JOURNAL AND PROCEEDINGS OF THE

INSTITUTION OF AGRICULTURAL ENGINEERS

Vol. 20 No. 3 - AUGUST 1964

JOURNAL AND PROCEEDINGS OF THE INSTITUTION OF AGRICULTURAL ENGINEERS

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IN THIS ISSUE

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The

INSTITUTION OF AGRICULTURAL ENGINEERS

PROGRAMME OF LONDON ACTIVITIES OF THE INSTITUTION 1964-65

to be held in the Main Hall of The Institution of Mechanical Engineers,
1 Birdcage Walk, London SW1

OPEN MEETING	MONDAY, 12TH OCTOBER 1964
10.15 a.m.	COFFEE.
10.45 a.m.	**'Some Aspects of the Economic Utilization of Farm Machinery'** by B. M. Camm, M.A., M.SC., Research Officer, Managing Director, Farm Planning and Computer Systems Ltd.
11.45 a.m.	**'The Development and Application of High Power Units in Agriculture'** by H. G. Pryor, A.I.AGR.E., Farmer.
12.45 p.m.	Luncheon Recess.
2.15 p.m.	**'Significant Features of Fuels and Lubricants for the Winter Use of Diesel-Engined Tractors'** by J. D. Savage, A.M.I.MECH.E., A.M.I.AGR.E., A.M.I.R.T.E., Diesel Engineer, Technical Services Branch, British Petroleum Company Ltd.
3.15 to 3.45 p.m.	TEA.
OPEN MEETING	THURSDAY, 28th JANUARY 1965
10.15 a.m.	COFFEE.
10.45 a.m.	**'The Handling of Unit Loads in Agriculture and Horticulture'** by J. B. Holt, M.SC.(AGRIC.ENG.), A.M.I.AGR.E., Harvesting and Handling Dept., National Institute of Agricultural Engineering.
11.45 a.m.	**'Work Study in the Mechanization of Farming'** by R. D. Hall, Horticulture (Work Study), Ministry of Agriculture, Fisheries & Food.
12.45 p.m.	Luncheon Recess.
2.15 p.m.	**'The Susceptibility of Fruit and Potatoes to Damage during Handling'** by H. C. Green, Harvesting & Handling Dept, National Institute of Agricultural Engineering.
3.15 to 3.45 p.m.	TEA.

THE ANNUAL CONFERENCE AND ANNUAL GENERAL MEETING OF THE INSTITUTION

will be held on Thursday 22nd April 1965 from 10.15 a.m. to 4.30 p.m.

Papers and Discussions will be held on the theme of:

'Grain Conservation'

Further details are to be announced

THE ANNUAL DINNER OF THE INSTITUTION

will be held in

St Ermin's Hotel, London S.W.1

on Thursday 22nd April 1965

Further particulars will be announced

INSTITUTION NOTES

Annual General Meeting

At the Annual General Meeting of the Institution, held in London on 28th April, nominations to fill vacancies among Officers and Ordinary Members of Council during the year 1964-65 were confirmed. This resulted in the following appointments:—

President:	W. J. PRIEST (Member)
Vice-Presidents:	J. H. W. WILDER (Member)
	W. G. COVER (Member)
Ordinary Members of Council:	J. A. C. GIBB (Member)
	T. R. ST JOHN-BROWNE (Member)
	H. J. NATION (Associate Member)
	C. V. H. FOULKES (Companion)
	C. V. BRUTEY (Associate)

After the Minutes of the 1963 Annual General Meeting had been confirmed, the President formally moved the adoption of the Annual Report of the Council for 1963. Drawing attention to the main items mentioned therein, Mr Priest said the Institution had suffered a grievous and deplorable loss in the death of Ronald Slade, the late Secretary. Tributes to his memory had been received from all parts of the world, giving ample testimony of the esteem in which Mr Slade had been held. The President went on to mention the tremendous assistance received during the ensuing weeks. Special gratitude was due to the Assistant Secretary, Miss J. P. Housley and the small staff at 6 Queen Square. Their loyalty and sustained diligence were in great measure responsible for the maintenance of the Institution's essential services and administration. In December, the new Secretary, Mr J. K. Bennett took up his appointment. In the months since, he had displayed great enthusiasm and capacity.

The President said he warmly associated himself with Council's acknowledgment of the work of the Examination Board during the year under review. The strengthening of the National Diploma in Agricultural Engineering, coupled with the introduction of the Part III examination, could not but enhance the quality of the Institution's membership, both at graduate and corporate levels, with resultant benefit to the industry at large. The President noted with pleasure the continued growth in membership of the Institution.

After touching upon other items in the Report, the President informed members that it was the intention of Council to amend the constitution so as to permit a Graduate to be elected to Council. Draft amendments to the Articles of Association to give effect to this and other revisions would be brought before an Extraordinary General Meeting in due course. Meanwhile, it was proposed that a Graduate be co-opted to serve on Council; this was shortly to receive attention.

Mr Priest concluded his remarks by thanking members for confirming his re-appointment as President of the Institution for a second year. He felt himself greatly honoured and would continue to do all in his power to advance the Institution's cause and uphold its traditions.

The Hon. Treasurer, Mr R. C. Dick, in presenting the accounts for 1963, was able to point to an encouraging surplus of income over expenditure. Although costs had risen in a number of directions, the increased subscription rates introduced in 1962 had effectively stabilized the Institution's finances; this was a reflection of the loyalty of members throughout the world. The accounts were adopted. Messrs Herbert Gimson & Son were re-appointed Auditors to the Institution for 1964.

Examinations 1964

The National Diploma in Agricultural Engineering and the Institution examinations were held in July at the Essex Institute of Agriculture and Rycotewood College, Oxon., by kind permission of the respective Principals, Mr B. H. Harvey and Mr C. A. Goodger. The examination results will be found on pages 124—125.

Council announces with pleasure that it has approved the award of the Colonel Johnson Medal to R. H. F. Brook (Essex Institute of Agriculture), the outstanding candidate among those who passed the 1964 N.D.Agr.E. examination with First Class Honours.

Of the 31 successful candidates in the N.D.Agr.E. examination, four passed with First Class Honours and eight with Second Class Honours. Nine candidates passed the Institution examination.

Overseas Agricultural Engineering Events

VIth International Congress of Agricultural Engineering Lausanne, Switzerland.

Organised by the Commission Internationale du Génie Rural (C.I.G.R.), this important Congress will conduct its proceedings from 21st to 27th September 1964, as announced in the July 1963 issue of the *Journal*. It is of special interest to note that this occasion coincides with the Swiss National Exhibition, also in Lausanne, which takes place only every 25 years and includes agricultural exhibits. Listed in the provisional programme of the Congress are such subjects as soil science and its application to agricultural engineering, drainage schemes, economics of irrigation, housing of livestock, pooling of machinery in co-operative farming and agricultural work study. Details of the Congress can be obtained from the Secretary, Institution of Agricultural Engineers.

Congress on Mechanization in Horticulture, Budapest

Jointly with the Hungarian Society of Agricultural Sciences, the Hungarian Society of Mechanical Engineers announces details of the above Congress to be held in Budapest on 20th-23rd October 1964. Subjects to be treated will include mechanization of soil cultivation, plant growing, plant protection, transport, gathering and processing. There will be displays of machinery employed in wine growing.

Particulars are available on application to the Hungarian Society of Mechanical Engineers, Budapest V, Szabadsag ter 17.

BRANCH OFFICERS and MEETINGS

EAST ANGLIAN BRANCH

Chairman:
W. G. Cover, M.I.E.E., M.A.S.A.E., M.I.Agr.E.

Vice-Chairmen:
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E. C. Claydon, N.D.Agr.E., M.I.Agr.E.

Committee:
A. G. Arboune, A.M.I.Agr.E.
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K. J. Benfield, A.M.I.Agr.E.
C. A. Cameron Brown, B.Sc., M.I.E.E., M.I.Agr.E.
J. H. Cock, B.Sc., A.M.I.Agr.E.
U. G. Curson, A.M.I.Agr.E.
G. D. Eglington, A.I.Agr.E.
F. L. Gammon, M.I.Agr.E.
G. C. Gooderham, A.M.I.Agr.E.
J. C. Mann, M.A., A.I.Agr.E.
R. F. Norman, M.Sc., A.M.I.Agr.E.
T. J. Rivers, A.M.I.Agr.E.
F. E. Rowland, M.I.E.E., M.A.S.A.E., A.M.I.Agr.E.
R. H. Rutterford, N.D.A., N.D.Agr.E., Graduate I.Agr.E.
N. E. Salmon, A.I.Agr.E.
J. Shewring, N.D.Agr.E., M.I.Agr.E.
W. M. Slater, A.M.I.Agr.E.
C. E. Westrip, M.I.Agr.E.

