all stock producers and to assist this end stock numbers per pen and per isolated unit have to be suitably restricted both as a means of reducing possible disease spread, of reducing stresses and of improving environmental control.

The Labour Factor

While the maintenance of positive health may be looked upon as the most essential factor in livestock housing, the reduction in labour requirements is likewise most important. The application of labour-saving methods has two objects, first the reduction of production costs and, secondly, the elimination of manual efforts as a means of cutting out drudgery and of allowing the stockman to concentrate on his prime task of stockmanship. To achieve maximum savings in labour far more thought must be given to schemes at the planning stage than has been practised heretofore. Management practices require to be clearly defined and to achieve this end considerable research is often necessary—the housing must always be

* Farm Buildings Dept., North of Scotland College of Agriculture.

designed to serve the stockman's stated practices as such practices dictate many factors in design such as rationed feeding as opposed to ad lib feeding. Here the advantages of simplification of method and flexibility may have to be assessed in comparison with a high degree of mechanization. The science of Materials Handling has an ever increasing part to play in livestock housing as does that of Work Study.

The handling of both feed, bedding where used, and muck (farmyard manure) form the major labour tasks in stock production and the simplification and mechanization of these tasks may be considered the major problem after the maintenance of animal health. While feed handling might be considered of prime importance it is the handling of the muck, and more particularly the disposal of this low-value commodity, that requires most consideration. No stock unit can be considered viable unless a truly economic answer for muck disposal can be evolved.

Structural Considerations

Because in this country we are so often concerned with existing structures we are far too prone to accept their limitations and endeavour to fit contemporary systems within their confines, an approach which so often has led to disastrous results. While admitting that for economic necessity the smaller farmer can often achieve an efficient production system, especially for pigs, within existing buildings, the full benefits available from new methods and mechanization are often greatly reduced by the adherence to existing buildings and sites.

Most forms of housing, particularly of cattle, appear expensive in relation to available returns and this section of design work warrants far more study and investigation than is at present permitted. In the field of pig and poultry housing prefabrication has been carried out to such a successful degree as to achieve a quite considerable export trade to Western Europe, but far more research is required both into low cost structural methods and materials. In Germany and Holland system building akin to that used in industry has been developed for agriculture, but it is doubtful whether the turnover will be sufficient to achieve the desired low costs. In this country the answer may be found by investigating the existing systems used in industry and using a limited number of their components, thereby gaining the benefit of the large scale turnover involved in this sphere of construction. The true benefits of mass production will never be fully available to agriculture until much greater standardization in management practices is adopted. An alternative is some form of round pole housing of the type adopted by Messrs British Beef in Suffolk but such is hardly applicable when controlled environment housing is required. This latter statement, of course, begs the question: in cattle housing, just what degree of environmental control is an economic necessity? This is just one of the many problems awaiting investigation.

DAIRY CATTLE HOUSING

Milk production involves a greater routine demand on labour than probably any other farm enterprise and for that reason the farmer has for many years sought to reduce the drudgeries involved. Of recent years the lowering of returns, the increase in costs and the scarcity of skilled labour have added further incentive to his quest. Up to the post war era dairy cattle were housed, milked and fed in byres, tied by the neck in single or double rows of standing with a trevis between each pair of beasts—a system which gave the cowman full opportunity to treat his charges individually but which involved a high demand on manual labour. The introduction of loose housing permitted a mass production approach, the cows being housed in groups in bedded courts and milked in a milking parlour. This development reduced the labour requirement largely through the dung handling being carried out once or twice a year by mechanical means. The advent of self-feeding further reduced the labour requirements of the loose housing system, while the introduction of the herring-bone milking parlour permitted a further extension of mass handling principles. The considerable bedding requirement, if the cows were to be kept clean, was a serious drawback in many areas and gave rise to a number of variations on the system, including the reduction of the bedded area in conjunction with outside loafing areas, the part-bedded part-scraped hard standing court, the bed-and-breakfast system wherein the cows lie on litter on the unconsumed area of their self-feed silage, the deep litter system wherein the bedding of sawdust and shavings was cultivated to induce bacterial action to dry out the litter as in poultry housing, part- and fully-slatted courts, and finally the greatest and most beneficial development of all, the cubicle system. This latter may be claimed to provide the advantages of mass handling common in all loose housing systems with the individual privacy of the byre when the cow is in the cubicle and with a minimum bedding requirement.

All these systems described, including others with minor innovations, are in use to-day but in this short paper it is impossible to describe them in detail or to attempt to describe their advantages and disadvantages. In spite of the obvious attractions of the loose housing systems a surprising number of milk producers still favour the cowshed as under this system they feel they can get a better performance from their animals through the facility for individual attention which the byre offers. Whatever system is to be adopted efficiency can only be achieved if great care is taken at the planning stage. All work routines must be carefully followed through in detail, the storage and handling of all feeds and bedding must be carefully studied as must be the handling of the muck and its disposal.

The Byre System

Although the basic layout of the modern dairy byre conforms in general with tradition many innovations are to be seen. Round-the-shed milking with delivery to a bulk tank has considerably reduced the labour requirement in milking.

The simplification of feed handling has not been easy.

While front feeding passes of barrow width are acceptable the space required for a passage for a bulk delivery trailer is hardly so, and as a result feeding from behind the cow is widely practised. However, there is surely little reason why a heads-in layout should not be adopted either to allow of the operation of a side delivery bulk truck or a mechanical feeder of the auger type.

Dung handling has been simplified by the use of both fixed and portable scrapers and also by the adoption of grid covered gutters where the dung and urine are flushed out of the building in the form of sludge.

Fully Bedded Courts

These are only likely to be seen in the future in areas where straw is plentiful and even then some form of raised standing at the trough will probably be included to reduce straw consumption. They have the advantage of eliminating the slurry problem which so frequently arises in other forms of loose housing. An allowance of 70 ft^2 per cow is a minimum, a straw consumption of 3 tons per cow is required and there must be accommodation for a dung build-up of at least 4 ft.

In its most simple form loose housing may comprise a bedded area, a self-feed silage pit and a milking parlour wherein a ration of concentrates can be fed. However, if other roughages or turnips are to be fed or if parlour feeding is not accepted a range of troughs, preferably with yoke ties, is required and this can amount to a considerable addition in capital outlay. The division of the herd for the separate housing of high and low yielders is a further stipulation which many dairymen might make and again it would add a further complication.

Part Bedded Courts

This system, designed to reduce bedding consumption, involves a bedded area of 30 ft^2 per cow and a similar area of hard standing for feeding/loafing which must be designed for easy daily scraping by tractor and blade with suitable sludge handling arrangements outside the building. Sub-division of the bedded area, which is generally rectangular in shape, prevents cows roaming up and down its length and so serves to conserve bedding. A building providing 30 ft width on either side of a central feed passage and troughs or mechanically filled troughs with a linear allowance of 2 ft per cow forms a satisfactory answer.

Cubicles

Probably no other innovation in livestock housing has been so readily accepted by farmers as the cow cubicle. It appeared to be a 'natural', affording all the advantages of loose housing with few of the disadvantages, while, as one dairyman put it, 'allowing the cow to maintain her dignity'. Many and varied have been the alterations to the original design of bed and cubicle division developed by the pioneer of the system, Howell Evans. While observation of the diversity of designs provides surprise at the efficiency of the many types in use the intending user must carefully study units in use if he is to avoid errors which can prove most costly.

Slatted Courts

While a slatted feeding stance in conjunction with a restricted bedded area may be an acceptable form of housing, the fully slatted court has not generally proved nearly so successful in this country as in the land of its origin, Norway. This is probably due to the large herd numbers involved and a lower standard of housing, as well as lack of attention to detail. That the system can work efficiently is proved by some isolated but notable examples. However, the advent of the cow cubicle system which provides such obviously superior cow comfort will probably mean that few, if any, further fully slatted floored courts will be constructed.

Costs

To quote *The Farmers Weekly* of 16 October 1964, reporting its annual National Farm Buildings Conference on 'Buildings for Milk Production'—'But how cheap can you go? At the top end of the scale, all-in costs approaching £200 per cow were quoted for push-button tower silo set-ups. Covered yard and latest herring-bone parlour installations came next at around £120-£140. Much lower down the scale was the milk-bail-and-little-else out-wintering system marked as low as £20 per cow'.

When comparing units built and equipped to a similar standard the contemporary milking byre unit is slightly dearer than the equivalent loose housing unit.

Current Data

The recommendations of the above Conference were published in *The Farmers Weekly* of 23 October 1964. These comprise a most comprehensive list of data on the subject which would be invaluable to anyone concerned with the design of buildings for milk production.

BEEF CATTLE HOUSING

In the field of farm buildings it is interesting to note how interest in various sections of housing increases and diminishes over the years. Up to 1960 only passing attention was given to beef cattle housing but since that date far reaching developments have taken place, involving a very wide variation in types of housing, with an equally wide variation in the crucial design factors of handling the feed, bedding and muck.

The desired environmental conditions for the various classes of stock are still ill-defined but observation has shown that irrespective of all other factors an ample airflow within the building is of paramount importance, particularly when stock are housed at the increased densities prevalent to-day. While the actual temperature of the house appears to be of relatively little import within the range of 35-65°F. sudden temperature fluctuations should be avoided as well as draughts. Certain reports indicate that 'barley beef' concentrate-fed animals thrive better in warmer buildings around 50°F. and that they are more susceptible to temperature changes and draughts. Insulated roofs have been adopted as much to prevent condensation problems as to provide heat conservation.

The number of buildings having a fully controlled environment are relatively limited and generally involve concentrate-fed animals on slatted floors. A fair proportion of new buildings may be said to have a partially-controlled environment achieved by use of an insulated roof, shutter-controlled vents and auxiliary fans. However, the majority of buildings are of the free airflow type employing all-round air inlets by means of spaced boarding, open ridge extraction and of ample cubic capacity.

Feeding arrangements dictate both pen proportions and layout. Concentrate feeding from self-feeders allows of maximum flexibility in pen proportions and simple automation of feed delivery. Bulk side- or end-delivery trailers require wide straight access passages within the building but permit of considerable flexibility in their use and in the materials they can handle. The various forms of mechanical feeders do not require the extra building space of the bulk delivery trailer but, as with all rationed forms of feeding in troughs, they require straight delivery lines. The liquid feeding of concentrates and self-feeding of roughages is still in the development stage but would permit flexibility both in pen proportions and layout.

The general rule is to design to reduce bedding requirements to a minimum by the adoption of minimum-bedding systems such as part-bedded part-scraped courts, cubicles and slatted floors. A notable exception is the new British Beef feed-lot in Suffolk, an area of abundant straw, which involves most elementary shelter and large consumption of bedding.

Tied System

Probably the only part of the country in which the tied system is being expanded to-day is in the North East of Scotland. Here the following advantages are claimed for the system—no bullying, cattle can get individual treatment and are more easily inspected, feeding can be as easy as in loose housing when a heads-in layout is employed, little bedding is used (rubber mats are about to be tried out), the manure can be handled in solid form by various mechanical devices, reasonably constant environmental conditions can be maintained and full-grown beasts can be housed in 26-28 ft^2. Because of these factors the tied system should not be dismissed without serious consideration. Admittedly, if the stock have not been tied when young they may check slightly at first. Some authorities claim that loose cattle maintain a better 'tone' and are less likely to go off their feed for periods. Rear grids and sludge mucking as well as slatted floors might be considered.

The following figures may be taken as a guide per 10 cwt beast:—area of building 30-32 ft^2, cost £35-£40, bedding per six months—straw at 3-4 lb daily 26/8d, sawdust at 2 lb daily 12/-.

Fully Bedded Courts

This system requires an ample supply of straw and in North-East Scotland an allowance of 60 ft^2 per beast is considered necessary or the straw consumption is unduly heavy—in other parts 30-40 ft^2 has been quoted.

The system offers comfort to the cattle if properly bedded and allows the dung to be handled in solid form by normal farm machinery. It has the disadvantages of requiring a large area of building per beast, the supply, storage and handling of bedding, the mucking out at least once in mid-Winter causing much upset to the cattle and possibly double handling of dung, the use of troughs, feeders and waterers of adjustable heights, and unless a fair depth of dung is left in the court at the mid-Winter mucking a considerable environmental change may occur.

Various methods of reducing bedding consumption have been tried including raised standings at the trough where most treading occurs, porous floors (although they have never been proved successful over a period of years), as well as floor drainage. Long narrow pens tend to consume more straw than pens of square proportion, while any division which will reduce the movement of cattle is advantageous as is the provision of a waterer with independent soakaway. The guiding factor in pen layout is the provision of 2 ft trough frontage per beast, a factor which is not applicable when the self-feeding of concentrates is practised. The latter system allows greater flexibility in pen design and appears to require slightly less bedding.

The following figures may be taken as a guide per 10 cwt beast:—building area 44 ft^2, cost £40-£45, bedding per six months—straw at 15-25 lb daily 97/- to 160/-, sawdust at 8-12 lb 48/- to 72/-.

The above cost refers to traditional construction standards. A notable break from this tradition is the conception adopted by British Beef in their feed-lot at Stowmarket where, by means of round pole construction and corrugated iron sheeted side walls and roofs, they hope to house 10,000 cattle at a price not exceeding £10 per head. In this area straw is in abundant supply and deep bedding on an earth floor will be practised. The houses comprise 36 ft wide sheds with 8 ft wide sleeper floored central passage down which the double side delivery feed truck runs.

Part Bedded Courts

These may be limited to 20 ft in width of which 12 ft is bedded and 8 ft is 'scrapable concrete' or slatted. The former system has proved most satisfactory at Harper Adams College, being said to offer a 50% saving in bedding over the fully bedded court, but requires tractor scraping every second day with a limited disturbance of the cattle in a unit of any size. Slatted feeding stances can employ sludge dung handling methods when sawdust is used as bedding, but if straw is used lifting slats and foreloader mucking is preferable.

The following figures may be used as a guide per 10 cwt beast:—area of building 44-46 ft^2, cost £40-£45, bedding per six months—straw at 8-12 lb daily 51/- to 77/-, sawdust at 6 lb daily 36/-.

At this point passing notice might be taken of non-bedded and water-flushed courts. Only two such units are known to the writer, one having brick floors and the other, that of Col. Drew in South Devon, having rubber covered wood block flooring. Both units are hosed out daily and Col. Drew's uses the Gulle system of slurry disposal.

In this category might be considered electrically heated no-bedding floors and dry muck scraping, although no such units are known. One authority has suggested that an animal would have to put on an extra ¼ lb daily live-weight gain before it would pay for the electricity and portion of the installation for under-floor heating.

Mention might also be made of part covered courts. The system is common in some areas but, where fully bedded, invariably giving rise to quagmire conditions. A modern conception might involve a restricted covered bedded area with feeding in uncovered slatted or scraped yards.

Cubicles

Cubicle units for beef cattle are being used in America and in Ireland and although the system is still in the development stage it offers exciting promise. An innovation to the normal form of cubicle housing is that used at Hillsborough in Northern Ireland where the cattle are held in the cubicles by rear chains and fed from a meal/fodder box which can be moved fore or aft to increase or reduce the length of the standing. A hinged flap is suspended above the feeding box to discourage the animal from standing forward and thus soiling the rear of the bedded area. Drainage has not been the serious problem which might be expected and is assisted by perforated concrete piping laid under the aggregate on which the sawdust is placed. The performance of the cattle in this form of housing has been most satisfactory. The cubicles provide the same privacy and peace to thrive so obviously enjoyed by the dairy cow when so housed and the cattle are reported to be much quieter than when housed in a bedded court. Bedding requirements are absolutely minimal, at the most ½ lb of sawdust per day. Dung handling can be as economical as any other system.