Honorary Secretary and Treasurer:
C. V. H. Foulkes, B.Sc., C.I.Agr.E., c/o County Education Offices, Stracey Road, Norwich. Nor. 49A

(ALL MEETINGS COMMENCE AT 7.30 P.M. UNLESS OTHERWISE INDICATED)

12th October 1964
LECTURE: 'Some Aspects of Agricultural Engineering in the U.S.S.R.', by J. E. Colman, A.M.I.Agr.E., (Colman Agricultural Ltd), at Shell-BP House, Princes Street, Ipswich.

2nd November 1964
LECTURE: 'Principle of Application of Hydraulics to Agricultural Machinery', by H. J. Hine, B.Sc., M.I.Agr.E., (Ministry of Agriculture, Fisheries & Food) at Owen Webb House, Cambridge.

13th November 1964
LECTURE: 'Compressor Design & Manufacture', by S. Goymour, at Shell-BP House, Princes Street, Ipswich.

26th November 1964
CONFERENCE: 'Potatoes—Cultivations, Weed Control, Harvesting.' 10.30 a.m.—5.00 p.m. at the Stuart Hall, Norwich.

14th December 1964
FORUM and discussion on Topics of Mutual Interest, at the 'Sporting Farmer', Princes Street, Ipswich.

15th January 1965
LECTURE: 'Plough Design and Manufacture,' by R. A. Brown, at Shell-BP House, Princes Street, Ipswich.

5th February 1965
ANNUAL DINNER at Owen Webb House, Cambridge.

15th February 1965
FILM and TALK (by representatives of Shell-BP) at Shell-BP House, Princes Street, Ipswich.

22nd February 1965
LECTURE: 'Problems of Tractor Testing,' by T. C. D. Manby, M.Sc., M.I.Agr.E., (National Institute of Agricultural Engineering) at Owen Webb House, Cambridge.

12th March 1965
FORUM—'Agricultural Engineering Education,' to be led by W. Akester, Hon.M.I.Agr.E., G. Boatfield, A.I.Agr.E. and B. Burgess, M.I.Agr.E.; at Shell-BP House, Princes Street, Ipswich.

March 1965
ANNUAL GENERAL MEETING to be held in Thetford at a venue, date and time to be arranged.

EAST MIDLANDS BRANCH

Chairman:
L. West, B.Sc., A.M.I.Agr.E.

Vice-Chairmen:
T. R. ST. JOHN BROWNE, M.I.Agr.E.
R. H. MIERS, B.Sc., M.I.Agr.E., A.M.I.C.E.

Honorary Treasurer:
J. CHATTERTON, B.Sc., A.M.I.Agr.E.

Committee:
R. D. S. BARBER, B.Sc., A.M.I.Agr.E. (*Honorary Assistant Secretary*)
J. BASIL, A.M.I.Agr.E.
E. F. BEADLE, A.I.Agr.E.
H. P. Crapp, B.Sc., A.I.Agr.E.
L. C. DRAPER, Graduate I.Agr.E.
B. FARRAR, A.M.I.Agr.E.
C. L. FOX, A.M.I.Agr.E. (*Press Officer*)
G. Hows, A.M.I.Agr.E.
K. H. LANE, A.I.Agr.E.
J. J. RAINTHORPE, C. I.Agr.E.
R. RUSSELL, A.M.I.Agr.E.
C. I. R. ST. JOHN BROWNE
W. J. WHITSED, M.E.Igr.E.

Honorary Secretary:
D. G. Wynn, A.M.I.Agr.E., c/o Allis Chalmers (G.B.) Ltd., Essendine, Stamford, Lincs.

(ALL MEETINGS COMMENCE AT 7.30 P.M. UNLESS OTHERWISE INDICATED)

29th September 1964
VISIT, commencing 10.15 a.m., to the Ketton Cement Co., Ketton, Stamford, Lincs., followed by luncheon and LECTURE: 'Pavements related to Farm Work' by P. G. Blythe, (Cement & Concrete Association).

13th October 1964
LECTURE: 'The Torque Convertor and Agriculture' by G. P. West, (British Twindiscs Ltd.), at the Allis-Chalmers Canteen, Essendine.

23rd October 1964
CONFERENCE, commencing 9.45 a.m.: 'The Mechanization of Livestock Feeding and Effluent Disposal,' Chairman—J. K. W. Slater, M.A., M.Sc., (National Institute of Agricultural Engineering), at Brooksby Hall, Melton Mowbray. Speakers: W. Marshall, (Farm Building Advisor, B.O.C.M.)—'Bulk Handling of Poultry and Pig Food'; O. Simon, (Farmer)— 'Bunker Cattle Feeding'; G. Smith, (N.A.A.S.)— 'Mechanical Manure Disposal'.

11th November 1964
LECTURE: 'Corrosion,' by E. H. Wise, (Hull Technical College), at Riseholme Farm Institute, Lincoln.

20th January 1965
LECTURE: 'Farm Dairy Machinery,' by P. A. Clough, B.Sc., (N.I.R.D.), at the School of Agriculture, Sutton Bonnington.

16th February 1965
LECTURE: 'Fertilizer Distribution and Placement,' by R. F. Norman, M.Sc., (Fisons Farmwork Ltd.) and J. D. Whitear, M.Sc., M.A., (Fisons Chemicals Ltd.), at Aveling Barford New Canteen, Grantham.

17th March 1965
LECTURE: 'Grain Drying and Storage,' by C. Culpin, O.B.E., M.A., M.I.Agr.E. (N.A.A.S. Liaison Unit, N.I.A.E.); at the Kesteven Farm Institute, Caythorpe Court, Grantham.

NORTHERN BRANCH

Chairman:
A. C. Ayton, A.M.I.Agr.E.

Vice-Chairman:
H. Howcroft, A.M.I.Agr.E.

Honorary Treasurer:
G. R. Winter, A.M.I.Agr.E.

Honorary Auditor:
P. Winter, F.C.A.

Committee:
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J. U. Charlton, A.M.I.Agr.E.
D. J. Greig, M.Sc., A.M.I.Agr.E.
W. Manners, A.I.Agr.E.
C. Moor, A.I.Agr.E.
J. L. Storey, A.I.Agr.E.
W. Younger, A.I.Agr.E.

Honorary Secretary:
H. B. Huntley, M.I.Agr.E., 4 Southwood Gardens, Gosforth, Newcastle-upon-Tyne 3.

(ALL MEETINGS COMMENCE AT 7.00 P.M.)

5th October 1964
DISCUSSION: 'Standardization of Wearing Parts for Agricultural Machinery,' at N.F.U. H.Q., 'Holmwood', Clayton Road, Newcastle-upon-Tyne 2.

2nd November 1964
LECTURE: 'Four-Wheel Drives for Agricultural Tractors,' (lecturer's name to be announced) at Carliol House, Newcastle-upon-Tyne 2.

30th November 1964
LECTURE: 'Large-scale Food Preparation Plants on Farms,' (lecturer's name to be announced) at Carliol House, Newcastle-upon-Tyne 2.

4th January 1965
DISCUSSION: 'Training of Farm Machinery Operatives,' at N.F.U. H.Q., 'Holmwood', Clayton Road, Newcastle-upon-Tyne 2.

1st February 1965
LECTURE: 'Buildings for Mechanized Livestock Farming,' (lecturer's name to be announced) at Carliol House, Newcastle-upon-Tyne 2.

1st March 1965
ANNUAL GENERAL MEETING at N.F.U. H.Q., 'Holmwood,' Clayton Road, Newcastle-upon-Tyne 2.

SCOTTISH BRANCH

Chairman:
I. J. Fleming, B.Sc., A.M.I.Agr.E.

Vice-Chairmen:
A. M. Russell, B.Sc., A.M.I.Agr.E.
W. J. West, B.A., M.I.Agr.E.

Committee:
J. Birnie, N.D.A., A.I.Agr.E.
M. H. Cullen, M.I.Agr.E.
T. Denham, A.I.Agr.E.
D. W. Garvie, B.Sc., M.I.Agr.E.
W. Godley, A.M.I.Agr.E.
R. G. Green, A.I.Agr.E.
J. C. Hendry, A.I.Agr.E.
D. A. Jack, M.Sc., N.D.Agr.E., Graduate I.Agr.E. (*Hon. Auditor*)
D. McArthur, N.D.Agr.E., M.I.Agr.E.
D. MacIntyre, N.D.A., N.D.Agr.E., A.M.I.Agr.E.
T. McLaughlin, A.M.I.Agr.E.
J. Pollock, Graduate I.Agr.E.
W. Rae, A.M.I.Agr.E.
R. T. Stirling, B.Sc., N.D.Agr.E., A.M.I.Agr.E.

Honorary Secretary and Treasurer:
J. Weir, B.Sc., A.M.I.Agr.E., c/o North of Scotland Hydro-Electric Board, 16 Rothesay Terrace, Edinburgh 3.

(ALL MEETINGS COMMENCE AT 7.30 P.M. UNLESS OTHERWISE INDICATED)

17th September 1964
VISIT: commencing 2.30 p.m. to Farm and Market Garden Enterprises, John R. Dale & Sons, Scoughall, North Berwick, East Lothian.

22nd and 29th October 1964
LECTURE: 'The Spinning Disc Fertilizer Distributor,' by E. E. Bragg, M.Sc., A.M.I.Agr.E., (Scottish Agricultural Industries Ltd.) On 22nd October the meeting will be held at the Savoy Park Hotel, Racecourse Road, Ayr, and on 29th October in Aberdeen at a venue to be announced.

23rd and 24th November 1964
LECTURE: 'Chemical Ploughing,' (by a representative of Plant Protection Ltd.) on 23rd November at the Silver Bell Restaurant, Bannatyne Street, Lanark and on 24th November in the Station Hotel, Perth.
13th and 14th January 1965
LECTURE: 'Streamlining Spares,' by B. Burgess, M.I.Agr.E., (Ben Burgess Tractors Ltd.), on 13th January at the Edinburgh School of Agriculture, West Mains Road, Edinburgh 9 and on 14th January at a venue in Aberdeen to be announced.
19th January 1965.
LECTURE: 'Wet Grain Storage,' by H. Denerley, B.Sc., (Rowett Research Institute), at the Station Hotel, Perth. (Joint Meeting with Perthshire Agricultural Discussion Society).
1st and 2nd February 1965
LECTURE: 'Irrigation,' by F. G. Ingleton, (Wright Rain Ltd.), on 1st February in the Masonic Hall, Laurencekirk (Joint Meeting with the Howe of the Mearn Agricultural Club) and on 2nd February at the Edinburgh School of Agriculture, West Mains Road, Edinburgh 9.
3rd March 1965
CONFERENCE: commencing 10.00 a.m. in the Dunblane Hotel Hydro. Details to be announced later.

SOUTH WESTERN BRANCH

Chairman:
G. A. Iles, M.I.Agr.E.
Vice-Chairman:
R. Zeale, A.M.I.Agr.E.
Committee:
J. G. Barker, M.I.Agr.E.
K. M. Base, N.D.A., A.M.I.Agr.E.
R. J. Davey, A.M.I.Agr.E.
R. Frost, N.D.A., A.I.Agr.E.
M. G. Harris, A.I.Agr.E.
H. W. Jeffery, A.M.I.Agr.E.
R. G. Pollard, B.Sc., N.D.A., A.M.I.Agr.E.
E. L. Williams, M.C., M.I.Agr.E.
Honorary Secretary and Treasurer:
J. B. Paterson, N.D.A., A.M.I.Agr.E., Seale-Hayne Agricultural College, Newton Abbot, Devon.

(ALL MEETINGS WILL COMMENCE AT 6.00 P.M. UNLESS OTHERWISE INDICATED)

23rd October 1964
VISIT: commencing 2.00 p.m., Engineering Dept., Cornwall Technical College, Redruth.
LECTURE: commencing 7.00 p.m. 'Teaching Structure and Aims of the National College of Agricultural Engineering,' by P. C. J. Payne, Ph.D., M.I.Agr.E. (Principal, N.C.A.E.), at Cornwall Technical College.
18th November 1964
JOINT MEETING with the S.W. Branch of the Institute of Welding at the Exeter Technical College, Hele Road, Exeter. Further details to be announced.
16th February 1965
JOINT MEETING with the W. Branch of the Institution of Mechanical Engineers: LECTURE 'Machinery Testing,' by D. I. McLaren, B.Sc., N.D.A., M.I.Agr.E., (National Institute of Agricultural Engineering), at the University of Exeter, Prince of Wales Road, Exeter.
March 1965 (*Date to be arranged*)
LECTURE: 'Electricity in Agriculture,' by J. A. C. Weir, N.D.A., A.M.I.Agr.E. (Electricity Council) and R. G. Pollard, B.Sc., A.M.I.Agr.E. (S.W. Electricity Board), at S.W.E.B. Demonstration Room, The Parade, Taunton.

WESTERN BRANCH

Chairman:
A. J. Bradshaw, N.D.Agr.E., A.M.I.Agr.E.
Vice-Chairman:
W. L. Hearle, A.M.I.E.E., M.I.Agr.E.
Honorary Treasurer:
A. W. Falconer, N.D.Agr.E., A.M.I.Agr.E.
Committee:
E. W. Davies, A.M.I.Agr.E.
W. W. W. Downing, A.F.R.Ae.S., M.I.Agr.E.
H. L. Harrison, N.D.Agr.E., A.M.I.Agr.E.
H. T. Horsman, M.B.E., B.Sc., M.I.Agr.E.
D. Macmillan, A.I.Agr.E.
A. J. Marshall, A.M.I.Agr.E.
T. Sherwen, M.I.Mech.E., M.I.Agr.E.
J. E. Spindler, M.I.Agr.E.
B. Stocks, A.I.Agr.E.
L. T. Weston, M.I.Agr.E.
Honorary Secretary:
H. Catling, N.D.Agr.E., A.M.I.Agr.E.
Engineering Dept., Royal Agric. College,
Cirencester, Glos.

(*continued on page* 123)

CHANGE OF DATE

The second *Subject Day* arranged by the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedford will be held on **6th October 1964** (not 8th October as originally envisaged) and will relate to 'Tractor Operator Comfort and Safety'. *Subject Days* are intended primarily for fellows and members of the British Society for Research in Agricultural Engineering, (Wrest Park, Silsoe, Bedford).

WESTERN BRANCH *(continued from page 122)*

(ALL MEETINGS COMMENCE AT 7.30 P.M.)

21st October 1964
PAPER: 'Hydrostatic Transmission,' by D. F. Howson, B.Sc., A.M.I.Agr.E., (National Institute of Agricultural Engineering) at the Angel Hotel, Chippenham.

18th November 1964
PAPER: 'Tractor Operator Safety and Comfort,' by T. C. D. Manby, M.Sc., M.I.Agr.E., (National Institute of Agricultural Engineering) at Hare & Hounds Hotel, Westonbirt, nr. Tetbury, Glos.

17th February 1965
ANNUAL GENERAL MEETING at 6.30 p.m. followed by: PAPER: 'Grain Drying in Bulk Storage,' by W. L. Hearle, A.M.I.E.E., M.I.Agr.E. (R. A. Lister & Co. Ltd.) at the George Hotel, Trowbridge, Wilts.

24th March 1965
PAPER: 'The N.I.A.E. Users Test Report Scheme,' by A. C. Williams, M.I.Agr.E. ('Farm Mechanization') at N.F.U. H.Q., Devizes, Wilts.

WEST MIDLANDS BRANCH

Chairman:
J. V. Fox, N.D.Agr.E., A.M.I.Agr.E.

Vice-Chairman:
E. Orchard, M.I.Agr.E.

Honorary Treasurer:
H. Howell, A.M.I.Mech.E., M.I.Agr.E.

Committee:
B. A. F. Hervey Bathurst, A.I.Agr.E.
D. Bomford, M.I.Agr.E.
J. Chambers, M.I.Mech.E., M.I.Agr.E.
M. Clough, M.Sc., A.M.I.Agr.E.
L. Evans, N.D.Agr.E., A.M.I.Agr.E.
M. Harvey, M.I.Agr.E.
E. Mander, A.I.Agr.E.
D. Purchas, A.M.I.Agr.E.
K. Roberts, A.M.I.Agr.E.
V. Statham, A.M.I.Agr.E.
K. Thomas, Graduate I.Agr.E.
R. Tristram, A.M.I.Agr.E.

Honorary Secretary:
A. Starley, A.M.I.Agr.E., 24 Hearsall Court, Broad Lane, Coventry, Warwicks.

(ALL MEETINGS COMMENCE AT 7.30 P.M. UNLESS OTHERWISE INDICATED)

Meetings will be held in Room 118, College of Advanced Technology, Gosta Green, Birmingham 4

28th September 1964 (commencing 7.00 p.m.)
SHORT PAPERS EVENING: (i) 'Problems of World Hunger,' by A. J. Walters, M.Sc., Graduate I.Agr.E., (Massey-Ferguson Ltd.); (ii) 'Batch Production in the Small Works,' by A. E. Whitehouse, N.D.Agr.E., A.M.I.Agr.E., (Bomford & Evershed Ltd.); (iii) 'Some Aspects of Work at the National College of Agricutural Engineering,' by B. A. May, N.D.Agr.E., Graduate I.Mech.E., Graduate I.Agr.E., (N.C.A.E.).

26th October 1964
LECTURE: 'Techniques in Welding,' by W. Archer, (British Oxygen Co. Ltd.).

30th November 1964
LECTURE: 'Tractor Transmissions,' by H. J. Nation, B.Sc., A.M.I.Mech.E., A.M.I.Agr.E., (National Institute of Agricultural Engineering).

4th January 1965
LECTURE: 'The Role of Paraquat in the Reduction of Cultivations in Arable Agriculture,' by D. Evans (Imperial Chemical Industries Ltd.).

1st February 1965
LECTURE: 'Mechanical Power Transmission between Tractor and Implement,' by L. G. Freeman (Hardy Spicer Walterscheid Ltd.).

1st March 1965
LECTURE: 'Steels in Agriculture,' by J. Williams, British Iron and Steel Research Association.