The following figures may be used as guide per 10 cwt beast:— area of building 40 ft^2, cost £40, bedding per six months at ½ lb sawdust per day 3/–.

Fully Slatted Courts

Slatted floored housing for beef cattle has now had a fair trial and in a recent survey of 95 units only one farmer declared his preference for the fully bedded traditional court. Injuries caused by the slats are of little account but stock should be four months old before being put on these floors. The advantages claimed are more animals housed (10 cwt beasts at 20 ft^2), saving in purchase, storing and handling of bedding, saving in labour, no disturbance of cattle when sludge mucking out is practised. The dung handling, however, is not completely trouble-free except in the case of 'barley beef' sludge. Sludge handling can be tricky if any quantity of long stuff gets through the slats, while in high level slats for solid muck handling care must be taken to drain off the urine.

Concrete slats are now almost the universal choice, having a top width of 5-6 in. gaps of 1½ in. and preferably of 'T' section with flat top surface and a 'pencil round' to take the sharpness off the top edges.

The following figures may be used as a guide per 10 cwt beast:—area of building 24 ft^2, cost low level slats £45-£50, high level slats £50-£55.

SHEEP HOUSING

While the housing of sheep in winter has been a traditional practice in limited areas of the country, it is only in recent years that it has received widespread interest. While this interest has largely been centred on the provision of housing for home-wintered hill hogs, a demand brought about by the scarcity and high price of good 'down-wintering', an increasing number of low country farms have been adopting the practice in order to save valuable acres from 'poaching' and to simplify the tasks of the shepherd. Recently the practice has been extended to the fattening lambs and to ewes which are lambed very satisfactorily inside with additional comfort and convenience to sheep and shepherd. While it is dangerous for an architect to forecast agricultural trends there are now developments under way with the object of achieving twice yearly lambing with two, three or four lambs per ewe at each crop. This will, undoubtedly, have to be carried out in suitable housing and under a high standard of management. The fattening of the lamb crop may yet require controlled environment housing for maximum thriftiness.

General Requirements

The objective in sheep housing is the provision of a simple shelter from the weather, a temperature relatively akin to that outside and very ample internal free airflow without draughts. The degree of enclosure of the building will depend on the local climate and siting. On sheltered low country sites open fronted sheds can provide a satisfactory answer but on exposed sites totally enclosed housing is required. The latter requires careful design if dry drift snow is to be excluded while still allowing a free airflow. To this end sparred upper wall boarding may be used. A common practice is to build a block wall to a height of 4 ft above slats or bedding and to overlap this with an upper sheeted wall by at least 9 ft, the upper sheathing projecting 9 ft beyond the outer face of the lower wall, thus providing a baffled inlet all round the building which can readily be controlled by an adjustable board. Open ridge extraction is normal practice. A minimum eaves height of 9 ft is desirable if a slatted floor is to be installed.

A large internal cubic capacity will assist the ventilation problem when a free airflow is planned and will also reduce condensation problems where uninsulated roofs are employed. Under certain conditions, particularly in lambing sheds, some form of roof insulation may be required if only to prevent condensation.

For flexibility in use a clear floor area is required whereon demountable pen divisions, troughs, hayracks, etc., can be arranged to suit varying situations—ideally under a portal type roof. It is well to remember the multi-purpose possibilities of such a building.

In most instances the sheep are manually fed but provision of access for the self-feeding of silage is gaining popularity and reduces the labour requirement. Already, in a number of cases, the fully mechanized feeding of haylage is practised using both auger and scraper bar systems and should sheep housing be developed on a large scale this practice will undoubtedly be expanded. Labour in mucking out can be simplified by designing for easy access for tractor and scraper-blade or fork-lift where scraped areas or deep bedding is employed. Where slatted floors are involved both the slatted panels and supporting framework as well as such above-slat fittings as pen divisions and troughs must be readily demountable. The internal fittings must be carefully arranged to permit the unit to be served with minimum labour both in handling the sheep and their feed, and this includes running the flock through a foot-bath. Where lamb fattening is practised proper weighing facilities must be included.

Flooring

The choice between bedded and slatted floors depends largely on management factors but sheep appear to thrive equally well on either type so long as their feet are healthy when first housed. Slatted floors, however, reduce the demand on labour and storage and give an assurance against foot troubles. While ewes are sometimes lambed on slats a bedded floor is more commonly used.

Slatted floors are made up in framed panels to form a reasonable two-man load and the actual slats are generally of the narrow 1½ in. wide chamfered design of Australasian origin or the 2½-3 in. wide Icelandic type slat with ⅝ in. or ¾in. gaps. While larch wears quite well a harder wood, such as keruing, will give longer life. Where sheep are run out during the day a 2 ft depth under the slats will suffice for dung storage but a 3 ft depth is essential where they are held inside all the time. If year-round lamb fattening was to be practised sludge mucking might be adopted so as to save lifting the floor for tractor access.

Guiding Dimensions

The dimensions of the building will govern the class of sheep and flock size and management practices. Where slatted floors are used Blackface hogs require 7 ft^2 per head when housed in the recommended lots of 50 per pen, but this could be reduced to 4 or 5 ft^2 if they were run in lots of 200 or 300. Where bedded floors are used hogs will require about 9 ft^2 and up to 12 ft^2 is provided for fattening lambs. Ewes on slats are allowed 12-14 ft^2 and up to 16 ft^2 on bedded floors.

The demountable pen divisions allow sub-division of the house to suit the particular conditions. Where ewes are lambed inside separate 16-20 ft^2 lambing pens are provided while later they are penned in larger groups with suitable creeps for the lambs. The recently introduced 2 ft 9 in. wide Icelandic pass-cum-trough serves as a useful demountable pen division. 12-15 in. linear trough space per sheep is a normal allowance with no pen width less than 7 ft. Watering facilities served by a well insulated stand-pipe are essential.

Housing Types

At this stage of its development it is difficult to classify sheep housing under recognized systems due to the wide variation of practices. Probably the most simple shelter is the traditional stell and its modern demountable sheet metal counterpart developed at the Rowett Research Institute. Equally simple in basic concept is the unit in Suffolk which comprises an unroofed slatted floor protected by surrounding straw bale walls wherein the sheep are fed from a perimeter trough which is mechanically filled with haylage from Harvestore silos.

Various forms of simple open-fronted mono-pitch shelters with both bedded and slatted floors are used on relatively sheltered sites, one such unit in Northumberland comprising two rows of open fronted inward-facing slatted floored sheds with central concrete passage serviced by tractor for both feeding and cleaning. However, the most common form of housing is the fully enclosed building with free flow internal airflow, generally comprising a structural frame, block walls to 5 ft height and corrugated sheeting above.

Costs

These vary greatly according to the siting, degree of enclosure required, the type of flooring and other considerations. The unit comprising a slatted floor, straw bale walls and mechanical feeding mentioned above is reputed to have cost £1.15.0 per ewe; a new slatted floored all enclosed hog house is unlikely to be built for under £5 per hog when allowing 7 ft^2 each, while up to £16 per ewe and lamb has been paid for a new shed of high standard with demountable steel partitions. To justify expenditure on sheep housing alternate use must be made of the building unless it is to be used for year-round fattening. Many slatted floored units are successfully used for hay drying while other uses include calf rearing and turkey production.

PIG HOUSING

Of all farm livestock probably none respond so well as the pig to good housing conditions and because of this factor much study has been given to pig housing in post war years. While many minor matters have still to be determined there is generally agreement on the desired housing conditions with one or two notable and successful exceptions. The maintenance of positive good health is recognized as the main objective in pig housing with emphasis on labour saving as a means of cutting out drudgery and thereby permitting the all-important stockman to concentrate his energies on the management of the pigs. Actual labour costs, although important, are but a small proportion of the outlay in pig production. Because management skills are so vital in achieving good returns, they must always be given priority of consideration and the housing must be designed to serve the management dictates.

As intensive units grow larger so greater care must be taken in the maintenance of health and the prevention of disease spread. The oft repeated advice of Sandy McGuckian 'Insulate and Isolate' is just as applicable to-day as it was when first voiced many years ago. To this end a standard of building quite new to traditional agricultural practice is now employed and a very high degree of inter-pen isolation, house sub-division, the restriction of numbers in any one house and periodic house 'resting'is common practice.

Environmental conditions commonly desired involve temperatures of 60-70°F. for feeding pigs, 60-65°F. for suckling sows with 70-75°F. for the piglets' nest; with proper ventilation based on pig bodyweight and controlled by automatic ventilation systems humidity factors cause little concern. In farrowing houses, even when insulated to a high standard, supplementary heating is necessary in winter, but in feeding piggeries body heat conservation by means of good insulation and controlled ventilation can provide a satisfactory temperature all the year round.

As in most matters there are exceptions—and successful ones—to the general practice which might be mentioned here. The well-known Roadnight system of group farrowing in simple uninsulated field shelters involves conditions far removed from those in the modern indoor farrowing house. Likewise the High Humidity feeding house with temperatures around 90°F. and relative humidity nearing 100% is as wide of general practice on the 'high side' as are the Swedish Cold Houses on the low side. Apart from anything else these exceptions may serve to emphasize the importance of management skills in pig production.

With the advent of more general agreement on housing standards it has become more feasible to produce standard housing on a 'package deal' basis if not yet with a throughput that would warrant industrial standard of mass production. While this development may tend to stifle individual initiative it assures the farmer of a house of proven performance, a benefit not always achieved in the 'one off' job.

Careful planning of the chores within the piggery (feeding, mucking, weighing and pig handling), both in individual pen and house layout design has done much to remove the old drudgeries. In farrowing and rearing houses the value of individual treatment and inter-pen isolation warrants extra labour rather than complete automation, but even here feeding is often simplified by the mechanical delivery of the feed to the actual pen for manually controlled delivery, while mucking out can be reduced to the pushing of the dung through slats or a slit adjacent to the pen door into a sludge channel or onto a mechanical scraper.

In feeding piggeries the advent of the slatted floor was the greatest labour saving development of recent years, the pigs treading the dung through the concrete, metal bar or mesh slats into a sludge conveying duct or holding pit. This completely cuts out a twice daily manual task and permits of a degree of inter-pen isolation never possible when sweep-through dung passages were employed. Where floor feeding is practised a slatted area of 1—1¼ ft² per pig is provided but where trough feeding is employed the whole pen floor or a greater proportion of it can be slatted.

The automatic delivery of feed, whether for trough or on the floor feeding, is now available to serve desired amounts of feed as often as required. Where dry feed is involved such automatic or semi-automatic systems based on linear design (straight runs) impose certain restrictions on pen proportions, but when pumped liquid feeding is involved there are no such limitations. This latter system permits the ready linking up of existing and new housing irrespective of its siting.

Dry Sow Housing

The extra care provided for the in-pig sow is one of the features of pig husbandry to-day. The most common practice is to run the sows in groups, often in deep-bedded courts, and to feed them in individual stalls so as to ensure that each gets its proper ration. The recently introduced dry sow stall system extends this individual care and when equipped with semi-automatic feeding and part slatted stalls labour requirements are reduced to a minimum. A number of stall designs are in use; where stall divisions are solid to the floor a width of 2 ft 6 in. clear is desired and the sows must face 'heads in' or else they may turn in their stalls; where tubular divisions or divisions with a 6 in. space next to the floor are used the stall width can be reduced to 2 in. clear and the sows can be faced 'heads out' if desired.

Farrowing and Rearing Houses

Apart from the Roadnight system already mentioned there are many other forms of ark housing in use which, while providing health-giving conditions for the stock, involve an 'all weather' pigman and ample 'clean' ground. Insulated arks and fold units are not cheap and due to inevitably hard usage their maintenance costs are high.

Permanent farrowing and rearing houses are built to a high standard involving good insulation standards, fully controlled ventilation and space heating. Where a large number of pens are involved they are designed in independent units to facilitate periodic disinfection and resting. A feed store and washing space can well be used as a baffle entrance porch to help maintain equable internal conditions.

Farrowing housing falls into two main categories. The first involves pens in which the sow and litter are kept from farrowing to weaning, the sow being usually farrowed under some form of crate control which can be removed three or four days after farrowing, creep facilities being provided for the piglets. Included in this category are the various Swing Side crate pens and the Solari pen. An innovation of recent years, the Pitmillan pen, involves the confinement of the sow in a tubular crate throughout the rearing period and simple low surrounding partitions to confine the piglets.

The second category involves special farrowing houses with solid-sided or tubular crates and separate rearing houses to which the sows and litters are taken 3-6 days after farrowing. While this second category involving two different houses is probably the most common and is favoured as easing the supervision of farrowing it does involve the stress of a housing change at a critical stage. Of solid-sided crates, the West of Scotland design, as used in the Muir of Pert house, is one of the best known, while of tubular crates that made by Ritchies (Forfar) is very widely used. Of rearing houses the variations of the Muir of Pert design principle offer very satisfactory results.

Fattening Houses

The most popular form of fattening accommodation is a controlled environment house with litter size or larger pen numbers, no bedding, a slatted dung area for sludge mucking and floor or trough feeding. There is much debate on the desirable size for pens and whether the undoubted benefits of small pen numbers (10) can outweigh the economies provided by large pen numbers (20 or more). Much argument also occurs on whether trough or floor feeding should be practised, the latter method being credited as saving 15% in capital cost while allowing 20% increase in pen numbers, but being discredited by stockmen on husbandry grounds. Semi or fully automatic feeding can be arranged to all types of pens although difficulties arise when dry meal feeding to large pen numbers with troughs at right angles to the main feed passage is required. However, pumped liquid feeding can provide a satisfactory answer.

E conomy in 'house room' is achieved by fattening in two stages with smaller pens for the younger pigs, while when large pen numbers are involved some small pens for the slower finishers are essential.

Kennel type piggeries aim to achieve economy by providing the pig with warm low cubic capacity sleeping quarters and uninsulated dunging areas and various conceptions of this principle are in use. The Solari design involves feeding in the kennel with roofed dunging area employing slatted floors or deep dung, while the Taymix design involves feeding in an unroofed yard which is cleaned out by a pressure hose.

The High Humidity type of piggery which has proved so successful under the very highly skilled management of its designer, Mr James Jordan, involves conditions which are quite contrary to normally accepted standards and at only 25% of normal housing costs. His piggeries are akin to rows of loose boxes of uninsulated reinforced concrete construction with ventilation controlled by way of a half heck door. Floor feeding is practised and dunging out is by way of a 2 ft wide strip of slats over a sludge channel. A temperature of around 90°F. and a relative humidity of nearly 100% is maintained with the surprising number of 21 air changes per hour. Not all who have attempted to emulate Mr Jordan's success have succeeded.

Various forms of courts, yards and deep strawed piggeries are used in areas where straw is abundant but they are becoming proportionately fewer compared with the all-inside controlled environment house.

DISCUSSION

Discussion opened when Mr Fraser of the North Eastern Farmers Ltd, Aberdeen complimented Mr Soutar on the excellence of his paper and suggested that the Institution of Agricultural Engineers, the Architects, and the Veterinary Association should work more closely together than in the past.

Mr Dixon of the West of Scotland Agricultural College asked Mr Soutar for his comments on the housing of sheep in small numbers as well as in large numbers. In reply Mr Soutar stated that this particular question was really best answered by the sheep husbandryman. All along the husbandryman had to inform the architect of his requirements and the building designers had to answer them. In this instance Mr Soutar confirmed the view that it would be very much better to work with smaller numbers of sheep, particularly if one was working with in-lamb ewes, when it was desirable to keep down to groups of ten or even to have individual pens for lambing.