9th April 1965
ANNUAL GENERAL MEETING at 6.30 p.m. ANNUAL DINNER at 7.30 p.m., both at the Regent Hotel, Leamington Spa.

8th May 1965
VISIT: National College of Agricultural Engineering, Silsoe, 10.45 a.m.—4.15 p.m.

YORKSHIRE BRANCH

Officers and Committee: to be announced

Acting Honorary Secretary:
E. D. Frost, A.I.Agr.E., East Riding Institute of Agriculture, Bishop Burton, Beverley, Yorks.

YORKSHIRE BRANCH (*continued from page* 123)

(ALL MEETINGS COMMENCE AT 7.30 P.M.)

4th September 1964

ANNUAL GENERAL MEETING, followed by FILMS on the Schlieren Technique, at the Griffin Hotel, Boar Lane, Leeds.

2nd October 1964

LECTURE: 'The Mechanization of Livestock Feeding,' at the Eden Bank Hotel, Tadcaster Road, York. (Lecturer to be announced.)

6th November 1964

LECTURE: 'The Sealing of Bearings in Agricultural Conditions,' at the Strafford Arms Hotel, Wakefield. (Lecturer to be announced.)

26th February 1965

LECTURE: 'Engineering Aspects of Safety applied to Agricultural Machinery,' at the Strafford Arms Hotel, Wakefield. (Lecturer to be announced.)

26th March 1965

ANNUAL GENERAL MEETING and PRESIDENTIAL ADDRESS, by W. J. Priest, M.I.Agr.E., at the Griffin Hotel, Boar Lane, Leeds.

30th April 1965

LECTURE: 'The Mechanization of Land Drainage,' at the Eden Bank Hotel, Tadcaster Road, York. (Lecturer to be announced).

AWARD OF JOHNSON MEDAL

Council has approved the award of the Johnson Medal to Mr R. H. F. Brook who passed the 1964 N.D.AGR.E. Examination with First Class Honours. Mr Brook also holds a Diploma in Engineering of the Loughboro' College of Technology; he received his training for the N.D.AGR.E. at the Essex Institute of Agriculture.

SCHOLARSHIP AWARDS

Scholarship Awards for the 1964-1965 Course leading to the National Diploma in Agricultural Engineering have been awarded as follows:—

The Dunlop Rubber Company Scholarship has been awarded to:

Leonard Wallace Ormiston, aged twenty-one.

Mr Ormiston is a graduate in Agriculture of the University of Reading. He will attend the Essex Institute of Agriculture to work for his N.D.AGR.E.

The Shell-Mex and B.P. Bursaries have been awarded to:

(1) Denis Richard Coote, aged nineteen.

Mr Coote has attended the College of Aeronautical and Automobile Engineering, Chelsea, for the past three years, and was one of the Wakefield Scholars of the College.

(2) Timothy John Manning Knight, aged twenty-five.

Mr Knight was formerly an apprentice of Ransomes, Sims & Jeffries Ltd, and more recently has been attending the College of Aeronautical and Automobile Engineering, Chelsea.

(3) Roger John Owen Thomas, aged twenty.

Mr Thomas is of an agricultural background and has attended the North West Wiltshire Area College of Further Education, where he recently obtained the Intermediate N.D.AGR.E.

The Shell-Mex & B.P. Bursary holders will attend the West of Scotland Agricultural College.

Examination Board in Agricultural Engineering

1964 EXAMINATION RESULTS

NATIONAL DIPLOMA IN AGRICULTURAL ENGINEERING

Pass with First Class Honours	*Training Centre*
BROOK, R. H. F., Beds	Essex Institute of Agriculture
CHICK, D. C., Co. Durham	Essex Institute of Agriculture
CORRIE, W. J., Lancs	Essex Institute of Agriculture
*TUCKER, N. G., Somerset	Essex Institute of Agriculture

Pass with Second Class Honours	
*GARLAND, P. J., Essex	Essex Institute of Agriculture
HARDING, J. S., Pembs	Essex Institute of Agriculture
LANDSBERG, T. M., S. Rhodesia	Essex Institute of Agriculture
†LEMON, R. E., Westmorland	West of Scotland Agricultural College
MOFFATT, D. I., N. Rhodesia	Essex Institute of Agriculture
PEARSON, M. J. C., Lancs	Essex Institute of Agriculture
ROWLING, M. S., Essex	Essex Institute of Agriculture
STATHAM, O. J. H., Beds...	Essex Institute of Agriculture

Pass	
BACCHUS, N. N., British Guiana	West of Scotland Agricultural College
BARTON, P. S., Yorks	Private Study
CALDER, S. R. W., Perthshire	West of Scotland Agricultural College
**CRALLAN, B. R., Somerset	West of Scotland Agricultural College
FARROW, B. T., Cornwall	Private Study
GEE-PEMBERTON, H. W., Somerset	Private Study
GORDON, D. J., Australia	Essex Institute of Agriculture
**KIDD, M. A., Wilts	West of Scotland Agricultural College
**LANE, A. R., Cornwall	West of Scotland Agricultural College
LESLIE, W. A., Morayshire	West of Scotland Agricultural College
**LEWIS, T. G., Mon	West of Scotland Agricultural College
**NATTRASS, D., Co. Durham	West of Scotland Agricultural College
**PAINTING, R. J., Oxon	West of Scotland Agricultural College
POWDRILL, C. L., Leics	Essex Institute of Agriculture
ROBINSON, K., Glamorgan	West of Scotland Agricultural College
SAMARASINGHE, D. K., Ceylon	West of Scotland Agricultural College
‡TROUGHTON, T. J., Glos	West of Scotland Agricultural College
**WHYTE, D. N., Norfolk	West of Scotland Agricultural College
**WILSON, J., Devon	West of Scotland Agricultural College

* Winner of Shell-Mex & BP Bursary Award 1963/64
† Winner of Dunlop Scholarship Award 1963/64
‡ Intermediate N.D.Agr.E. gained at College of Aeronautical & Automobile Engineering
** Intermediate N.D.Agr.E. gained at North West Wiltshire College of Further Education

MEMBERSHIP EXAMINATION

Graduate Membership Examination Syllabus	*Training Centre*
BURCOMBE, R. J., Glos	Rycotewood College
DOE, R. H., Surrey	Rycotewood College

Institution Examination Syllabus	
COOTE, D. R., Sussex	College of Aeronautical & Automobile Engineering
FROST, E. D., Yorks	Private Study
FRY, J. R., Oxon	Rycotewood College
PATEL, V. C., Uganda	College of Aeronautical & Automobile Engineering
PETTIT, R. F. R., Suffolk	Rycotewood College
STORR, K. A., Lincs	Rycotewood College
THRAKAR, H. G., Uganda	College of Aeronautical & Automobile Engineering

THE IMPORTANCE OF AGRICULTURAL ENGINEERING IN RELATION TO FEEDING THE WORLD

by W. J. Priest, M.I.Agr.E. *

The Sixth Wakefield Memorial Lecture of the College of Aeronautical and Automobile Engineering, Chelsea, delivered at Chelsea Town Hall on 23 April 1964. (Copyright Wakefield Memorial Trust).

It is a generally accepted fact that agriculture is the world's oldest industry, practised in order to supply mankind's greatest physical need, namely, food. Yet, traditionally, for centuries, agriculture was associated with Adam's stern dismissal from the Garden of Eden, as recorded in the Book of Genesis:— 'By the sweat of thy face thou shalt eat bread,' words which surely imply rather strongly that getting sufficient food to live on would involve extremely hard labour!

For centuries, I repeat, that implication remained in agriculture; it was generally accepted that farm work must be laborious in the extreme. Then came the age, frequently portrayed in literature and song, when 'to plough and to sow, to reap and to mow' were looked upon, by the uninitiated, as simple, idyllic operations. The farmer and his men (and women) worked hard and long; ploughing, such as it was, was done with a crude implement cutting—or just scratching—one furrow at a time; sowing broadcast by hand was customary, while, later in the season, a gang with sickles and scythes undertook the reaping operations, and, finally, the use of a hand flail for threshing, completed the cycle of the farming year. Labour was cheap and plentiful, and a couple of centuries ago, it was not unusual to find in a harvest field in this country, over 100 people at a time—including musicians and refreshment dispensers.[1]

Certainly, it is a little difficult to determine just when engineering, in its broadest sense, first came to be applied to agriculture. It could be argued that in Old Testament times there was some sort of agricultural engineering, in view of the fact that Isaiah, a prophet in war-troubled Israel, looked towards days of peace 'when swords would be beaten into ploughshares.'

But, to-day, we are not really concerned with the somewhat slow progress made in past years in applying engineering skill to the needs of agriculture. It is, however, relevant to remind ourselves that 100 years ago, early in December 1864, there died a man called John Fowler who, in the face of considerable opposition, and by sheer doggedness and perseverance, successfully utilised steam power for land cultivation. Fowler began his work in the early 1850s, first with mole draining, and, subsequently on ploughing. By the middle of January 1856, he had decided in consultation with William Worby, the implement expert of the well-known firm of Ransomes of Ipswich, that a balanced plough hauled by a stationary double-drummed windlass driven by a portable steam engine, had distinct possibilities. The order for this equipment was placed with Ransomes on January 30th, 1856, and on April 10th of that year, it was working at Nacton where it ploughed an acre in an hour.[2] Evidently, over 100 years ago, there were some engineering products that could be turned out pretty quickly!

Progress continued, and seven years later, at the Royal Agricultural Society's meeting at Worcester, John Fowler was demonstrating cable ploughing with a pair of steam traction engines which moved along the headlands. Steam culture, as it was called, had arrived and was accepted. It heralded what may well be considered the upsurge of agricultural engineering in this country, though whether agricultural engineering as then practised would measure up to the high standard aimed at by your college is a matter for conjecture! Undoubtedly, there was considerable enthusiasm, as may be gathered from the judges' report on some steam cultivation trials at Newcastle in 1864, which reads:—

> 'In an adjoining field, Fowler and Howard ran a neck-and-neck race. The pressure of steam was seldom less than 105 pounds on the square inch—the pace was tremendous. It was fortunate that Fowler's engine was working from the nearside; had it been otherwise the flywheel which fled off the shaft, instead of alighting against the hedge, must have dashed into the group of spectators causing a frightful loss of life. Howard's pace was much faster than would be desirable for everyday work. The smokebox and lower part of the funnel were nearly red hot. The implement travelled at a great pace and, coming into contact with a large stone, the shock was sufficient to throw the driver with violence to the ground, where he lay for some minutes stunned and sick.'

* President, The Institution of Agricultural Engineers.

I suggest we leave it there. The point I want to emphasise is that those who successfully applied steam power to agriculture were acknowledged as engineers, but many years had to pass before anything approaching similar acknowledgement was accorded to those who designed and produced the implements which actually did the work. In fact, I would say that, for far too long, these latter were looked upon by acknowledged engineers in much the same way as wasps must be regarded in a nudist colony! Yet, in the latter years of the last century there was many a powerful plea put forward for the 'more general and intelligent adoption by the British farmer of the assistance of the agricultural engineer.'

One such plea was strongly expressed by a leading engineer to the Farmers' Club, in the 1880s, when he said that 'in this country farm machinery generally is not used to anything like the extent it could and should be; owing in a great measure to the ignorance and indifference of farmers themselves, who drift on, wasting horseflesh and provender in doing by animal power that which ought to be done cheaper and better by steam.' This same engineer urged that 'it should be part of the education of every young farmer to make himself acquainted with the elementary principles of farm machinery, and acquire as much skill in the use of his hands as would enable him to do any simple repairs.'[3]

But, obviously, there were many traditions about agriculture that could not easily be broken. New methods, many of them apparently revolutionary, were regarded with suspicion; their adoption would mean the displacement of the plentiful supply of cheap labour available in all the farming areas of this country; machinery, like that the engineers of the day were endeavouring to foist upon farmers, was too much in the nature of an expensive luxury that might anyway do much more harm than good to the land.

In spite of their frustrations, however, the visionaries and pioneers persisted. The self-binding reaping machine, as it was then known, increasingly took the place of the teams of scythe and sickle men; threshing machines operated by steam enabled flails to become museum pieces—but there was still a long and hard road to be pursued before it was admitted that the advancement of agricultural engineering was important to the great task of feeding the world.

The New Day

The real influence of the development of the internal combustion engine is something that can never be properly measured. The effect of that development has been so far-reaching. Time and again it has been emphasised that the internal combustion engine has been responsible for the rapid expansion of a mechanized agriculture, and that is to a large extent true, although it does not represent the whole story!

When the internal combustion-engined tractor was introduced to this country as a suitable prime mover for farming operations, the same suspicion as greeted steam power was quickly apparent. That 'suspicion' was expressed in varying ways. An important factor—and one to which little publicity has been given—was, that the majority of farmers were extremely nervous about having petrol anywhere around their property. They had become accustomed to sparks which could fly from the chimneys of steam engines, and to the hot cinders which had to be disposed of when fireboxes were raked out, but petrol—that was a flammable, explosive liquid, which had to be treated with the greatest caution; it was certainly not the kind of stuff to have anywhere near a farm!

That sort of thinking was prevalent in this country when the first World War started in 1914. It was the food shortage brought about by the German blockade which injected a new degree of importance to British agriculture. More land had to be cultivated, and cultivated quickly. Much more home-grown food for man and beast had to be produced if these islands were to survive. The armed forces and munitions production made fearful inroads into available manpower, farm labour became scarcer, with the consequence that the agricultural tractor was accepted, probably far more quickly than it would have been had war not have intervened.

The acceptance of the farm tractor, however, did not accelerate immediately the pace of agricultural mechanization. So often in the years between the two great wars was British agriculture in the doldrums economically. True enough, there were many engineering firms which, in the 1920s designed and produced tractors, but the efforts of many of them could not be sustained.

Moreover, there was at the time little encouragement for agricultural engineering research and development work. Yet, in every sphere of engineering, there are always pioneers, and the world to-day owes much to those who pioneered the cause of modern agricultural engineering in the couple of decades between the two world wars.

The establishment by the University of Oxford of the Institute for Research in Agricultural Engineering—which was the precursor of the National Institute of Agricultural Engineering—was a bold step. There were relatively few farmers, and few implement makers who, at that time, would have believed that the Institute's work would make such a tremendous difference to agriculture not only in this country, but throughout the world.

This, of course, relates to what have been called some difficult years for British farming and British engineering, namely, the 1930s. In that period, there were two matters in particular which excited considerable interest, but which did not then make very striking progress. The first came to be known as electro-farming. Again, a comparatively small band of pioneers, prominent among whom were some qualified electrical engineers, were working on methods by which electric power could be effectively used in agriculture. They could see that with the progress of the grid network, electricity utilisation—in this country at any rate—could be extended. Rural electrification was so obviously something that could be a 'boon and a blessing to men.' Yet electro-farming, as then envisaged, did not at that time get very far.

The other matter was the introduction here of the combined harvester-thresher as it was then known. When the combine was first brought to this country, it was, of course, already well known in the U.S.A. and Canada. In fact, before the end of the last century, a social historian had expressed pleasure at 'seeing this wonderful machine at work in California in 1887. It was propelled by 16 mules, harnessed behind it, so as not to be in the way; but steam power is now used . . . When agriculture in this country', he continued, 'is treated as work of national importance, such machines will render us, to a considerable extent, independent of the weather, and will therefore become a necessity.'[4]

In 1932, combines harvested over 4,000 acres in Great Britain, but it was already being realised that if reaping and threshing were to be a combined operation, then the problem of drying the grain was bound to be one which called for early solution. But, again, progress was slow, due, to a large extent, to the fact that the economics of agriculture were so unstable.

It seems incongruous that it took a second World War to emphasise the real importance of British agriculture and agricultural engineering. When that war started, the tractor was generally looked upon as not much more than a substitute for the draught horse. Its potential as a power unit was certainly not fully appreciated. The full exploitation of tractor hydraulics was something that seemed to be far away; the development of self-propelled farm machines was apparently a long way off.

Full Mechanization

I have purposely sketched this background against which the title of this lecture should be set, though I would not like you to think that this is merely a historical discourse. Technological history does not serve its objective unless it challenges the mind to present and future needs.

There is no need to dwell upon the fantastic progress made during the last couple of decades in this country's agricultural engineering. But I want to present to you two simple, yet very significant, statistics, which relate to the United Kingdom. It has been computed that, in 1938, the total farm tractor horse power was 1,327,000; by 1962 (the last year for which figures are available) that total had multiplied to 12,722,000. It relates to tractors only, and takes no account of other self-propelled farm machines, or of the power output of fixed machinery at the farmstead. The figures show that in 24 years, tractor horse power increased nearly ten-fold, whilst in the U.S.A. the comparable increase was less than four-fold. This country can make up for lost time when it sets its mind to it!

The question that is always before agricultural engineers and the agricultural engineering industry is 'What shall be done next?' Here, for a moment, I go back again a few years to some words of a distinguished Past-President of the Institution of Agricultural Engineers, Mr Douglas Bomford, who said (in 1955) 'It would be a regrettable thing if, at any time, we accepted the view that our mechanization was even approaching finality. There is, however, an entirely new stage in mechanization open to us. We have seen animal power displaced by machine power and the machine take over the more complicated processes which could once be carried out only by the human hand, but in most cases the man must still be there to direct and control the machine. It is likely that the farmer's future requirement will be that the machine should direct and control itself. If, for example, a plough were designed which could be started in a furrow and then left to plough the field by itself, the limitations now imposed on the working hours of the plough by the working hours of the man would be removed. There is no reason why a self-controlled plough should not work 22 hours in a day. This would at least double the output of the machine as compared with its working hours when man-controlled, and would help the farmer with his capital investment difficulty. This kind of development may not be very far away.'[5]

Therein, surely, is depicted something of the exciting future for those who engage in agricultural engineers: the prospect of a day—which may not indeed be so very far away—when automatic control systems will have a prominent place in many farming operations. But are the abilities and energies of agricultural engineers to be solely concentrated on objectives of this nature, exciting and scientifically probable though they may be?