The view expressed by Mr Soutar was endorsed by Mr McCrae, a veterinary surgeon from Perth, who felt that the health aspect of in-wintering sheep required the utmost care. It was essential, in his opinion, that the animals be free of pneumonia and also free from worms before they were in-wintered.

Mr McCrae asked what the incidence of injured teats in cows was with the cubicle system as compared with the traditional byre, and he also asked for Mr Soutar's views on underfloor heating of pigs for the duration of the first 16 weeks, as it appeared to be a new aspect that should be followed up with a view to cutting down the illness risk from birth, through weaning, and on to the early stages of feeding.

In his reply Mr Soutar regretted that no figures were available with regard to udder damage. In so far as floor-warming was concerned, he felt this was definitely good, particularly in rearing pens. Frequently pens were washed, the concrete became soaked, and whilst it looked dry on the surface, it still had a high water load, and only too often young pigs were then taken and placed on this damp concrete at a stage which was most critical, i.e. in their early life. Electric floor-warming still required further investigation but certainly some of the big commercial producers, such as Mr McGuckian in Northern Ireland, were finding the system advantageous.

Mr R. J. Forsyth, of the Farm Buildings Department, West of Scotland Agricultural College, commented that, whilst he had no actual figures on teat injury, the evidence available from cubicle installations with which he was personally involved showed a definite tendency for there to be much less damage than in byres.

Mr Elder from Renfrewshire stated that with over two winters experience with 100 cows in cubicles, no teat damage, no big hocks, and no big knees, had been encountered. Mr Elder asked Mr Soutar for his views on the insulation of cow cubicle beds, possibly with expanded polystyrene. Mr Soutar replied that he was more concerned to ensure a freely drained bed, with the dry surface that accompanied it, rather than with insulation.

Mr R. J. Forsyth felt that the use of expanded polystyrene was not too good in this instance as it was liable to soak up moisture, either from the ground underneath the floor, or from liquid spilled on top of the floor, which could penetrate the topping concrete, thus necessitating the provision of some moisture proof material above as well as below the insulating layer. Mr Forsyth felt that for applications of this nature, within cubicle houses or byres, the use of the simple hollow clay building-block was to be advocated, since the 1 in. to 1½ in. air space helped to prevent the transfer of moisture from beneath to the lying surface.

Mr Alan Mackay of Messrs D. W. Taylor & Sons, Dorset, commented upon the application of electric underfloor heating and stated that since August, 1964, they had installed cables in all their pens for fattening pigs. Up to the present time it had been found to be an economical proposition, particularly in the semi-intensive type of fattening pen. The cost had been relatively low and no straw had been necessary.

Mr T. Wilson of the East of Scotland College of Agriculture, Perth, expressed the view that the cheapest form of insulation for cubicles or for anything else was straw. Secondly, the practice of tying animals up by the neck in cubicles was becoming increasingly evident and it appeared that a mistake with cubicles was that they were fixed hard into the wall, whereas had they been kept back at least 6 feet all the animals could have been tied by the head, leaving still enough room for feeding passage up the front.

Mr Rennie from Dunbar asked for comments upon the necessity of a roof over the areas used for in-wintering of sheep, or if the open area as used in Suffolk was more desirable. It seemed that if one could enclose the sheep, feed them conveniently and not have the expense of putting a roof over the top of them, this would be a tremendous step forward over the earlier conceptions of in-wintering.

There were many forms of 'folding' sheep, stated Mr Soutar, some of which had a hard standing with a roof over them, and the sheep were quite in the open. In other cases a confined area of roof was provided with an open yard. The type referred to by Mr Rennie as the 'Suffolk' type, was shown because it was of interest but could hardly as yet be classified as a system, in fact Mr Soutar felt it was unique.

Dr Ian Cunningham of the East of Scotland College of Agriculture commented on the College's experience with ewes over the past four years at Edinburgh. Three systems had been tried, namely in the field with little shelter, in an open yard with concrete bottom, and in a shed. The second system had been found to present slurry problems.

During the past winter 60 ewes had been kept on slats, the area being enclosed with corrugated iron for shelter purposes, and these were just beginning to lamb at the time of the Conference. However, results over the three previous years with the open yards gave birth weights which were slightly heavier than for those obtained with ewes in-wintered, and also heavier than ewes out in the open field. Thus results achieved with a system similar to that described by Mr Soutar were found to be satisfactory to date, although there were indications that the roof was not necessary for the later lambing ewes, i.e. lambing in March, whereas it would be an advantage for earlier lambing ewes, i.e. in January.

Mr Young, a company representative from Perth, remarked upon an electric underfloor heating installation for pigs for a small area involving three farrowing pens only, with which he had been associated. The farmer had assured Mr Young that a noticeable increase in farrowing had been experienced, and the health of the pigs had been much better. The heated area used had removable steelwork and could thus be used if a cow, a calf, or a sheep or a lamb was ailing. In general terms the underfloor heating had been of great benefit in this instance. Mr Young agreed with Mr Soutar that further investigation into this application was merited.

LIEUT. COL. PHILIP JOHNSON

It is with deep regret that the death is announced of Lieut. Col. Philip Johnson the Foundation President of the Institution. It is known that he had been ill for some time but his death was entirely peaceful at his home in Preston on 8th November.

Lieut. Col. Johnson was the First President of the Institution at its inception in 1938 and retained the Presidential Office for nine years. He was elected an Honorary Member in 1947.

The funeral of Lieut. Col. Johnson took place quietly at Preston Crematorium on 11th November. The Institution was represented by the President and other Senior Officers.

A full appreciation of the life and work of Lieut. Col. Johnson will be published in the next issue of the *Journal.*

THE DESIGN AND OPERATION OF MECHANICAL FEEDING SYSTEMS FOR BEEF AND PIGS

by D. J. B. CALVERLEY, BSC(AGRIC), MSC(AGRIC ENG), AMI AGR E*

A paper presented at the Scottish Branch Conference of The Institution in Dunblane on 3 March 1965

At no time in the past can there have been any phase of agriculture in which interest and development has proceeded as fast as that of mechanizing the husbandry of livestock. Less than a decade ago mechanical feeding was as novel as a combine harvester in the 1920's and only five years ago the storage of high moisture grain was of little more than academic interest.

The danger of rapid adoption of new ideas is that often the farmer is ahead of the research and experimental worker and therefore runs a considerable risk of making mistakes, sometimes expensive, that might otherwise have been avoided. Those who follow do well to look at and criticize these mistakes and be grateful they are able to profit from them. Only now is a pattern beginning to emerge, by trial and error, of the correct approach to and the important aspects of mechanical feeding.

This paper does not attempt to be comprehensive but sets out to discuss these aspects which appear to have been overlooked or under-emphasized.

Mechanical feeding is part of the larger problem of materials handling on the farm. Lip service is paid to this concept but there are too few indications that it has sufficient meaning in the comprehensive planning of a farm. It is regarded by Mellard (1961) as an attitude of mind as regards to:

1. The elimination of unnecessary handling both in number of times handled and distances covered.
2. The minimization of remaining movements by a combination of processes.
3. Mechanization—provided this is practical, but only after elimination and minimization.

For mechanization to be possible machinery must be available and the material in a suitable condition for the machines to handle it. This material/machine relationship is contrasted between forage feeding for beef animals, and cereal feeding for pigs in a dry or liquid form. Automatic feeding systems capable of self control, require a material/machinery relationship that will permit a flow of material into the machine as it lies in its storage condition. Fluids perform this function naturally and by the application of pressure will move vertically as well as horizontally. Grain will flow as fluid when the friction between the particles or between the particles and the container is less than the force inducing movement. It will thus flow downhill under gravity and uphill by use of mechanical force. Forage crops present a more difficult and complex problem. Any attempt to make the material granular, by chopping into short lengths or into cubes by pelleting or wafering, still results in particles which have an irregular shape and a high inter-'granula' or particle friction. O'Callaghan (1964) suggests also that there is an interparticle attraction which furthers a predisposition to bridge and cause interruptions to flow. It has been found (Witz 1962) that chopped silage and hay is quite free flowing if it is kept in motion, but if allowed to accumulate becomes non free-flowing. The physical condition of material is therefore as closely related to the method and machinery by which it is to be removed from store, as to the method of storage or conservation. Conveyors and feeding equipment also vary in their capabilities of dealing with different kinds and conditions of material.

* National Agricultural Advisory Service, Ministry of Agriculture, Fisheries and Food.

FEEDING SYSTEMS FOR BEEF

The word silage now is significant only in describing the method of conserving forage. There is probably greater variability between samples of silage than between some hay and silage. High dry matter silage in tower silos relates to materials of 40-60 per cent dry matter. It is removed by top or bottom unloaders. Top unloaders commonly consist of augers, which may have knives fastened to them, scraping the layers of silage to the centre of the silo where it is elevated by a blower or auger and discharged into the chute on the outside of the silo. Bottom unloaders remove silage from the bottom of the silo by using drag chains. To obtain best results from these unloaders forage needs chopping short into lengths not exceeding 2 in., 1 in. being ideal. Within limits consistency of chop length is more important than an average length which may include long filaments that become entwined about other particles inhibiting granular movement. Stiffness of each discrete particle is important in this connection to permit the forage to break up easily into freely flowing material. An analogy can be made with a collection of match stalks and a bag of cotton threads, each thread the same length as a match. It will be appreciated that the matches will easily shake apart, but the cotton threads will cling together in bunches through intertwining of the filaments.

Stiffness of forage is a function of maturity of the grass and the species or variety. As a rough approximation it has been said (Mead 1965) that the sum of the crude protein and crude fibre contents of grass totals 40 per cent of the dry matter. At early stages of growth the protein content is high, and the fibre content low. As the plant continues to grow the proportion of protein falls and that of fibre rises. At the stage of growth when the flowering shoot appears, the character of the fibre changes and begins to liquify. This is associated with an increasing indigestibility of the crude protein. (M.A.F.F. 1953). Obviously, therefore, the younger the plant is cut the higher will be both its protein content and general nutritional value. However, the total dry matter yield is then low, moisture contents are high, making wilting difficult and the material does not handle well. As the grass grows older it yields a higher total dry matter and wilting and mechanical handling are simplified. At the same time the protein and nutrient value is reduced. The problem is to select the right stage at which to cut the crop. The answer will depend upon the intensity of feeding and class of stock for which the silage is intended. For highest value feed the optimum time to cut is probably the week preceding the emergence of the flower heads.

This point is stressed because it is evident that many farmers with tower silos regard high dry matter silage as being more akin to hay than silage. This may be due to the misleading influence of trade names associated with silage made in proprietary silos. Certainly too much tower silage is made like moist hay rather than dry silage. This represents a substantial waste in terms of grassland productivity and potential of an efficient method of conservation.

Unfortunately grass cut at the optimum stage contains soluble sugars in varying amounts depending on the species. These sugars are released through damage to the tissues and become distributed over the outside of the grass particles. They appear as black syrupy deposits on working surfaces of machinery reducing substantially the specific output. On long conveyors the increase in power requirement may cause serious overloading of the conveyor motor. The phenomenon is more apparent when blowing chopped forage into the silo and water has to be sprayed into the eye of the blower to wash away the deposit or lubricate the grass to induce it to flow at reasonable rates. These sugars are an essential part of the energy content of silage and there would seem to be little that can be done at present to overcome this problem except regular inspection of conveying equipment, and removal of the deposits when they become serious.

Stiffness is associated with certain grass strains and varieties. Italian rye grass is excellent in this and other respects but suffers from being an annual. Of the perennial rye grasses S24 and S321 are erect and stiff and have the advantage of a relatively low fibre when mature. Timothy with Meadow Fescue is well adapted to the north since its growth pattern responds to light more than temperature. Normal hay types yield well at the first cut but the aftermath is late and poor.

Other factors which affect the characteristics of chopped forage are relatively unknown. Moisture is known to play some significant part. At low dry matter content the additional weight of water causes dense packing and reduces the friction between the unloader auger and silage making it difficult for the unloaders to bite in. With soft material the condition is made worse. Culpin (1962) suggests that bottom unloaders may not work with silages of 25-35 per cent dry matter and top unloaders are known to have similar difficulties. To avoid expressing free moisture dry matters should be not less than 35 per cent or 40 per cent for silos from 50 ft to 70 ft high. Very high dry matter silage is more spongy and unloader control is difficult, but once in motion is easily handled.

By virtue of the method of conservation high moisture grain can be considered in the same context as silage. In contrast to silage high moisture grain will flow readily in conventional conveyors, once movement has been initiated. Spontaneous flow may be retarded by a number of causes, bridging or arching and the binding action of mycelia hyphae growing amongst the kernels are likely to be the most important. Bridging, which occurs in the funnel of flow through the centre of the silo when using a single auger for emptying, can be broken by putting the auger into a different place in the silo and setting up a different flow path. When flow is held up by mycelia hyphae, flow funnels cannot be established and the apparent bridge remains unbreakable however the emptying auger is moved about the bottom of the silo. A bottom sweep auger unloader which removes grain from the whole cross sectional area of the silo will satisfactorily break the hyphae. Top unloaders also are satisfactory, and because they do not cause air contamination throughout the mass of grain appear to be the best method yet of unnloading moist grain.

Hay is the most widespread method of conserving livestock fodder but nowhere as yet is it completely mechanically handled in this country. Traditional long hay is not likely to be considered on mechanized farms. Baled hay can be handled into the storage barn or stack by machines but some hand work is needed to remove bales from store and prepare them for feeding by cutting the string or placing on an elevator. Chopped hay has better characteristics for mechanical movement. Its production however necessitates field chopping at 35-40 per cent moisture content, to prevent losses from shattering, followed by some process of barn drying. An auger unloader has been developed to remove chopped hay from a drying floor (Weeks and Kleis, 1962) but this has not been produced commercially. In any event such large volumes of hay are involved when it forms a substantial proportion of a diet that, for the time being, it is better self-fed than to have to deal with problems of mechanical removal from store. Table 1 shows the volume of chopped hay as dried. The volumes will be considerably increased if the hay is removed from the drier for storage elsewhere.

TABLE 1
Volume of Chopped Hay

Treatment	*Volume ft^3/ton*
Baled	240 — 280
Long chopped (6 in. and over)	450 — 550
Short chopped (1 in. - 2 in.)	240 — 300

The Germans claim to have completely automated hay feeding through the use of towers. These are about 25 ft in diameter and built of a steel framework supporting perforated corrugated steel sheets. Chopped hay is blown into the tower leaving a central hollow shaft through which the hay is ventilated horizontally. The hay is unloaded from the top surface by spider wheels causing it to fall down the shaft on to a mechanical conveyor.

Wafering is a method of hay packaging which retains the roughage of baled hay while providing the flow characteristics required for mechanical handling. Considerable progress has been made in the development of field hay—wafering machines in the U.S.A. (Dobie 1964). Wafers are produced from made hay at 10-15 per cent moisture content during dry weather. Production costs are $3 to $4 per ton more than baled hay, but the premium on the sale value is more than $5 per ton. Clearly this system of hay making has many appealing virtues, but it is unlikely to be of commercial value until methods of wafer making at moisture contents over 30 per cent have been developed.

Forage Feeding Layouts

The design of a feeding system can be considered in three parts.

1. Feed storage.
2. Method of feeding.
3. Integration of all the facilities required for the stock—housing, water, manure disposal, etc.

1. Feed Storage

The selection of a silo or other storage unit is made on the basis of efficiency of conservation, suitability for mechanical or automatic feeding and cost.