There are, I submit, some other considerations which must be kept very much in mind; considerations which are not being entirely overlooked in the current education and training of agricultural engineers. In this country, we are frequently—and quite properly—reminded that the work of agricultural engineers is making an increasingly notable contribution to the nation's export business. There is no reason on earth why high-quality engineering should not bring beneficial commercial results. Yet agricultural engineering must achieve something more than commercial success, however necessary that is in this day and age.

It must not be overlooked that upon agricultural engineers rests a very large part of the responsibility for providing the world with food, and it is not always apparent that we are quite certain about what this responsibility involves. In recent years, the world has been awakened to the great need of the under-developed territories, in which millions of people exist at starvation level. The task of bringing about the progressive improvement of the agriculture of these countries so often seems a baffling one; peasant-farming along out-dated yet very traditional lines cannot be transformed into modern agricultural practice in the twinkling of an eye, despite the fact that there are some well-meaning people and organisations which apparently think such a course is possible.

Undoubtedly, the right approach to the problem has been made by the Food and Agriculture Organisation of the United Nations, which has enlisted the aid of numerous able and practical experts; but it is essential to get the whole problem in its right perspective—its solution depends on something much more than charity from the world's more prosperous nations.

To make my point, I must resort to some more statistics! Those on the rate of increase of the world's population are staggering. It is estimated, for example, that by 1980, the world population will reach 4,000 millions, the annual increase at present being 45 millions.

And nowhere is the population 'explosion' more serious than in the so-called under-developed and developing countries, where food resources are sorely limited.[6] To-day, 68 per cent of the world's population lives in Africa, Latin America, and Asia, and by the end of this century this proportion may have risen to 80 per cent. In Africa, for example, the population is expected to increase from 240 millions to 663 millions and in Asia from around 1,640 millions to 4,250 millions.

Providing food only to under-nourished, hungry people will do little, if anything, towards solving the overall problem. So often history has shown that the beneficiary dislikes his benefactor. Moreover, no race of people can develop intellectually and ethically unless they have work; in fact, work demanding intelligence could be a check on the ever-increasing population of hungry people.

Thus, I submit, agricultural engineering has a special role in the under-developed countries. Providing under-nourished peoples with the means to feed themselves is, I believe, a job which can be successfully undertaken only by agricultural engineers. It is a job which must go forward with all branches of agricultural science, and not follow behind as has happened too often in the past.

But I must endeavour to be a little more objective, having done this bit of 'preachifying'. A few months ago, it was pointed out that, in spite of the great advances of our time in agricultural mechanization in the developed countries of the Western Hemisphere, it is startling to realise that 80 per cent of the world's crops are still cultivated by hand or with primitive animal-drawn implements.[7] In some cases, of course, attempts have been made to overcome the limitations of primitive implements by the somewhat sudden introduction of mechanization, and it has been discovered that that line of approach has not always met with the success that was expected.

It has, therefore, had to be realised that 'Tractors for the Hungry'—however laudable the thought that prompts the action—may not necessarily always be the best way of initiating improvements in farming techniques in many under-developed areas. Apart from technical difficulties of operating tractors and machines under conditions for which they have not been specifically designed, but which may be overcome to some extent by the adaptation of existing machines or the design of new ones, there are frequently social and economic problems which are not easily solved.

As well as mastering purely technical matters, therefore, agricultural engineers must familiarise themselves with the social and economic problems of any country whose agricultural development they hope to assist.

These problems are considerable, and it is doubtful if hitherto they have been given sufficiently careful study by highly-industrialised countries such as this. On-the-spot investigations[8] have revealed that, in many backward areas, the annual income of peasant farmers is so low (as low as £30 a year), that they just cannot afford to buy very much of the sort of equipment that has been sent out to them.

By tremendous efforts, a farmer in this category may buy himself a plough costing, say, £6 or £7—but seldom can he ever afford to buy anything else. Having got his plough, the tendency is for him to cultivate more land than he used to do with a hoe—and then finds, of course, that he cannot cope with the increased weeding and harvesting work—which have to be done by hand.

Some possible solutions to problems such as these were offered in a *paper presented, two years ago, to the Institution of Agricultural Engineers.[7] The author, Mr I. Constantinesco, urged that what is wanted is not *always* an increase in the area of land under cultivation, or an increase in the output per man, but rather an increase in the yield per acre, by the aid of simple, strongly-made, cheap implements, with which to perform all the essential operations of initial ploughing, seeding and subsequent weeding. There are many places where the animal-power era has not ended, and in all such places improvement in farming techniques could undoubtedly be assisted by an efficient, but cheap, multi-purpose implement.

Looked at through many Western eyes, it may appear ludicrous that highly-trained agricultural engineers should be challenged to devote their technical skill to the designing and provision of simple implements that are essential in so many areas to bring about steady, yet real improvement in agricultural productivity. In this context, the work that is being done by the Commonwealth Liaison Unit (in conjunction with the Department of Technical Co-operation) at the National Institute of Agricultural Engineering is still not as well known as it ought to be. The development of animal-drawn tool bar equipment, a simple rice thresher, and an equally simple one-wheel-drive tractor represents a tremendous contribution to the steady transition from primitive to more mechanized farming. A few commercial firms are likewise taking an interest in this and similar matters—but, undeniably, the financial rewards are small.

Better tillage implements are not the only problem. There are many attendant matters, such as irrigation, which are equally important; they are matters which agricultural engineers cannot overlook.

Yet if we again look back over the years for a moment, it is readily appreciated that agricultural engineers have never been reluctant to take bold steps. 'A time for boldness' is a well-worn cliché to-day; but agricultural engineering in relation to feeding the world still demands boldness.

It is, therefore, not unreasonable to argue that the development of machines for use in this country and for export to similar countries and climates (where there are often food surpluses) should become secondary to the development of implements and machines for the hungry, under-developed territories. As I have already said, the equipment needed may be so different from our own that the first requirement may sometimes be no more than a better spade, and the second a better ox-plough. The primary difficulty, undoubtedly, is in discovering and defining the requirement.

It means that a man sent to these under-developed

* 'Research and Development towards Improved Farm Implements for Peasant Farmers in the Tropics' by I. Constantinesco, B.SC., N.D.AGR.E., M.I.AGR.E. (Jnl. & Prcdgs. Vol. 18 Part 4).

territories needs to be an agronomist, a mechanization expert, and something of a designer, to be able to compile data which could result in useful production. That is why, in every scheme of agricultural engineering education, the mechanization part is positively vital. It seems to me that there is plenty of scope for men trained in this way, particularly if they can be provided with the means for making and testing prototypes in the territories which they endeavour to help.

Unquestionably, it is a good thing that, at present, this country's farm machinery exports are at such a high level. To turn from thought of them to the provision of equipment for the primitive races is not easy; but, even on a commercial basis, it could become worth-while, because, surely, if this country can solve the early problems of development, it has a good chance of being entrusted with subsequent and much more remunerative ones.

Before all up-and-coming agricultural engineers, therefore, there is this tremendous challenge. It may sound extremely idealistic—but it is difficult to think of anything more worth-while. The world can never be freed from hunger unless agricultural engineers are encouraged to play their part to the fullest possible extent.

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J. E. BYWATER, M.I.MECH.E., M.A.S.A.E., M.I.AGR.E.

Sir Patrick Hennessy, Chairman of the Board of Ford Motor Company Ltd, has announced the appointment of Mr J. E. Bywater, M.I.MECH.E., M.A.S.A.E , M.I.AGR.E. to the Board of Directors. Mr Bywater will concentrate his attention on the development of the Company's tractor activities.

He joined Ford of Britain in 1939 and held several positions in design engineering, including Manager of the Company's Birmingham Research Centre and subsequently Assistant Chief Engineer.

From February 1962 he has been Chief Engineer in the Ford Motor Company's Tractor Division in the United States and on 15th June 1964 was appointed Assistant General Manager of that Division.

Mr Bywater is a Vice-President of the Institution. He became an Associate Member in 1952 and was transferred to full Membership in the following year.

DRYING BEFORE STORAGE

by W. F. Williamson*

Based on a Paper presented in Norwich at the Annual Conference of the East Anglian Branch of the Institution in November 1963

Introduction

One of the many difficulties faced by agriculturists is the need to buy machines which can only do seasonal jobs. A particularly good example of such a machine is the specialised grain drier. It is even more seasonal than most farm machines because in some years it may be needed very little; but there is nearly always some drying to be done and to meet farmers' various requirements a number of different machines have been produced.