Horizontal silos are generally not suitable for automatic feeding systems. Greater use could be made of existing silos for forage box feeding by increasing the depth of storage to 12-20 ft high and unloading by tractor mounted silage grabs. Unloading rates at 12-15 tons per hour are many times faster than mechanical unloaders in tower silos.

Tower silos can be automatically unloaded. They are available in concrete and steel, as open or unsealed, with no attempt, other than silage-making techniques to control the atmospheres inside the silo. Gas-tight or sealed silos of steel protected by various types of vitreous enamel cost 30-40 per cent more than concrete. They are suitable for all materials and generally the efficiency of conservation is considered higher. However, the results of research at the University of Massachusetts (Kleis 1964) are supported by experiences in this country, that ' "hermetically sealed" silos are neither hermetically sealed nor are necessary for high dry matter silage'. The conclusion can be reached that any conventional silo (except wood) in good condition can be sealed sufficiently well for satisfactory silage storage.

It is to be expected that cereal feeding for beef will increase. The feeding of dry grain is an established technique and has developed from conventional methods of harvesting and storing grain in traditional growing areas. Cereals have a potentially greater yield of starch equivalent per acre than forage and when used as the exclusive or a significant part of the ration lead to more intensive systems of feeding. The storage of barley at high moisture through fermentation and the refrigerated storage of moist grain assist in overcoming the problems of harvesting and storage in these areas where weather conditions preclude normal methods of harvesting. The storage units for cereals may be tower silos of the type used for silage, or small containers for refrigerated or dry grain filled at regular intervals.

All the storage units should be grouped together into a one feed centre. In its simplest form it may consist of a single tower silo, in others there may be several silos, bulk storage bins and equipment for metering and processing. Silos are the principal items and their positioning is important in relation to roads, buildings, material movement and drainage. The difficulties caused through wrongly placing a silo can sometimes be overcome by the extensive use of conveyors, but this at best increases the cost and complexity of the system.

The principle of siting of feed centres is to establish a locus through which all the ingredients of a feed pass to be mixed, measured and conveyed to mechanical feeders or forage boxes. There are four rules of thumb which help to establish this principle.

(*a*) Silos and other storages should be adjacent to each other and close to the yards.

(*b*) Silos should not be put into the yards (except for the 'Lazy Susan' type of feeder in which the feed trough revolves at the base of the silo.

(*c*) Silos should not be built opposite the end of a conveyor or feeder limiting its expansion.

(*d*) Rows of silos must be parallel or at right angles to the direction of the conveyor feeder.

These rules emphasize the significance of the silo in influencing the orientation of other buildings and structures about it and the subsequent development of the farmstead. There is no one design of feed centre which is the best and many different designs may serve the same purpose equally well. They are intended to and should become the central point of the feeding operation. Motor switches, fuses and other relevant electrical control gear will be installed here. Processing (rolling and grinding) and metering equipment may be needed and space must be provided for this equipment as well as for its maintenance and repair. These centres have a sophisticated function and their layout and development requires appropriate consideration. They must be covered to give protection not only to the equipment but also to those who operate and maintain it. A simple shedding can usually be built as a lean-to on the silos and will go far to encourage tidy house-keeping habits.

2. Mechanical Feeding of Forage

There are two methods of feeding:

(*i*) Conveyor bunk feeders.
(*ii*) Forage boxes and fence-line feedings.

(i) Conveyor bunk feeders are designed for and capable of automatic control. They are frequently and misleadingly referred to as auger feeders, since they are available in many forms, scrapers, conveyors, oscillating conveyors, chain and flight conveyors, as well as many variations of auger conveyors. The ideal conveyor should be capable of:

(*a*) Conveying short fibrous material, ground meal or a mixture of both without particle separation.

(*b*) Discharge from the conveyor into the whole length of the feed bunk simultaneously and uniformly irrespective of fluctuating rates of loading.

(*c*) Be capable of adjustment to allow lower or higher rates of discharge along selected sections of the feeder.

Few feeders achieve this ideal but in many instances the application may be such that simple feeders are satisfactory. Table 2 describes the characteristics of the more common types of conveyor feeders.

3. Forage Boxer

A system employing forage boxes to overcome the difficulties of scattered yards can be a satisfactory transition stage from self feeding to mechanical feeding. Forage boxes are now manufactured as accessory assemblies to be added to existing wagons and trailers and can be made to serve a variety of purposes (Coolman 1964). Most forage boxes can be loaded with forage and ground meal and mixing by the discharge mechanism is generally considered good enough, although there is no experimental evidence to substantiate this. Special wagons are available for ground meal or rolled grain. The essence of successful use is that the operator can adjust the rate of feeding either by a speed control built into the wagon power unit or by varying the ground speed. Front-unloading wagons give the best view of the discharge.

Fence-line feeding requires adequate access for the forage wagon and a hard 8 ft wide roadway for all weather operations and continuous traffic. Turning areas must also be concreted and these have to be surprisingly large.

TABLE 2

CHARACTERISTICS OF CONVEYOR FEEDERS

Description	*Filling Manger*	*Even Distribution*	*Material Condition*	*Particle Separation*	*Cleaning Action*	*Variable Distribution*	*Feeding Rate*	*Power hp/ 100 ft length*	*Metering*
Open bottom auger	Progressively from end to end	Difficult to achieve	Roughages up to 4 in.	Some	None	Not possible	Not restricted	5+	Possible
Enclosed augers with slots or holes	Continuously along length	Fairly good with consistent material	Roughages up to 2 in. in length with/or concentrates	Some	None	Each side by diverting boards. Along length by governing discharge holes usually into sections	Any	5	Possible by time
Auger in J trough	Continuous along length	Fairly good with consistent condition of material and rate of feeding	Roughages up to 3 in. with concentrates	Some	None	Not possible within the length of the feeder	Any	5	By time
Revolving tube augers	Continuous	Good	Roughages up to 2 in. length and mixed with concentrates	Negligible	None	Not possible with open top auger troughs	Any	3-5	By counting number of discharges
Bottom of 3 way discharge augers	Continuous	Good	Roughages up to 2 in. length with/or concentrates	Negligible	None	To each side and along length by presetting discharge control	Any	5	By counting discharges
Chain and flight	Continuous	Good	Roughages up to 4 in. length with/or concentrates	None	None	Not possible	Any	1½	Possible by time
Oscillating conveyors	Progressive end to end	Even loading at controlled rate very critical	All Materials	None	Yes	Not possible	Not restricted	3	Very difficult

TABLE 3
Access for Forage Wagons

Width of Roadway	
Minimum	8 ft
Maximum	10 ft
Doorways	
Width minimum ..	9 ft
Height minimum ..	12 ft
Minimum access on straight to building or feeding trough ..	10–15 ft
Turning space for tractors and:	
4 wheeled forage box ..	30–35 ft
2 wheeled trailer ..	36–48 ft

Forage wagons in conjunction with large horizontal silos unloaded by tractor grabs or mechanical unloaders are well suited to the larger and expanding units.

4. Planning and Integration of Livestock Requirements

The detailed appraisal of all the considerations leading to the evolution of a comprehensive plan for a livestock unit are outside the scope of this paper. Housing requirements, method of feeding, watering, ventilation, animal movement, drainage, manure removal—each contributes to and influences the final decision on what the plan shall be. The specific requirements of the machinery for feeding can be more easily stated. They include:

(*a*) Economy of movement of materials and effort,
(*b*) Simplicity of design and operation
(*c*) Flexibility to be able to absorb changes in feeding practices and techniques of conservation.
(*d*) Capability of complete mechanization and automation so that 'man time is used first to think and last for power'

(*i*) *Conveyor Feeder Layouts*

The basic plan is essentially that of a rectangular livestock area with the feed centre built about an extension of the conveyor feeder outside this area. The livestock area may be an open yard, an enclosed building with the conveyor forming a fence line or a special building for confined housing.

Where the area on each side of a conveyor is further sub-divided into small areas to contain a small number of cattle—i.e. groups of 25 or so, some attention has to be given to the shape of the area in order to provide sufficient trough space. The linear footage of trough requirement varies according to the frequency of feeding and the type of feed. Experience of some feeders suggests that more space is needed for mechanical feeders with silage than self fed silage or mechanically fed barley. It would appear that the 'come and get it' appeal when the conveyor rattles, attracts cattle to the feeder although they may be satisfied. However there are many who disagree with this.

TABLE 4
Trough Length Capacity at 600-1000 lb Liveweight per Foot of Feeder

Cattle per foot length trough	*Feeding System*
3	Dry meal unrestricted
1.2	Unrestricted high dry matter silage and fermented barley
0.5 — 0.6	Limited feeding

(*ii*) *Forage Box and Fence Line Feeding Layouts*

The layouts are different in two respects from those with conveyor feeders: the feed troughs are moved to the periphery of the yard and the shape must be changed to give the necessary length of feeding space. Feeding is unlikely to be done more than twice daily and the full trough allowance should be given. Separation of the feed centre from the yard allows some simplification of design. Scattered yards of indeterminate size and shape can usually be incorporated in a mechanical feeding system providing that access is available and that there is sufficient peripheral length to provide the necessary trough space. Where feeding is to be done inside a building the extra space needed for a forage wagon may be very costly. Also because of the more extensive use of space, drainage and manure collection will be more difficult.

Control Systems

Among the advantages claimed for a mechanized feeding system using tower silos is a reduction in labour. At the present time, although work is made easier and more congenial, any saving of time is more apparent than real. The reason for this seems to be a lack of understanding of the essential material/machinery relationships and the absence of simple controls and safety devices necessitating constant supervision.

Silo unloaders and feeders usually give most trouble. The means of achieving an optimum material condition has been discussed earlier and these will improve the reliability of equipment in terms of higher specific outputs and consistent loading rates. Ammeters should always be wired into motor circuits and these will give a visual indication of over- or under-load conditions. The ammeter need not be fitted at the motor switch but at a location where it will be visible by somebody working. Several ammeters in series may be needed in some cases. When associated with an audible warning system attention can be drawn to potentially dangerous conditions of over load. Simple flow sensing devices can detect the cessation of flow at any particular point and be made to stop equipment. When the silo unloader has been manually started and lowered on to the silage, a simple time clock can be used to activate the winch motor for a few seconds and lower the unloader each third or fourth revolution. Once adjusted the time of winch motor activation will only need to be shortened in duration as the silage becomes more dense.

These examples can be increased in number and elaboration using simple inexpensive equipment to give a system of more or less complete control and protection. Feeding controls can also be linked to those for feed preparation and in suitable feeding systems permit the use of lower horse power motors and lower installation costs (Moe 1964). A fully automatic feeding system working without attention and supervision has been in operation for some years (Calverley 1964).

PIG FEED SYSTEMS

In contrast to forage most pig food has handling characteristics that can be accommodated by existing machinery. Ground meal has the worst flow characteristics but once movement is initiated by some mechanical motion or by suitable design of containers, even this material can be handled easily. For this reason problems in mechanizing pig feeding, apart from those of processing, are chiefly associated with methods of metering and rationing and with the production of a physical form—meal, pellets or wet mash—which will produce the best overall results from the pigs.

A further significant aspect of pig feeding is the relatively little influence that the requirements for mechanical feeding have on the structural and environmental requirements of pig housing. This can be attributed to the greater fund of knowledge of the environmental requirements of pigs and their economic significance, but also the relatively cheap and simple equipment needed to convey pig food. Restricted feeding requires adequate trough or floor space, and wet feeding introduces the physiological phenomenon of simultaneous eating and urinating for which special drainage provisions are needed. This simple application of machinery has led to a number of manufacturers offering feeding equipment as packaged units, capable of being fitted into almost any system of housing. Many design decisions and the problems of integrating components have thus largely been taken by the manufacturers of the equipment. The farmer is concerned with selecting which system is best suited to his requirements.

Dry Feeding Systems

1. Conveying systems

Most of the conveyor types used for grain are capable of handling ground or pelleted feeds. Pneumatic conveying, especially when part of the milling process, can be used but proper precautions are needed against dust and it is generally less satisfactory than other types of conveyors.

Enclosed auger systems using $3\frac{1}{2}$ in diameter augers will handle meal and pellets up to 1 in. in size. Sections can be connected to give a total length from one motor up to 200 ft including vertical or inclined sections. The versatility of auger systems has been increased by the development of corner components allowing inclusion of right angle bends. The conveying capacity ranges from 6-25 cwt per hour with $\frac{1}{2}$-1 hp motors. Discharge outlets may be installed at any required point. Auger systems may be used in any location, indoor or outside, but their most usual application is probably that of conveying from a fixed distribution point to a number of houses within a small area, each with its own feeding system. A new development of the auger sometimes referred to as a helical or open auger is intended for conveying within piggeries to feeding points. It is capable of 90° bends and will deal with pellets up to 1 in. diameter.

Chain conveyors using 3 in. wide link chain running in an open trough are suited to meals, but limited to pellets having a maximum diameter of $\frac{1}{4}$ in. This type was originally designed as a poultry feeder for the continuous distribution of feed. It can be used in a continuous conveying circuit where the total consumption does not exceed 600 lb per hour or for the filling of hoppers for self feed systems. Chain and flight conveyors having $1\frac{1}{4}$ in. discs or flights inside $1\frac{1}{2}$ in. diameter tubing are rather more flexible. They have a higher rate of conveying, will take particles up to $\frac{1}{2}$ in. diameter and will convey vertically and horizontally in the same circuit. Gravity discharge can be arranged at any point.

2. Feeding

The simplest and cheapest method of restricted feeding is 'on the floor'. The required amount of meal or pellets is dropped from a dispenser suspended over the approximate centre of the pen. No distribution is necessary and no troughs or special feeding area has to be provided. The dispensers are circular or rectangular containers with a capacity up to 40 lb meal. The amount in each dispenser is regulated in almost all cases by a sliding sleeve which can be raised or lowered to vary the depth of meal dropped from an overhead conveying system. The dispensers themselves are capable of considerable sophistication and in at least one installation are operated from a central control point some distance from the piggery. More conventionally, and more suited to good husbandry, they are operated electrically or by wire release by the pigman inside the house.

Self feed hoppers require very similar considerations to floor feeding, except that the hoppers are filled instead of dispensers. 4 pigs per self feeder hole or 3 lineal inches of trough space appears to be the optimum density. Space has to be provided for the hopper in assessing pen capacity.

Feed dispensers for restricted feeding in troughs have to distribute the food along the trough so all the animals may feed at one time. The trough allowance per pig is now increased to about 12 in. each which requires a considerable length of trough for single sided feeding, or feeding area for double sided feeding. Commercial equipment usually relies on a number of dispensers fitted at 3 ft centres over conventional troughs. Continuous dispensers, usually fitted in larger units, which travel along the trough measuring the amount for each section, require the troughs to be at the front of pens in a continuous line. This may impose difficulties in obtaining maximum density of pigs except in narrow buildings.

There is considerable scope for variation in design when considering the method of conveying food from the processing or feed centre to each pig house. There is no direct relationship of size of unit to method, the distances involved being more significant. In compact enterprises several units can be accommodated by chain or chain and flight conveyors, each of which can include some 1800 ft of conveyor in up to 4 circuits. These circuits can be used as conveying systems to houses, each with their own feeding systems, or to distribute feed within the house if distance permits. On extensive units small feed stores are best established at each house or group of houses. This

Practice has been well exploited in the broiler industry. For large units outside storage bins are used with an auger conveyor to fill the feeder hopper, or the feeder may withdraw directly from the storage bin. Inside hoppers filled by auger conveyor from a tipping trailer or mixer wagon may be sufficient for smaller installations.