This paper is a survey of the types of machines which may now be obtained; but before going into this matter in detail it may be interesting to note the rapid increase in the numbers of driers in use which has followed the similar, but greater, increase in the numbers of combines. The figures given in Fig. 1 are from Ministry of Agriculture statistics and refer to machines in England and Wales. It is probably true to say that before the first date on this chart, 1946, most of the driers were on large farms, and were of the continuous flow type. There were also in existence some home-made tray and vertical batch driers and a very few in-sack driers—the latter provided mainly for drying various farm seeds. About 1949 driers other than the continuous type began to increase. In 1952 silo and sack driers were recorded separately in the machinery census and in 1954 tray driers were counted separately from the continuous flow driers.

The trend until 1962 is shown in the chart. If tray and sack driers are added together, both being batch driers of a type distinct from silo driers it will be seen that rather more than one-third of the installations in 1962 were batch driers, about one-third continuous flow machines and rather less than one-third silo driers. Sack driers are obviously becoming less in demand. Some are being converted to tray driers. It is hardly necessary to point out that the numerical chart gives no idea of the relative drying capacity of the different classes of machine.

Referring to the acreage distribution chart for 1962—at this time there were enough continuous driers to provide one for each farm above 400 acres total area, and enough of all other types to provide for farms from 400 acres down to 250 acres. Of course they would not in practice be distributed as logically as that, nor would all the farms in these size ranges be cereal growing farms. In 1962 there were already 52,350 combine-harvesters.

It is not practicable to enumerate all the driers at present being produced but an attempt will be made to show the variety of types of batch and continuous flow machines, working from the simple to the more complex in each class, and starting with batch driers.

* National Institute of Agricultural Engineering.

Batch Driers

One of the simplest driers and the cheapest in first cost is the sack drier. It can be made in almost any size and a range of fan-and-heater units are made which are suitable for it, from small all-electric models to large oil-fired ones. The sack drier is particularly suitable for drying seeds in small batches which must be kept strictly separate. An oil-fired unit having a conventional platform with separate sack holes, is in use at N.I.A.E. Another sack drier in use there has a plenum chamber covered with strong expanded metal on which batches of sacks are closely packed. A conveyor alongside eases the labour of loading and unloading. As this drier is in the main seed store an indirect oil-fired heater is used. This stands outside the building. For in-sack driers direct-fired oil burner units are generally used but gas-burners are also available. In one such unit gas is also used in the engine which drives the fan. Waste heat from an engine driving the fan is the only source of heat in another make which is sometimes used for drying large stacks of sacked grain.

The batch drier next in order of simplicity is the horizontal tray type. Some fixed horizontal tray driers are used for grain, having been installed mainly for drying grass, but as these are inconvenient to empty, tray driers for grain are made to tip, usually endways, to concentrate the grain to one or two discharge points. Other driers are now made which tip sideways, thus saving height and tipping effort. To minimise the potential drying time wasted whilst a tray drier is emptied and refilled some machines are built with trays at a fixed slope with hoppers above and below them to enable batches of grain to be quickly dumped, the hoppers being filled and emptied whilst drying proceeds. All tray driers have the advantage that, within limits, any size batch can be dealt with, however small. They have the disadvantage that at the end of drying there is a considerable moisture gradient across the batch, necessitating careful mixing during emptying in order to reduce unevenness in the finished product.

Batch driers are also made with vertical compartments. Several makes have a number of narrow grain walls, and a low power requirement. They are compact and could presumably be installed under a loft floor from which they would be fed. They have simple pot-type burners. Another vertical batch drier has comparatively thick grain walls to give increased batch size and good heat economy.

Another distinct type made with filling and emptying hoppers is one in which the grain being dried is held in the middle compartment which is fitted with inverted V-shaped air ducts for introducing the air. Three similar ducts, with ends open to atmosphere, allow some of the exhaust air to escape and the remainder passes out

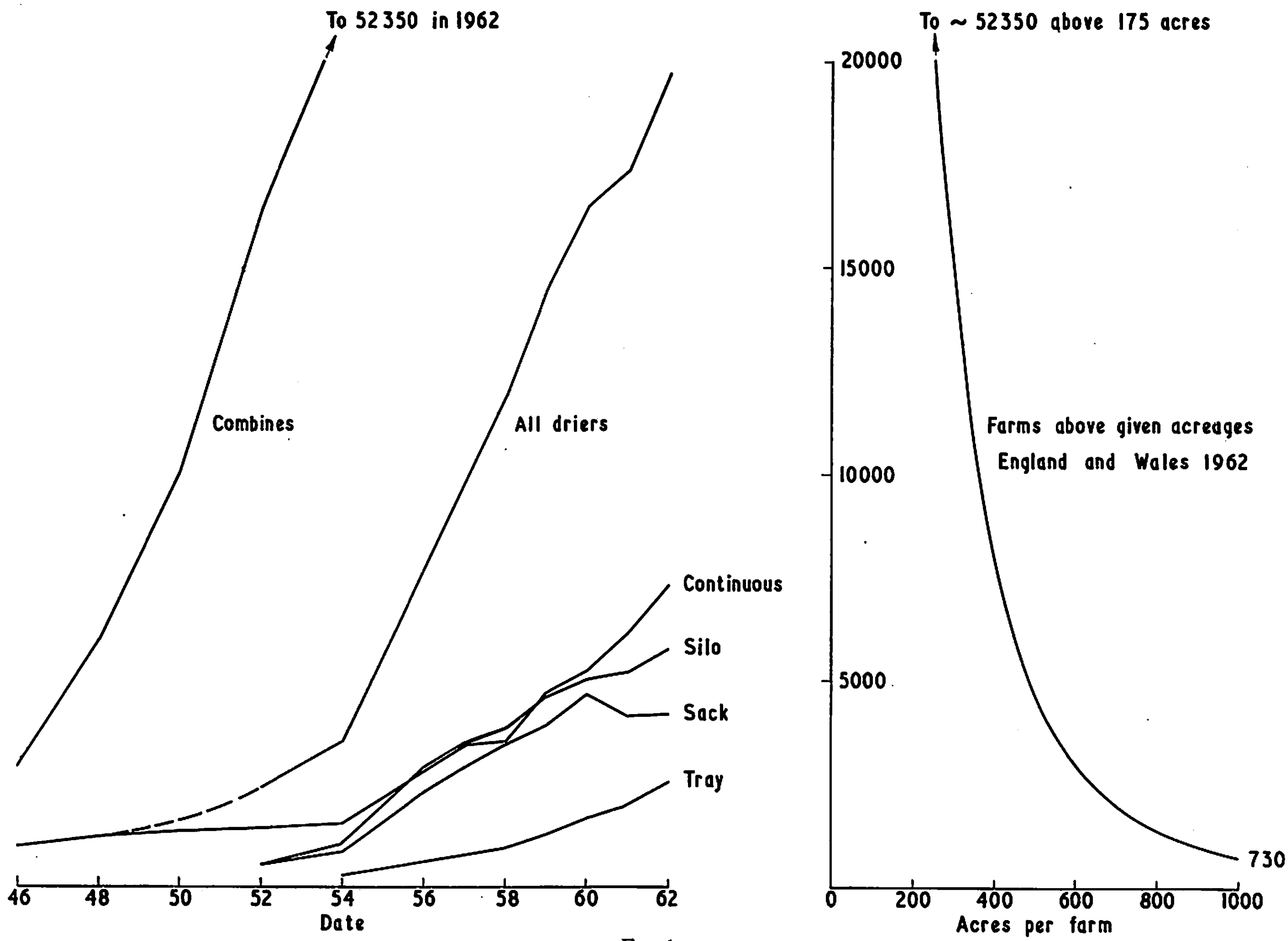


FIG. 1

Increase in the use of combine-harvesters and grain driers and farm size distribution curve. From M.A.F.F. Statistics for England and Wales.

through the upper grain surface. The lower hopper is designed so that grain can be tipped into it to be transferred to the feed hopper by a pneumatic elevator which can at other times blow dry grain to where it is to be stored.

Continuous Flow Driers

If one accepts the need for elevators and conveyors in either case it is not a big step from a complex batch drier to a simple continuous flow machine. In terms of drying capacity the latter may even be cheaper, especially in the larger sizes. The advantages to be expected from the continuous flow machine are a saving in labour and a reduction in the size of a machine for a given ouput because of the avoidance of idle time, and still more by the ability to use higher air temperatures in many cases.

Apart from differences in arrangement of the drying compartment which, as with batch driers, may be horizontal, sloping or vertical, there are differences in the flow of air relative to the flow of grain; driers may thus be further classified as cross-flow, mixed co-flow, and counter-flow. The most numerous class is the cross-flow which may be briefly described as follows. The grain column is retained between perforated metal walls and rests on a base plate. A reciprocating discharge mechanism is used to discharge grain over alternate sides of this plate at the desired rate so that the grain slowly descends, the column being continuously replenished by gravity flow from above. A fan draws air through the column, heated air being admitted to the upper part and air at atmospheric temperature to the lower part. There is inevitably a moisture gradient across the column but as alternative discharges from opposite sides of the column occur at frequent intervals a well mixed and reasonably uniform sample results. A constant hot air temperature is usually maintained by a thermostat and the degree of drying is regulated by altering the rate of flow of grain through the drier.