Liquid Feeding

A system of liquid feeding through pipelines consists of a large mechanical mixer in which whey or water is mixed with meal, and a pump and pipe network through which the liquid feed is pumped. The recommended mixture is about 4 lb meal per gallon of water giving a liquid that will flow into feeding troughs when not pressurised. Mixing is very rapid, probably due to a deep vortex formed in the tank, at some 3-5 cwt per minute. The fineness of grinding does not appear to have effect on the efficiency of mixing or the physical condition of the mix. Unground cereals and swill are sufficiently well mixed to give consistent distribution without any apparent particle size or weight separation in the pipelines.

A water and meal mix should be given at the rate of 3-5 lb per day to each pig at 140 lb live weight, equivalent to $\frac{1}{2}$-$\frac{3}{4}$ gallon at each feed. Rationing of the feed for the whole piggery can be done by controlling the amount of meal mixed in the tank. Precise measurement of the feed to each pen can be done by pre-measurement in a tank or by flow meter, but these methods are clumsy and expensive. Calibration of the feed trough by filling from buckets and then filling to the correct mark has been found to be quite acceptable.

The method of feeding commonly practised is for the pig man to more or less feed by hand by turning a plug cock and filling the trough as he watches it. This necesitates 12 in. per pig trough space as well as taking considerable time. 25-30 pigs can be fed per minute unless the pens are widely dispersed. New techniques are being developed in which a continuous flow of feed is passed before the pigs for a selected period of time, several times per day. The surplus feed is returned to the mixer and recirculated. Two pilot schemes using this system have recently been installed on large commercial units. Floor areas for liquid feeding are restricted in conformity with the need for sufficient trough space. An alternative method of feeding which has not been fully exploited as yet is to use up to 6 lb meal per gallon of water, yielding a 'porridge' which can be fed on the floor. Such a system might also simplify the drainage and urinating problems which are significant in all liquid feeding.

The mechanical advantages of liquid feeding are considerable:

(*a*) It can be adapted to extensive housing systems and fitted into existing piggeries having sufficient trough space.
(*b*) Dust, always associated with movement of grain products, is eliminated in the pig houses.
(*c*) The mechanics are simple; all the moving parts (pump and mixer) are contained in the feed centre.

A number of precautions have to be taken in the construction of a system and these are listed elsewhere (E.D.A. 1964).

Comparison of Feeding Systems

In an attempt to evaluate each system of feeding, feeding trials are being carried out at Experimental Husbandry Farms of the Ministry of Agriculture.

Up to the present no outstanding differences have been recorded. There was no clear-cut difference in days to bacon weight and there was little difference in conversion between dry meal and wet. In grading, the pellet-fed group did better than dry meal, which in turn did better than the wet, but the overall difference is so small that it is unlikely to be significant. Most of the pigs were trough fed; it was noted that the amount of wastage was negligible and it was impossible to detect differences between treatments. If floor feeding had been included with the risk of greater feed wastage, the advantages of pellet or wet mash might have become more apparent.

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DISCUSSION

Mr Robertson, a farmer from Ross-county, asked first if the engineers and scientists could devote some attention to bringing about improvements in silage conservation in horizontal silos, and secondly if it was feasible to suggest field wilting to 40% dry matter under Scottish conditions.

In reply, Mr Calverley stated that the difficulties which arose with high dry matter silage often began with the assessment and meaning of the word quality. 'Did quality mean the nutrient value of the silage or did it refer to what the silage would produce, for example in terms of actual milk production? The two did not necessarily mean the same thing, depending on how much of the material the cow needed to eat or was prepared to eat.' If silage clamps were made of sufficient height for self-feeding it would be most difficult to get adequate consolidation and to exclude air. The easiest, and in fact the only way in which to get sufficient consolidation in a shallow silo was by means of the weight of water in the grass, as it gave a limp material which would pack tightly. Material of not more than 30% dry matter was needed in horizontal silos in order to give sufficient consolidation for a fairly high efficiency of conservation. Material of a higher dry matter required a long wilting period and ended up being springy or fluffy.

This would not consolidate and would tend to have more open spaces, and there would be a higher dry matter loss during conservation. This was why horizontal silos were limited to low dry matter silage for self-feeding. In deep horizontal silos, with the silage 20 feet deep, higher dry matter material could be used, i.e. material of about 40% dry matter gave results similar to those with tower silos.

High dry matter silage was desirable primarily because of increased intake by cattle—there seemed to be an increasing intake as the dry matter increased up to 45%—beyond which there appeared to be no increase in the total intake of dry matter. Therefore, if silage could be made at up to 45% d.m. the optimum intake would be achieved and, all things considered, would result in the optimum production of milk or meat. Thus at this stage there appeared to be an advantage in tower silos.

Field wilting could be difficult during inclement weather but by making use of modern rapid hay making techniques to get fairly rapid wilting, a 40% dry matter level was not impossible in Scotland. In the east of England, a target level of 45% matter would be more appropriate and more easily attained.

MR HARRISON, Aberdeen, said that turnips were still grown to a large extent in the North of Scotland. With turnips and hay one was considering two rather difficult fodder crops, in fact possibly the most difficult products to combine and process. He asked for any ideas as to how one could put up a simple storage building and process these two materials and feed them to livestock.

Mr Calverley stressed that the problems so far discussed related to the continuous flow of materials from storage in bulk. In the case of turnips and hay it might be reduced to the problems of batch handling. It would be necessary to consider, for each feed, how much hay and how many turnips would be required and whether any, or what form of, processing was involved, i.e. baled hay might be chopped and the turnips sliced. This quantity of feed could be removed either by mechanical conveyors or by tractors from the main store as needed, then processed and fed. Alternatively, intermediate stores could be established in the feeding area and replenished periodically as needed. Feed was more likely to be hand loaded on to the choppers or slicers mainly because this was the simplest way of measuring the amount fed. He had seen such systems in Scotland using several of the kinds of feeders mentioned in the paper.

MR HOWIE said that in certain parts of Scotland extreme difficulty was encountered in reducing the moisture content of the baled hay to 40-45%. With the leafier types of material, it was almost impossible in certain areas. In view of this he asked if Mr Calverley would lower the 'critical' point given as 45-50% for the East of England and as 40% for Scotland, even further for the wetter areas in the West of England. At what point would a machine such as a top unloader cease to function?

In replying, Mr Calverley stated that it was not possible to define, only in terms of moisture content, the exact point at which such equipment would cease to work, he knew of the successful operation of top unloaders handling material of 30% or less dry matter, where the material was chopped short and was stemmy.

If the material was young and succulent at the time of cutting and chopped generally into reasonably short lengths but had long 'filaments' in it, then the dry matter should be up in the region of 40% plus for a top unloader to work satisfactorily.

With regard to the degree of field wilting which could be achieved in various parts of Great Britain, Mr Calverley stated that a high proportion of the tower silos installed in the country were north of the Border. This indicated that many people were having success in wilting to a satisfactory level in these parts of the country, which Mr Calverley thought encouraging and was his reason for selecting the 40% dry matter figure for Scotland.

Mr Calverley thought that whilst the system could have been adopted, there might have been trouble if the height of 9 ft only was used with 40% dry matter material, since there would have been insufficient weight for adequate consolidation—the height of the settled material would have had to be more than 9 ft. The standards of management and techniques of silage making would need to be of a high order to ensure that the silo would be filled continuously, rapidly and sealed over as quickly as possible.

If the settled height was 10 ft, some form of silage grab or tractor operated device would be required for unloading. From this point a forage box, or an adapted dump box could have been used for fence line feeding direct from the chopped silage in the bunker silo.

MR WILSON, Dunbartonshire, asked what was the value of one cow's dung for the year, mixed with straw or in any other form. Mr Calverley stated that one of the difficulties in trying to assess the value of manure was the time of the year at which it was applied, i.e. application of nitrogen in the autumn would be of little help owing to leaching which would result in a high proportion of it being lost in the drains. Potash, likewise, would be lost, whereas the phosphate would remain more fixed as it would be less soluble in the soil.

THE COLLECTION OF MANURE FROM HOUSED LIVESTOCK

by R. J. FORSYTH, DA(GLAS), ARIBA, FRIAS*

A Paper presented at the Scottish Branch Conference of the Institution in Dunblane on 3 March 1965

Perhaps the old north country proverb 'Where there's muck there's money' does not necessarily apply under present-day farming conditions. Indeed, the ever-increasing cost of labour involved in handling straw, firstly as bedding and later as dung, by traditional methods; the trend in recent years towards a type of housing which has little or no bedding to absorb the liquid or semi-liquid manure; the more stringent regulations of the River Purification authorities; these all add up, compelling the farmer to consider alternative ways and means of handling the muck, and to think again about its value. In some cases, manure disposal may even be regarded as merely a necessary evil—one which yields a useful bonus perhaps, but a bonus which the farmer could conceivably do without if the handling could be avoided.

Reference has been made to 'traditional' methods of handling the dung. If we have an agricultural tradition in the West of Scotland, it must surely be dairy farming. Equally, if we have a traditional type of house for the dairy herd—it must surely be the byre. The problem of muck handling within the dairy byre will therefore be briefly discussed.

Firstly the design, or formation, of the byre 'grip' or dung-channel must be such as will allow the unobstructed flow of liquid-manure along its entire length. Secondly, it should ensure that animals, when lying down, are reasonably clear of the dung. These conditions are governed by the width and depth respectively of the grip. This problem of keeping cows clean is further aggravated by the pernicious habit that many of the animals have of standing back in the grip and transferring wet muck from their feet to the bed, where it inevitably finds its way on to the flank or udder of the cow. Of the various devices aimed at discouraging this behaviour, the 'Uncomfortable Slope', is probably the most effective. From the investigation carried out by the Department some years ago, the consensus of opinion among farmers who had installed this form of grip strongly favoured its adoption.

Apart from the more traditional system of mucking out the byre by 'Brush-and-Shovel', we now have at our disposal a variety of mechanized methods. These include:

1. various forms of tractor-mounted scraper-blades;
2. the belt-type byre-mucker, where a rubber belt, which normally lies in the grip, is pulled over a roller at the end of a ramp outside the byre;
3. the 'Continuous Chain' or 'Around-the-Byre' system, which has scraper-blades permanently fixed at right angles to an endless chain which travels down one grip and up the other in conveying the dung to the muck-spreader;
4. the 'Shuttle-stroke' or 'Hinged-paddle' system, in which the reciprocating paddle, or scraper, returns neatly to the side of the grip.

On the subject of manure disposal from dairy byres, it is perhaps of interest to examine briefly a system which originated in West Germany a few years ago, and which has been proved practical and applicable under a wide range of conditions. This is the 'Holz' manure-disposal system in which the slatted-floor principle has been applied to the traditional dairy byre. Briefly, this consists of a deep, grid-covered, V-shaped manure channel, laid to a fall of 1 in 66. Water is added to the channel to a minimum depth of 4 in. to ensure a suitable consistency of sludge. Manure—liquid and solid—is collected and held in this channel for a maximum period of 4 days. To empty the channel, a simple hand-operated sluice-gate is lifted, allowing the sludge to flow into a small cutter/pumping tank outside the building, whence it is pumped into a large collecting tank. The size of this larger tank is based on an allowance of 7.86 yd^3 per cow housed over a 90-day period, (approx. 16.5 ft^3/cow/week). The disappointing feature of the system is its high cost and whilst it works extremely well it is doubtful whether it competes in cost with the alternative systems of mechanical mucking already mentioned.

Court-and-Parlour Systems

The Court-and-Parlour has never been very popular in the West of Scotland—less than 1% of milk producers in this area have adopted the system. The main reason for this has been the scarcity and subsequent high cost of straw for bedding, requiring, as it does, some 15-20 cwt per cow, to keep the animals even remotely clean. The 'Slatted-floor' may appear to have been the answer, by way of saving straw for bedding and labour in mucking out. These floors, however, whilst useful in the housing of youngstock, beef cattle, and especially pigs, leave much to be desired as a lying-surface for milk cows, from the point-of-view of both teat injuries and damage to haughs. Inasmuch as slatted courts have been adopted, however, it is useful to take a brief look at how the dung is removed from under the slats. There are two main methods of approach. Either the manure is handled as a material—in which case the liquid is drained off separately—or, alternatively, it may be handled in a semi-liquid state, as *sludge*, where all the liquid manure is retained with the dung and where, in most cases, it will be necessary to add water to ensure that the liquid will flow.

Considering the method whereby the muck is handled as a *solid* material—it may be possible on sloping ground,

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to plan the building so that the animals enter the slatted area from the higher level whilst access is available for mucking out by tractor/fore-loader underneath the slats, from the lower ground. For this purpose the slatted floor requires to be about 8 ft above ground level. Where this headroom is not available, there are two alternative methods of removing the muck in its more solid state. In these cases, the slats are raised only a few feet above ground level and the under-floor space is sub-divided by low walls which, in turn, support various rows of slats. The under-floor channels thus formed, may be only about 3 ft in width—in which case each row of short slats is lifted in turn, making the channels accessible to a fore-loader mounted on a tractor which straddles the channel being emptied.

In the other system, the channels may be about 7 ft wide so that by uplifting the slats, the tractor has direct access between the channel walls.

The important thing to note in comparing the three systems of handling dung as a *solid* material, is that where headroom beneath the floor is available, it is unnecessary to lift the slats, whereas, in the other two systems, the slats must be lifted. Whether these are of concrete or timber, this business of lifting slats can be a tedious and back-breaking job, and one to be avoided if at all possible.

We may now deal with the other approach to the problem—that of conserving all the manure, liquid and solid—and adding sufficient water to enable the mixture to be removed as *sludge*. There are two alternative means of removing the sludge—in the first case, lifting occasional slats and sucking the sludge up by vacuum-tank and, secondly, by lifting simple sluice-gates at the lower end of shallow channels, to allow the sludge to flow into a larger cross-tank whence it may be pumped, or drained off by gravity, into the muck-spreader.

The Cubicle System

Although the author feels that the slatted-floor as a lying surface for milk cows has not been too successful, one must hasten to add that slats used in conjunction with the 'Cubicle' system of housing cows, have already proved highly satisfactory as a means of simplifying the handling of the dung. Whilst it is not the intention to discuss cubicles in any great detail—other than those features which affect dung disposal—let there be no doubt as to what 'Cubicle Housing' involves. This is essentially a system of keeping cows which combines the *bedding economy* of the byre with the *labour-saving* features of the cattle-court.

Whilst a variety of designs for cubicles appear to work extremely well, it seems to be agreed that some form of step, or kerb, between the access-passage and the lying-area is desirable. This helps to keep the bedding in place, prevents the cow reversing into the cubicle and the sludge from spewing over on to the bedding area when the passage is being scraped. Even in the best planned schemes, dung or urine is occasionally deposited on the wrong side of the kerb, and the kerb tends to keep it there. Solid dung is readily seen and can be removed; urine, on the other hand, is soaked up by the bedding, resulting in wet lying condition. This kerb is raised on wood fillets at each partition to provide a draining gap, so that any liquid falling inside the kerb will automatically drain out on to the passage.

Access-Passage or 'Gangway'

It is important that the passage should be kept clean. Solid passages normally require cleaning daily especially in the case of cows newly admitted to the system. These cows may choose to lie down wherever there is a build-up of muck. Where the passage is slatted, a minimum width of 6 ft 6 in. is presently recommended, although this could be narrower. For solid passages, a minimum width of 8 ft is recommended.

If the passage is of solid flooring, the slurry may be pushed out of the house by tractor/scraper or by hand squeegee. For this operation, the passage is best laid level throughout its length so that the liquid manure will remain with the dung to form a 'soupy' mixture which will run, or flow, in front of the blade, leaving a reasonably clean, non-slip surface.

Slats

Taper-sided concrete slats with top-width of 4-6 in., and $1\frac{1}{2}$ in. gaps between slats, are almost universally accepted as the most satisfactory for mature animals. At 6 in. depth, these can span up to 8 ft, whereas, pre-stressed slats, of similar depth, can span up to 12 ft.

Slats, of course, may be of different designs and made of different materials such as timber, T-iron, perforated metal and cold-pressed steel.

Timber slats—oak, elm, or larch—are light in weight but can become slippery, and have a life of only about five years. Perforated-metal or 'steel-mesh' floors can cause injury unless coated in some way; plastic-coating wears off and in the process, tends to obstruct the perforations. Nylon coating is superior but the cost tends to be prohibitive. T-iron slats are heavy to handle and costly.

The cold-pressed, 16 gauge ($\frac{1}{16}$ in. thick) high-tensile steel slat, is a new development which has come to us from America. These are 'U-shaped' in section, each slat locking on to dove-tailed, cross-pieces which ensure that the slats do not warp or twist. These are available in two sizes, one being suitable for pigs and the other for cattle. The latter have, in fact, been under test for young-stock housing at the College Animal Husbandry Experimental Unit over the past winter. Experience to date has not been too encouraging in so far as these tend to be slippery, and conversion rate for animals confined to these slats, compared with a similar group confined to concrete slats, has not been so good.

Certain economies are claimed through reduced weight and space required in transportation. The cost, however, is still expected to be in region of 10/- to 12/- per square foot of floor, as compared with 7- 8/- per ft^2 for concrete slats.

Under-Slat Tank, or Channels

The main questions which arise with regard to the internal arrangements for handling sludge are:

1. What quantity of dung-and-urine is produced?
2. How much dilution is desirable?
3. What storage capacity should we allow for?
4. What form should the channel take—cross-section or longitudinal fall?
5. Whether there should be sluice-gates; if so, what kind? How often?

Dealing with these in turn—firstly, the amount of dung-and-urine produced—a variety of figures are available from a number of sources, varying from 8.2 ft^3/cow/week to 11.2 ft^3/cow/week.

Dilution?

Early evidence suggests a dilution-rate of 1:1 as a practical minimum for disposal by vacuum-tanker but it is thought that some modern spreaders can deal with a 50% diluted slurry. For distribution by 'Organic Irrigation' via pipelines, a 1:2 dilution is recommended.

Storage Capacity

The size of tank will depend upon the class and number of stock which it serves, the proposed dilution rate and frequency of emptying.

Where it is possible to provide deep storage channels directly under the slats, and to have these emptied at fairly regular intervals, this may be cheaper than constructing shallow channels linking up with a separate covered storage tank outside the building. It must be remembered, however, that to pump directly from channels or tanks immediately under the slat, is to pump from the area of least agitation and this can, under certain circumstances create problems. These under-slat channels are sometimes shallow-rectangular in section (say, 12 in. deep) with sluice-gates to be lifted at fairly frequent intervals. More often, however, these are deep-rectangular in section with sluice-gates which require to be lifted less frequently. Another alternative consists of a 'V-shaped' channel, either shallow or deep in section. Other considerations being equal, all three types have been known to give satisfactory results. On the other hand, each type has also been known to give trouble. In this respect, the Farm Buildings Department is at present carrying out a series of tests in collaboration with the Department of Animal Husbandry to compare the relative efficiency of the three types of channel. These have been installed under a single range of slatted-floor pens, at the Animal Husbandry Experimental Unit, so that all three channels are operating under reasonably similar conditions.

Unfortunately the work, which entails the taking of a large number of levels over a long period, is still in its initial stages and so no conclusions can yet be drawn.

The problem is to obtain maximum agitation or flushing effect in a channel in which the sludge has no initial movement or flow, e.g. a Static Tank. Failure can result from a number of reasons:—

(*a*) Bedding material or waste silage passing through between the slats
(*b*) Omitting to add water to the channel before the stock are admitted to slats
(*c*) Too much fall in the channel resulting in the liquid draining off and leaving the solids behind
(*d*) Channels too long—without intermediate sluice-gates, resulting in minimum agitation at the closed end.

Where the flow of any liquid in a drain fluctuates—as in the case of a sludge-channel where the level drops as it empties—the 'Egg-shaped' drain (or the next best, which is the 'V-shaped' channel) is normally more efficient than a square-section channel, since it maintains the ratio-of-depth of liquid to the cross-sectional-area of the flow, as the level drops (i.e. it maintains maximum H.M.D. for each level of liquid). Theoretically, therefore, the best shape to ensure maximum flushing effect would appear to be a 'V-section' channel with a half-round, glazed-tile bottom. The haunching, or sloping sides, must however slope fairly steeply, to avoid solids or sluggish material being left 'high and dry' as the level of the sludge drops. In a Cubicle House or Cattle Court, however, where no milking operations are carried out, should we strive for such high standards of cleanliness? If we are agreed that something less would suffice, then one might suggest the adoption of a rectangular-section channel—this being cheaper to construct and having a much greater storage capacity.

Sluice Gates—What kind?

Sluice gates are normally of plywood, timber, or steel-plate. Timber gates, apart from wearing at the edges, present few problems. Metal gates, on the other hand, are often too heavy for one man or even two men to lift. For this reason, where sludge channels are of such cross-section as to necessitate a large gate, the sluice should be of timber or, alternatively, twin steel gates should be installed.

Sluice Gates—How often?

Since the quantity of sluggish material remaining at the closed end of the channel, appears to be roughly proportional to the length of the channel itself, it would seem sensible to divide a long channel into two or more short sections, emptying each section in turn so that the flow of liquid from the upper sections will flush the lower ones; thus only a relatively small amount of sludge will be left at the closed end.

Carrying this principle to its ultimate conclusion—the best arrangement, where access permits, would seem to be to deepen the channel at both ends to form two storage tanks with a gate at each end of the channel only, so that by raising the gates alternately the whole length of the channel could be flushed. For such a system, the floor of the channel should, of course, be laid level throughout its length and breadth.

Pasveer Oxidation Ditch

At the beginning of this Paper, it was suggested that due to prohibitive costs and the increasingly stringent regulations governing river pollution, farmers were being compelled to consider new methods of manure disposal and that some farmers were even prepared to forego fertilizer value if a cheap and efficient disposal system could be found. It was, in fact, with such problems in mind that *The Farmers Weekly* recently organized a short study-trip to Holland—in which the author was privileged to join—with a view to investigating the possibility of adopting, for farm use, the 'Pasveer Ditch' system of sewage disposal. This system, designed by Dr A. Pasveer, a bacteriologist with the Research Institute for Public Health Engineering in Holland, was intended for the treatment of domestic sewage emanating from small rural communities. Whilst the treatment of farmyard manure was not envisaged during the development stages, the principles involved in this system gave sufficient reason to believe that such application had distinct possibilities.

It is already known that in any 'activated-sludge' system, a given quantity of sewage can be completely purified if a sufficient quantity of oxygen is supplied and further, that by increasing the supply of oxygen, a larger quantity of sewage can be treated. Similarly, with the Pasveer system, purification is closely related to the degree of aeration, so that if the solids-content of the sewage is high the oxygen input must be correspondingly increased.

The treatment involves a single process—namely the purification of untreated sewage by oxidation, in an open ditch. Raw sewage is pumped, or piped by gravity, into a simple ring-shaped aeration ditch 3-4 ft deep and is immediately diluted by the partially treated sewage with which it mixes. The capacity of the ditch is based on 300 m^3 per 1,000 head of population. Air is introduced to the sewage by means of a mechanically-propelled 'thrasher' or rotor-brush, straddling the ditch. The function of the rotor is two-fold; it oxidises the sewage by creating a turbulence, giving maximum exposure to the sewage-particles thus allowing oxygen to be dissolved in the liquid. Secondly, it circulates the sewage around the ditch, at a velocity of 1 ft/s which is necessary to keep the floc in suspension. This velocity is easily maintained if the volume of the liquid approximates 8,000—10,000 gal per foot-length of rotor. The diameter of the rotor is always 28 inches, whereas, the length varies according to the sewage loading. A rotor length of 2 metres per 1,000 head of population is considered satisfactory. The cycle of operations may be controlled either by a time-switch or, alternatively, by an electrode in the ditch, making and breaking contact as the liquid in the ditch rises and falls.

Under working conditions the rotor is in motion for a period of 4 hours. It is then stopped for an interval of ¾ hour to allow the suspended matter to settle out. The inlet to the ditch is then opened (or pump switched on) for approximately 15-20 minutes, allowing a fresh supply of untreated sewage to flow in. The flow of sewage displaces the clear top-liquid over a weir at the opposite end of the plant. This completes the cycle of operations, the inlet then closes and the rotor starts up again. When the sludge builds up beyond a certain level in the ditch, the surplus is pumped out on to a drying bed so that the volume of suspended solids is kept fairly constant. The accumulation of sludge takes place very slowly, since approximately 70-80% of the organic matter is digested in the process.

The operation consists of the settling out of the suspended matter in the sewage and removing about one-third of the liquid as clear water—retaining two-thirds with the settled sewage.

Cost

Depends upon the construction of the ditch and the amount of electricity consumed, which is proportional to the quantity of effluent handled.

For agricultural purposes, it has been estimated that 1 cow is equivalent to 5 persons, and 1 pig is equivalent to 4 persons. These figures, however, may only be taken as a rough guide since, for example, under certain circumstances the pig could be equivalent to 2 or even 6 persons. Using the first figures:—

Ditch capacity/cow = 350 gal
„ „ pig = 280 „

Electricity

On an estimated consumption of 18 kWh/person/a:—

Consumption/cow = 90 kWh/a
„ pig = 72 kWh/a

Based on local 'Farm Tariff' rates (1¼d per kWh) these figures reflect a running-cost per pig (weaning to bacon) of approximately: 3/–
+ a Capital cost (1-2/– per pig) say: 2/–

∴ Total cost per pig— 5/–

This figure may appear high, but it may be stated on good authority, that muck-shifting at even 12/– per pig (weaning to bacon) can still show an extremely worthwhile profit.

DISCUSSION

MR MURTON, a farmer, raised the question of draining off the liquid from the sludge, to enable sludge to be handled by the tractor fore-loader, as difficulty had been experienced on his farm with this problem. It was his experience that no water had been necessary to make the slurry sufficiently liquid to run.

In reply, Mr Forsyth stated that his reference to removal of liquid referred to a totally-slatted floor for beef cattle when a solid-dung residue was required. He also referred to the best arrangement, as shown by Mr David Soutar, whereby a shaft is incorporated down from the slats in the centre of the sub-floor below the slatted area, with slots between boards up the four sides of the shaft, allowing the liquid material to drain away from the solids into a drain under this shaft. Another way to achieve this would be to slope the floors slightly towards the open end from which the under-floor space was to be mucked out, and to put strong boards at the front, collecting the liquid outside the door, or entrance to the space underneath the slats, in a gully or cross drain.

Mr Murton stated that the above method of holding back the solid material had been tried but the gaps between the sleeper barrier silted up and became a watertight barrier. Mr Forsyth added that he knew of installations of this type that worked satisfactorily, but pointed out that a variety of factors might contribute to the trouble, e.g., excessive amounts of hay passing down between the slats, the type of diet, the shape and layout of the system.

With regard to the necessity of adding water to get the dung to flow in the channels, Mr Forsyth's experience indicated that, in order to achieve a satisfactory flow, the addition of water had been found necessary and engineers had assured him that the sludge had to be diluted to ensure that the suck-lift pump would operate satisfactorily.

Mr Robertson asked if information was available on the application, life and cost of synthetic rubber as a means of forming a slurry reservoir as opposed to the traditional methods. Mr Forsyth replied that whilst he had seen these displayed at exhibitions for water storage, he was not certain how they would stand up to the acids present in manure and he had no experience of their application for this purpose. In relation to the oxidation ditch, in some cases, no lining had been necessary other than for the area immediately adjacent to the oxidation rotor.

Mr Young, Perth, stated that there was a suitable material available for effluent pits or tanks and reservoirs —it has been used for one-million gallon reservoirs for fire prevention, etc on farms. The material was rubber sheeting known as 'Butyl' or 'Tufline', which over a period of 11 years had proved resistant to soil acids and other acids in general. It was tough and resilient and it had lasted satisfactorily, provided that it was laid on an even surface, free of sharp stones, tree roots, etc. It was manufactured by a leading petroleum company and was available in 0.03 in. thickness at approximately 12/- per square yard, ready prefabricated for use.

Mr J. Douglas, Dalmahoy, Edinburgh, asked if there was any chemical on the market that could be added to the slurry to help break down the solids. Mr Forsyth replied that a chemical had been added at a farm in Northern Ireland but the cost proved prohibitive. The chemical was not initially marketed for the purpose but it was found to have the desired effect.

Mr Alston, Edinburgh, asked if the 'clear' liquid discharged from the 'Pasveer' ditch was sufficiently free of bacteria to satisfy the current requirements regarding river pollution. Mr Forsyth said that the findings indicated that sewage purification by the Pasveer method was superior to that of the more conventional activated sludge systems where a B.O.D. level of 92 to 94% was obtained. Investigations carried out in a number of oxidation ditch installations in Holland had a B.O.D. removal of 95 to 98%. The resulting sludge from this system was claimed to be of great value as a fertilizer and was also claimed to improve greatly if left lying over the winter period.

EFFLUENT DISPOSAL – STILL A MAJOR PROBLEM

by W. T. A. RUNDLE, MI AGR E*

A Paper presented at the Scottish Branch Conference of the Institution in Dunblane on 3 March 1965

Effluent has been present since man first kept animals in pens or cages, and for a century the bulk of the solids and liquid in the excreta has been retained in straw or other absorbent media. The excess liquid has always been allowed to run out and then, as the quantity increases, it becomes a serious nuisance at its source and has either been drained, pushed or pumped away, quite often into the nearest stream or river. This is perhaps not deliberate, but it has often found its way into a main water course having travelled through ditches and small streams on its way. Developments in stock keeping during the last 10 years have led to increasing volumes of effluent accumulating from the stock housing, and the ultimate condition is now being reached where no absorbent material is being used and the total excretions immediately become effluent.

Legislation has now been enacted in England, which prevents the discharge into streams and rivers. The Rivers (Prevention of Pollution) Act 1951, prescribes that it is an offence to discharge polluting matter into a stream. The same Act also prescribes that it is an offence to bring into use a new outlet and to make a new discharge of sewage or trade effluent to a stream without the consent of the River Board. This requirement was extended to estuaries and certain tidal waters by the Clean Rivers (Estuaries & Tidal Waters) Act 1960, but not to tidal water around the sea coast.

The Rivers (Prevention of Pollution) Act 1961, prescribes that the persons responsible for the making of discharges of sewage or trade effluent to streams, which discharges were being made before the 1951 Act came into force, must seek the consent of the appropriate River Board for continuation of the making of the discharge. The Salmon & Freshwater Fisheries Act 1923 makes the killing of fish by pollution an offence. The Public Health Act 1961 extends the definition of effluent in the Public Health (Drainage of Trade Premises) Act 1937 to include farm drainage so far as connections to sewers are involved. Consequently these wastes may, if the local authority approves, be discharged to a sewer. The conditions in Scotland are similar, and, no doubt, legislation will have the same effect here as it is having in the South.

This then is the problem. Part or all of the effluent from modern stock units has to be disposed of as quickly as possible, but in future the liquid cannot be allowed to go down the nearest drain without thought being given to its ultimate destination. For the remainder of this paper it is proposed to use the term 'Slurry', which may be defined as the effluent from stock units mixed with a varying percentage of water according to how it is going to be handled.

A wide variety of equipment is now available to handle this slurry. Its selection depends upon the method adopted for stock housing and the size of the enterprise, together with the proximity to the land and the stock types concerned. It is important not to overlook the simpler methods of handling, particularly when the numbers of stock housed are small; namely the hand brush or scraper, small motorised and tractor-powered scrapers, into standard farmyard manure (F.Y.M.) spreaders, Rotaspreaders or trailers. Occasionally, when buildings are on a slope the angle of the slope will permit easy manhandling and will, therefore, keep any capital commitments at a very low level. Where the number of stock and lay-out concerned does not permit the use of these simple solutions, then more sophisticated lay-outs have to be considered. Accumulation and storage methods have to be worked out. All of these seem to require a pit or holding tank which will vary in size or shape according to the type of equipment which is to be used to effect disposal. Equipment which is in current use can be broadly divided into two categories:

1. Mobile Trailer Type Equipment,
2. Pumping Equipment.

Mobile Trailer Type Equipment

This will operate from rather small tanks and is used mainly on farms which carry up to 50/70 dairy cows or 400/500 pigs. This equipment is usually designed to handle the slurry from all forms of stock (straw and waste silage is only suffered and not intended!) with approximately 10% of water by volume. More dilution will be necessary during hot dry weather to prevent scorching when discharging on crops. This can be waste water such as that from chicken drinkers or washing down from the dairy, or it can be added direct if the slurry is not sufficiently fluid when it has to be handled.

Probably the most well-known of this type of equipment is the vacuum tanker. There are many different types, but they all derive their name from the way in which they are filled by a vacuum, created by a p.t.o. driven vacuum pump which is mounted on the draw-bar. These vacuum tanks vary in capacity from 250 to 750 gallons. They are very fast-filling; the small ones at about 75 gallons per minute and the larger ones at about 200 gallons per minute. The small ones generally discharge by gravity, and the larger ones either:

* Wright Raine Ltd.

(*a*) by gravity,
or
(*b*) by compressing the contents of the tank to blow the the contents through a control valve at the outlet,
or
(*c*) by mechanical means such as an auger and spinning spreader plate.

These vacuum tanks are all suitable for extracting manure directly from under a slatted floor area both from pigs and barley beef. A small amount of water may be required to be added for this purpose. Tanks with 'blow-back' agitation definitely have an advantage for these conditions.

There have been two relatively recent introductions in this type of equipment; the 'Slauger' system which houses a vertical p.t.o. driven auger in a hexagonal casing, and which will draw from a storage tank and deliver slurry into a specially built 750 gallon spreader trailer at the rate of 200/250 gallons per minute is the first of these. The second is the 'Rotaspreader', which is an open topped semi-circular two-wheeled trailer of 300 or 600 gallon capacity, with a p.t.o. driven longitudinal shaft which carries short chains. The shaft rotates and the chains fling the contents of the trailer into a fairly even spread. It will handle both traditional F.Y.M. and slurry, but, when dealing with the latter, has to have a separate pump to fill it from the holding tank.

Pumping Equipment

The techniques involved in this country for dealing with slurry in this way have been greatly influenced by the continental Gulle principle. If slurry is to be pumped, the percentage of solid and liquid should not be higher than 10%, which means that when dealing with total excreta it must be diluted at least 1:1 with water by volume. This means that, when comparing this technique with that used on mobile trailer type equipment for handling the total slurry from a given number of animals, almost double the volume of material has to be dispersed. Despite this apparent handicap, sufficient installations of this type have now been running for some time to establish that this method of disposal can be very effective and cheap to run, although its capital cost is usually much higher than that of mobile methods.

There are four cardinal rules which must be observed for any successful pumping system:—

(*a*) any form of total slurry must have added to it at least an equal volume of water. This can be done either by using run-off rain water from roofs or yards, washing down from milking parlours, or water direct from a supply main. This ensures easy pumping; field conditions may call for more dilution as high as 3:1 on a hot, dry day.
(*b*) The size of the water main supplying the stock unit concerned must be adequate to provide the volume of water necessary to dilute the contents of the storage tank in not more than 8 hours. More failures amongst pumping systems have been caused by the lack of a suitable water source than from any other reason.
(*c*) The mixture must be stirred at least once every 24 hours.
(*d*) For trouble-free running exclude straw and waste silage from the system. This can be done with suitable planning and a little care in operation.

The first point which has to be considered for a pumping system is a holding tank. Its size has to be determined by the volume of slurry expected from the stock concerned. The volumes of excreta produced daily from mature animals are set out in the table below:—

	Dairy Cows	*Pigs at* 150 *lb* *Meal Fed*	*Whey Fed*	*Battery Birds per* 1000 *head*
Daily Production of total excreta, undiluted				
(*a*) in gallons	9	1.1	2	28
(*b*) in ft³	1.45	0.18	0.32	5
At 1:1 dilution				
(*a*) in gallons	18	2.2	4	56
(*b*) in ft³	2.9	0.36	0.64	10

From this table one can easily see the volumes of material which have to be handled from a given stockholding, and from the figures it is relatively easy to make calculations with regard to mechanical disposal. The volume of excreta produced daily from the animals concerned is multiplied by the number of days that it is desirable to hold the slurry, usually 14-21.

On stock units of up to 50 cows or 200 pigs, small tanks 10 ft × 15 ft × 10 ft deep are effective. The agitation of this size of tank does not normally require a fixed mechanical agitator; a good stirring effect can be achieved by using a by-pass system from the pump which is used to empty it. Larger stock units obviously call for bigger holding tanks and these are usually 10 ft deep × 10 ft wide and either 15 ft, 30ft, 45 ft, or 60 ft long. Mechanical equipment is available to suit these lengths of tank, the most common type of which comprises a longitudinal shaft with cross paddles bolted to it. The shaft is rotated at approximately 15 rev/min giving a very thorough stirring action.

There are now appearing on the market p.t.o. driven probe type agitators, and some Continental electrically driven ones which are mounted on two wheels and can be man-handled along the side of the tank to stir up the contents prior to pumping out. They are effective, but occupy a man's time in operating them for probably 7/10 minutes per 1000 gallons stored. These portable agitators have at the end of a 10 ft long driving shaft a two-bladed propeller which is shrouded in a short tubular housing. The propeller sucks the slurry in through the shroud and in so doing agitates the mixture and emulsifies it.

Two types of pump are in common use, the most popular is the single stage centrifugal type with an open vane type of impeller which avoids blockages. These have a relatively low operating efficiency, usually between 30% and 50% power-in to slurry-out, but they are low in initial cost and have an excellent service life. They usually give delivery pressures up to 120 lb/in². For heads higher than this the piston type pump has to be considered.

These are more expensive, give an 80% efficiency being positive displacement, but because they have many more moving parts than the centrifugal pumps they have a very much higher maintenance cost.

One distinctive feature of all pumping systems is that they can be fitted in such a way as to allow either water from a fresh water supply or the thin liquid from the storage tank before its contents are stirred to be pumped back onto concrete yards, standing areas, silage faces, etc., to enable them to be rapidly swilled down. The most important design feature of this technique is to ensure a flow of at least 60 gal/min. High pressure is not so important. The washing down hose should not be more than 30 ft long, otherwise it becomes unmanageable and wears out rapidly. This restriction in length often necessitates the installation of a suitable system of pipe work, usually 2 in. bore, to be installed around the areas concerned, with quick action outlet couplings at suitable points.

The N.A.A.S. quote cleaning down times for 1000 gallons of slurry; these are set out below:—

LABOUR FOR COWYARD CLEANING

Method of Cleaning	*Frequency*	*Man Minutes per 1000 Gallons of Manure*	
		diluted	*undiluted*
By hose using dairy washings and recirculated water from storage tank	daily	18	17
Hand scraping with help of dairy washings and rain water	daily	173	148
8 ft wide scraper blade on Allen scythe chassis	twice daily	69	52
Hand scraper from one edge of yard, remainder by front mounted scraper	daily	130	67

This is a convenient point in my paper to attract attention to the need for excluding straw, and Fig. 1 shows a typical example of a special grid for this purpose. The main thing to remember is that it should be 2 ft in width and it should be as long as the installation will allow. The one illustrated is fitted across a gangway which leads from the milking parlour to the lying-in yards. It is, in fact, at the end of approximately 100 yards of covered concrete which runs across the end of some old Sussex barns. The cattle lie-in on straw, the drainage is allowed to come out onto a 14 in. wide concrete walkway, the cows are fed in troughs on either side of it, and every morning this path is swilled down. The whole thing works extremely well and is very clean.

Fig. 2 shows a typical layout for three stock units all drained into one receiving tank agitated by re-circulation from a tractor-driven centrifugal pump.

Fig. 3 shows a layout for a mechnically agitated tank collecting from silage face, lying-in yard, milking parlour, etc. Note the special dungstead to the right of the picture, arranged to receive the straw and silage which is either washed or scraped across the drains. The bulk of the solids and liquids are swilled through the grilles, and the

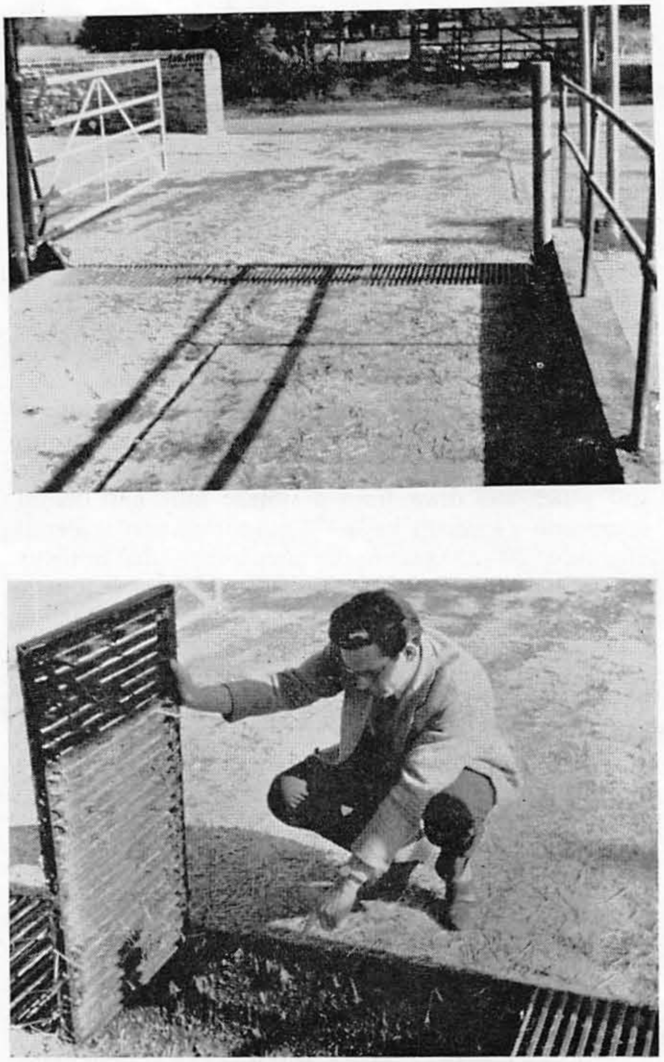

Fig. 1

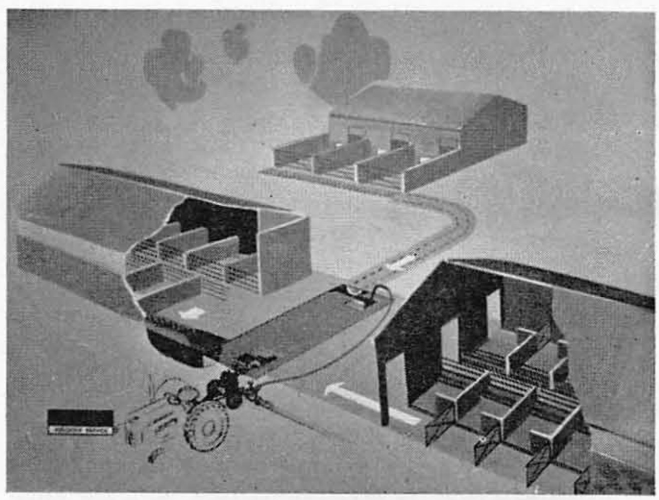

Fig. 2

straw is retained to be dealt with by trailer or tractor spreader.

Distribution from pumping systems is carried out either directly through portable light weight irrigation pipe to the field or through an underground mains system, and thence through portable equipment in the fields concerned. Pumping rates for this type of system are normally between 70/110 gallons per minute, which necessitates the use of 3 in. pipe to keep the velocity of the slurry high enough to prevent the solids from settling. Underground pipe can be of either rigid asbestos or P.V.C. Spreading in the field is usually effected by a two sprinkler system (see Fig. 4). The changeover valve allows one sprinkler to be in operation whilst the other is being moved, thus permitting continuity of pumping while the collecting tank is emptied.

The following Tables give some comparisons of effective times for handling slurry in the two methods described above.

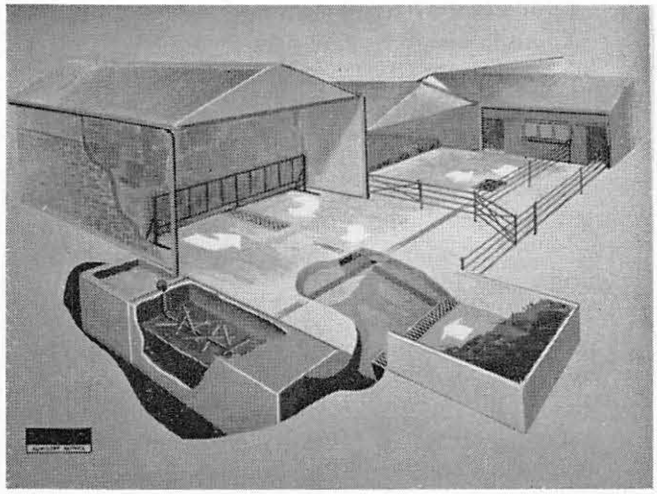

Fig. 3

N.A.A.S. BULLETIN

Labour for Distribution by Spreader Tank

Mean Spreader Tank Size (gallons)	*Mean Time (Man Min.) Per Spreader Tank Full*				
	Filling	*Transport*	*Spreading*	*Total*	*Total per 1000 gal*
100	7.0	10.0	3.7	20.7	207.0
300	5.9	7.0	3.6	16.5	55.1
475	12.0	9.5	5.5	27.0	56.5
700	5.0	10.0	4.8	19.8	28.3

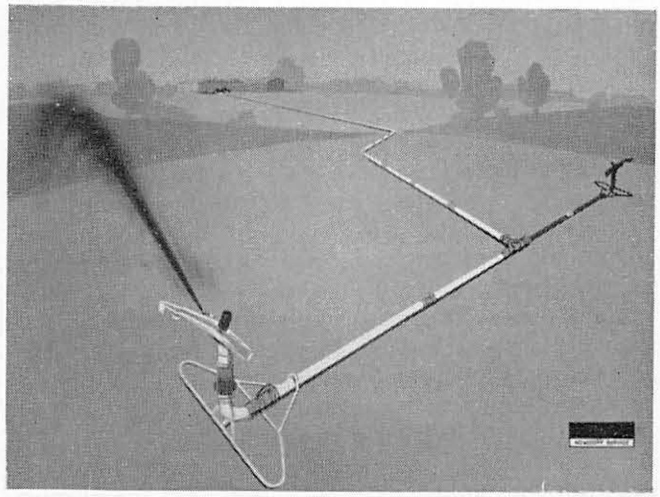

Fig. 4

Labour for Distribution by Pipeline

Actual Volume Pumped (gal)	*Labour per Storage Tankful (Man Min.)*				*Total Man Min. per 1000 gal*
	At Tank	*Travelling*	*Moving Equip't.*	*Total*	
5,000	12	8	20	40	8.0
8,000	11	3	28	42	5.2
12,000	10	3	20	33	2.7
15,000	20	15	57	92	6.1
20,000	5	40	80	125	6.2
20,000	10	40	40	90	4.5
21,000	15	10	30	55	2.6

Slurry has a very real fertilizer value, but this can only be realized when it is applied to crops during the growing season. However, when considering slurry handling this value does help to offset the cost of handling it. Many attempts have been made to place a cash value on it, one example of which is quoted below:—

N.A.A.S. Southern Region

Material	*Application Rate*	*Units N*	*'Available Nutrients'*	
			P_5O_2	K_2O
Neat Cow Sl'y	5000 gal/ac	35	30	100
Neat Pig Sl'y	2500 gal/ac	38	55	53
F.Y.M.	10 ton/ac	30	40	75

It is interesting to note that 10 tons of F.Y.M. and 5000 gallons of neat cow slurry each supply about the same amount of total solids. This example is used because it is believed to be a reasonable average and it is easy to make a comparison when considering rates of application in the field.

The next question to be answered is how much slurry can be safely applied per acre. This very much depends upon soil type, state of fertility of the soil at the time of application, and the crop growing or to be grown. One inch of rain falling on one acre is termed an acre inch and is equal to 20,000 gallons. If the soil type is very heavy and subject to run off or to percolation through cracks, either of which could lead to contamination of water courses, then the application at any one time should be limited to $\frac{1}{3}$ in. or 7000 gallons per acre, but if the soil is lighter in texture and more absorbent and the crop will allow accumulation of solids, then it could be allowed to go as high as 1 in. at a time or 20,000 gallons. A common-sense way to apply slurry could well be to give the equivalent fertilizer value to the rate at which one is applying F.Y.M. at present, and reference to the table on the values (above) gives an excellent lead in this respect.

Slurry can be handled effectively and efficiently, but there are still the problems of disposal in the field:

1. handling the equipment in the field (it is not by any means an amenable job),
2. the smell, which is quite a problem in populated areas (smell masking chemicals are available, but are not totally effective),
3. the area of land required to spread the quantities of slurry concerned, particularly on the bigger stock units which are now being formed.

One attempt has been made in this country to tackle this problem in the form of a digester, the lay-out of which is shown in Fig. 5. It was found, however, that it would need a tank approximately 30 ft by 10 ft by 10 ft to handle the slurry from 150 cattle. The approximate cost of this equipment, including a digester, heater and small gasometer is probably in the region of £5,000 installed. The digester could certainly be made to work, but the relatively low temperatures encountered in this country as opposed to South Africa where it was developed required a greater percentage of the gas produced to keep the contents of the digester at 90°F, which is essential for gas production. Thus, at least $\frac{1}{3}$-$\frac{1}{2}$ of the gas produced had to be consumed to ensure continuous operation, and unless the remainder of the gas could be efficiently utilized, then there seemed to be very little to be gained from installing such a unit. By virtue of the way it works it is necessary to have a complete slurry handling system, so that the material can be collected, agitated and pumped into the digester at regular intervals, either daily or weekly, and, subsequently, equipment must be provided to pump out the sludge and supernatant material. By virtue of the gas produced and a slight reduction of solids by anaerobic digestion, the volume of material put in is reduced by approximately 20%, but this still has to be removed and spread in some form or other. There is no smell with the sludge produced, but such a plant is perhaps too expensive for removing the smell! So far, therefore, this particular approach seems to be uneconomical, and as far as is known, is not making any commercial progress in this country. Lagoons are not reliable in this country—again probably because of our relatively low atmospheric temperatures. One feels that both the smell and the handling of portable equipment could be overcome if it were possible to pump the slurry daily onto small areas of land which are reserved for this purpose. The sites would have to be carefully chosen to avoid contamination, but such a system could be completely automatic.

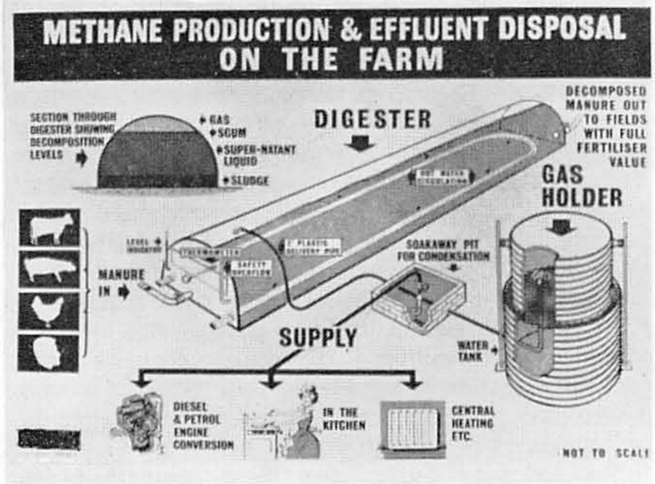

Fig. 5

There is already one cannery in this country which discharges from 100,000/300,000 gallons of effluent per day over a 5 acre block of land. This has been done for 9 months of the year for at least 4 years. So far the grass is still growing, and has not become completely blocked. Farm slurry would behave in the same way as cannery effluent, but the author is sure that the problems involved can be solved.

DISCUSSION

Mr W. J. West, Director of the N.I.A.E. Scottish Station, asked if difficulty might not be encountered during periods of extreme cold, with Mr Rundle's method of application of effluent, i.e. little and often, where irrigation lines were used, especially in northern areas of the country.

Mr Rundle said that the problem could probably be overcome by introducing a compressor into the system and emptying the system with air, which had been found to leave the system very clean. The emptying of the distribution system, in particular the underground mains, was very important. This was another reason for advocating regular pumping rather than intermittent use as it avoided choked and/or split pipes.

Mr McKelvie stated that he had found that a slatted system with a deep channel worked extremely well with the tanker method. It had been possible to make 24 trips with the thick sludge per day, i.e. some 750 gallons. If coupled with sufficient storage, say for 3 to 4 months, this avoided the necessity for pumping on the 'little and often' basis as the distribution of effluent could be achieved where and when it was wanted.

Mr McKelvie added that he had experienced no trouble in cleaning out deep channels right along the 100 ft length in his buildings with one sluice gate.

GENERAL DISCUSSION

(following all four papers)

MR SOUTAR replied to a farmer's question asking for information on an efficient method of keeping hay or silage out of slurry, particularly in relation to slatted courts for beef cattle. He felt that the most effective, though somewhat costly method, was to use yolked ties. The system ensured that the animals were held at the trough whilst they were feeding so that they cleaned up all the hay or silage, but, when the animals were free and the yokes were shut, the animals were kept out.

The next most effective method was possibly the Swedish feed pass which Mr Soutar thought preferable to the Norwegian bar at a level 4 in. below the animals' shoulder. The latter was supposed to stop the animal from tossing its head but often it resulted in the animal feeding in such an uncomfortable position that it satisfied its immediate appetite and then took the largest bite that it could, stepped backwards and dropped the fodder, a portion of which then fell through the slats.

MR R. J. FORSYTH added that he assumed that Mr Soutar had referred to the 'tombstone' feeding fence when he mentioned the Swedish fence. At the Animal Husbandry Experimental Unit of the West of Scotland Agricultural College a heavy metal grid had been placed on top of the silage, which forced the animals to pull the silage through the grid and prevented them from taking up too much at a time. Mr Forsyth added that quite an important feature was to have the trough wider than would normally be the case, so that, for a given quantity of silage, the trough did not have to be filled up to the level of the horizontal rail of the 'tombstone' fence. If the trough was against a wall the distance between the wall and the barrier should be 4 ft 3 in., and the bottom of the trough curved towards the fence so that the food came forward automatically to the animal.

In reply to a question concerning the cost of tower silos and ancillary mechanical equipment as compared with self-feeding silage costs, MR CALVERLEY replied that the cost of the silo would depend upon the type that was built. A sealed silo would cost of the order of £8 per ton of silage stored at about 40% moisture content or more. If an unsealed or concrete stave type silo was erected the cost would be £5 to £5.10.0 per ton of silage, with dry matters of 40% in about 500 ton silos. Comparing these prices with a roofed bunker type silo for silage of a dry matter of 30% at £5 per ton, a differential was evident and the big concrete tower silos were probably cheaper than the self-feed silage roofed bunker silo accommodating silage at 6 to 8 ft depth.

The cost of a concrete silo of 500 tons was approximately £2,000 to £2,500 plus, the silo unloaders cost £550, and the feeders about £4 per foot run or £250 for a 60 ft run. A complete installation including £1,500 for field equipment, i.e. a forage harvester, a forage box and a blower to fill the silo would cost approximately £5,000.

A comparison of this with the cost of a self-feed silo showed the capital investment was definitely higher, but the justification was probably in one or all of the four following points:

(*i*) There was a higher dry matter conservation.

(*ii*) The nutritive value was potentially higher; it had been said that more milk could be obtained from a ton of dry matter from high dry matter silage than from a similar weight of dry matter derived from low dry matter silage.

(*iii*) Regular feeding had been said to involve less wastage than ad lib feeding, and thus there would be better usage of what dry matter was conserved in the first place.

(*iv*) There would be a potential labour saving.

When budgeting for a tower silo system one's own monetary value would be placed on these four possible advantages, according to the system and local factors. One would have to consider them in conjunction with the amount of silage to be made. The point at which the expenditure of capital was justified, on the basis of the additional dry matter which would be conserved in a tower as compared with a clamp, would be at about the 70 cow unit. Beyond 70 dairy cows there should definitely be a more appreciable saving with the tower silo producing more dry matter per acre.

MR DAVID HAZEL, Perth, said that, recently considering the possibility of changing from his present self-feed system to tower silo equipment, he felt the cost was excessive and he therefore wondered if the bunker silo side could be raised in height. It could be filled with chopped silage at one end with a cutter blower delivering from a dump box to say 10 ft height, and covered with plastic. The cutter blower and dump box would be gradually moved back, filling the silo progressively from one end to the other. The capital outlay of this system would have been approximately £1,250 for the additional equipment. He asked if this system could also have dealt with 40% dry matter silage, since bales could have been placed on top of the plastic to consolidate the chopped material.

ELECTIONS AND TRANSFERS

Approved by Council at its meeting on 29 July 1965

ELECTIONS

Member		Hayter, D. R.	Herts
Associate Member		Bean, G.	Beds
		Devine, E. S.	Beds
		Pirie, F. J.	Warwicks
		Restall, G.	Warwicks
		Richardson, P.	Beds
		Tapp, G. E. E.	Surrey
Associate		Adam, J.	Stirlings
		Caton, A.	Surrey
		Cooper, J. E.	Montgomerys
		Cryer, I. J.	Cornwall
		Garrett, R. E. D. N.	Wilts
		Hill, R. W.	Warwicks
		Pape, K. W.	Notts
		Payne, A. T.	Glos
		Overseas	Finlayson, W. H.	Australia
	Overseas	Mitchell, W. J. R.	Nigeria
Graduate		Inskip, J. B.	Staffs
		Leslie, W. A.	Morays
		Sykes, A.	Yorks
	Overseas	Brown, W. T.	Uganda
Student		Bennett, C. J.	Kent
		Eaglen, C. J.	Beds

TRANSFERS

Member		Bailey, P. H.	Beds
		Shepperson, G.	Beds
		Slater, J. K. W.	Beds
Associate Member		Hanavan, M. T.	Essex
		Morris, D. K.	Warwicks
		Peters, E. W.	Staffs
		Webb, A. S.	Northants
Associate		Worsley, R. A.	Glos
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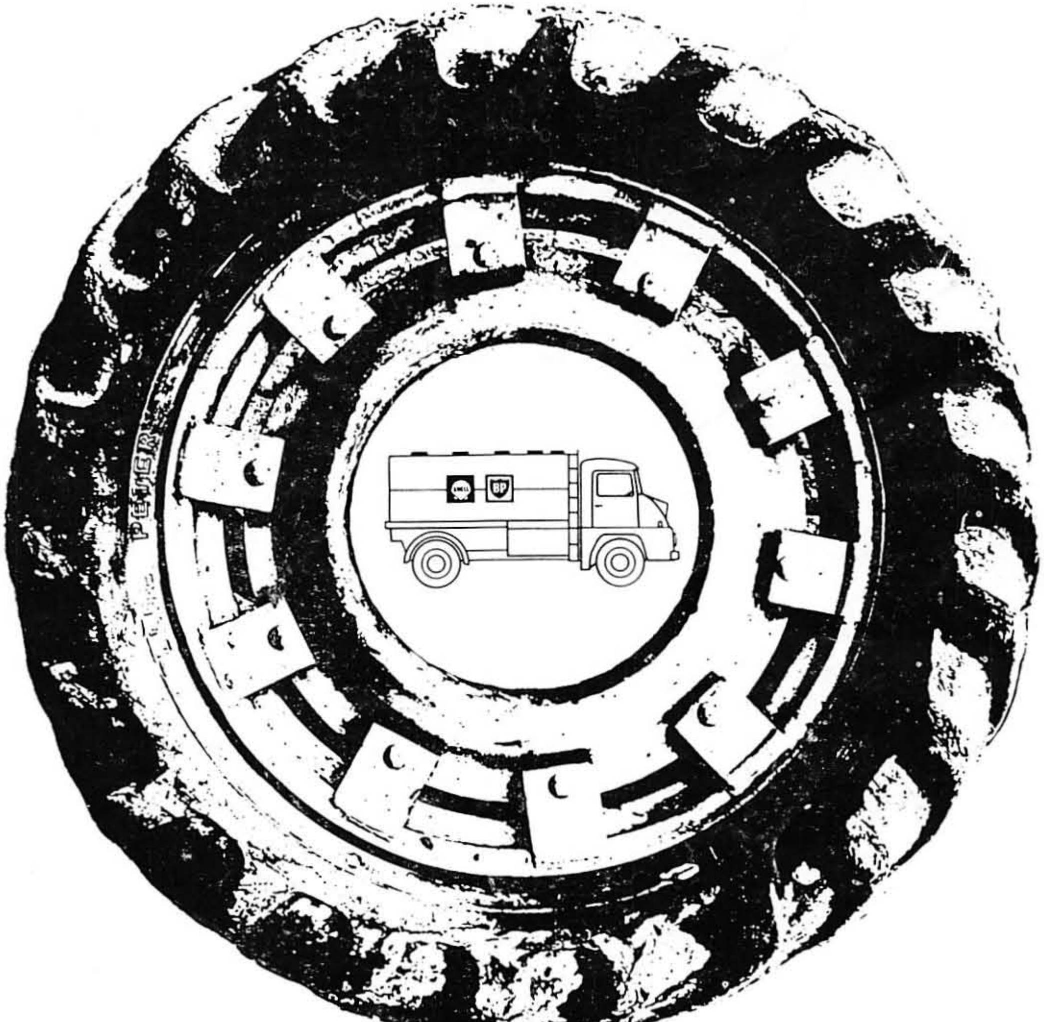

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