The same state of affairs applies whether the column is vertical or horizontal but various modifications are incorporated in individual designs such as mixing devices, different arrangements of fan or fans, numbers and shape of grain columns, etc.

Starting again with a horizontal type, several similar machines have a single reciprocating tray which may be inclined slightly to vary the depth of bed from end to end. Grain is admitted and discharged through control gates and a third gate is placed between the drying and cooling sections so that the depth in the cooling section can be reduced to allow a higher rate of airflow for cooling. Two fans are used.

Another make has multiple horizontal trays and grain is of course mixed in falling from one tray to the next below. The use of suction fans makes it easy to duct exhaust air and dust out of the building in which the machine is housed.

Another horizontal drier, very suitable for seed drying, also has a series of trays. Each tray has its own fan and each drying tray its separate furnace so that hotter air can be used at each successive drying stage, the last tray being used for cooling. The grain is well mixed between stages and turning devices similar to miniature ploughs are fixed at intervals along the trays for intermediate mixing. The louvred bed is easy to inspect and to free from seeds which might contaminate successive batches.

Sloping tray driers are made by one firm in a variety of forms with single or multiple trays. These trays are set at a fixed slope sufficient to allow grain to slide down over the louvres by gravity. The depth of the bed is controlled by a number of freely rotating finned rollers which may be adjusted as to height individually to control bed depth and can if necessary be power-driven when light seeds are being dried. The flow of grain is controlled by varying the speed of the discharge elevator which has widely spaced troughs extending the whole width of the grain bed. To avoid dust nuisance exhaust hoods and fans can be fitted to these driers. In a recent model an exhaust fan also serves to draw air through the cooling section.

Driers with vertical grain walls are made in a variety of designs. In some, two columns of rectangular cross-section are placed side-by-side; one has four columns arranged in a square and others have cylindrical retaining walls for the grain column.

A number of makes of vertical driers have grain columns in zig-zag form. One design has turnover shelves placed in the grain columns to cause further mixing. Other driers with zig-zag grain walls differ in detail. One for instance re-uses air from the cooling section to heat the incoming grain. Some are made in large sizes with a manufacturer's rating of 10 t/h.

Various other designs of cross-flow drier have been produced in which special care has been taken to avoid excessive heating of the grain, having regard to its varying moisture content in the course of drying. In one the air is made to pass four times through the descending grain. It extracts heat from grain in the cooling section and is reheated before each subsequent passage through the drying sections. Introducing heat in stages and reversing the direction of airflow allows the grain temperature to be kept at a lower level than if all the heat had been applied at once, and from one side of the column.

Besides the mill driers made by firms specialising in milling machinery there are two conventional types of mixed flow driers available for farm use. These have a descending column of grain traversed by a system of ducts for introducing and exhausting air, inlet and exhaust ducts being fitted in alternate sets at different levels. In one, imported from Sweden, the ducts are all parallel and in a British-made machine each section of the drier has ducts at right angles to those in the next. Good mixing is obtained. The grain capacity of these driers is high for their rated output, which helps to improve their thermal efficiency.

Another type which does not fit into any of the above categories is the spouted bed drier. In this a horizontal bed of grain which may be 12—18 in deep is fluidised and kept in a turbulent state by air being forced through at a sufficient velocity. Fan power requirement is higher than in conventional driers but the moisture gradients which occur in machines without means of mixing are avoided.

Apart from one German-made machine there is, to the author's knowledge, only one counter-flow grain drier. In this machine the air, drawn partly through the furnace and partly through the cooling section, is led to a set of inverted V-ducts. From these it passes upward through the grain to the collecting chamber above, from which it is exhausted by a fan to atmosphere. Grain is elevated to the top of the drier and levelled by a cross conveyor, adjustable for height. The main bed of grain moves vertically downward opposite to the flow of air. Grain is therefore nearly dry before it meets the incoming hot air.

As was implied earlier the high overhead costs in drying grain due to seasonal use tend to make running costs relatively less important than capital costs. It may however be interesting to show some comparative figures for heat requirement per pound of water evaporated for some driers which have been tested. Most range between 2,000 and 3,000 Btu/lb evaporated. What this means in terms of fuel requirement for drying from 20 to 15% at 1 t/h output rate is shown on the right of Fig. 2. The separate, isolated points are from German test reports.

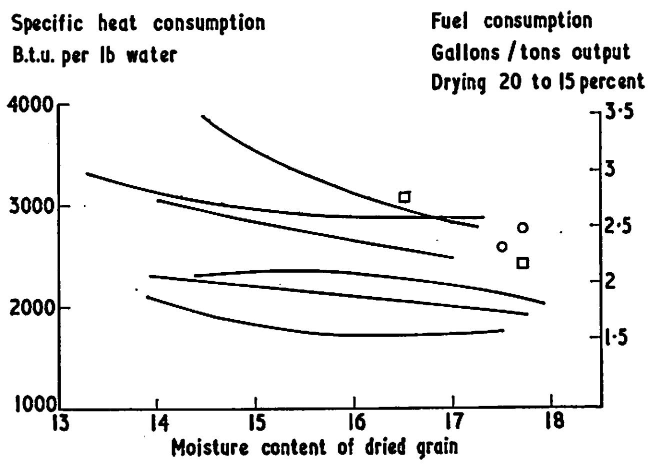


FIG. 2
Examples of heat requirements of grain driers, from published test reports.

Automatic control of the discharge of grain from continuous flow driers to give reasonably close control based on output grain moisture content is now a possibility. Exact control whether manual or automatic is very difficult with grain driers, which necessarily contain a large weight of material which is subject to slow or rapid changes of input moisture content. The N.I.A.E. has been working on a system based on the adjustment of throughput in response to the signal from a capacitance type moisture monitor. The initial work has already been described*, and the unit has since been adapted to control a farm drier in 1964.

* Matthews, J., 'Automatic moisture control for grain driers' J.Agric.Engng.Res. 1963 8(3)207.

ASPECTS OF THE FUTURE DESIGN OF FARM MACHINERY

by L. P. EVANS, N.D.AGR.E., A.M.I.AGR.E.*

A Paper presented at a meeting of the West Midlands Branch of the Institution on 6th January 1964

The Development of Farm Mechanization

Mechanization on the farm began as a logical development of equipment to ease the burden of hand work and to carry out accepted cultivation and other work programmes in a more sophisticated manner. For instance, man has accepted for very many centuries that it is necessary to cultivate the soil to increase its productive capacity and that in temperate climates it is also necessary to invert the soil in order to bury surface weed growth and trash to effect its decomposition. Hence the introduction, probably 2,000 years ago, of very simple wooden cultivation implements which began as hand tools and soon became increased in size and powered by draught animals.

From this point onwards progress was very slow and in fact in certain countries, where economic and social problems have hindered development, little change has taken place. In this paper it is intended to deal only with the further problems of the more rapidly developing countries such as our own, since it can be assumed that similar progress can be made in the more backward countries providing that this progress comes slowly and that no attempt is made to cover a century's work overnight.

Like most other industries, that concerned with agricultural machinery in this country began to make better progress after the Industrial Revolution some two centuries ago, which allowed the cultivation impliments, though not changing much in appearance, to be manufactured wholly from steel, so improving strength and durability. From this time onwards the changes in farming practice resulting from land being farmed in larger units lent itself to more rapid development, but the power of draught animals was the limiting factor. The turn of the last century saw the introduction of mechanical power units from which the modern tractors have been developed. The development of agricultural tractors and more complicated machinery during the last twenty years has continued at such an alarming rate that one might well need to stop at this point and consider very carefully along which courses further progress should be directed.

The title adopted for this paper was arrived at after considerable thought which led the writer to the belief that we are at this moment passing, without fully realising the fact, a very critical point in this development programme. One can say that up to a year or two ago the development of machinery was still concerned with providing equipment to mechanize existing jobs which had hitherto been carried out by hand or by the use of more primitive tools. Whilst development of these machines could continue and their performance and efficiency could be continually improved, little thought was given to whether the operation being carried out was in fact desirable or necessary because it had been carried out in a more primitive unquestioned manner since time immemorial.

So it is that to a greater extent the machinery manufacturer is beginning to determine, by the continued development of a machine, the application to which that machine is put, instead of developing machinery to suit new applications brought about by the discovery of more beneficial field operations and more suitable crop varieties. A happy balance must therefore be maintained and to this end it becomes increasingly necessary that the efforts of the soil chemist, botanist and engineer must be pooled to ensure that the most satisfactory solution to any problem is found. In these matters the soil chemist or botanist face the difficulty that development of plant varieties in particular and perhaps to a lesser extent of chemical fertilizers, sprays and cultivation techniques is likely to be held to a much slower pace than that of many machines.

Efficiency of Machine Utilization

The agricultural industry is the largest industry in the world and as such has a very great influence on its economic development. This therefore places a heavy responsibility on everyone connected with the industry to work for greater efficiency. By greater efficiency we mean the increase in production to maximum proportions whilst striving to keep cost and effort to a minimum. Optimum efficiency in many areas of the world, and even our own country today is no great exception, is limited by the fact that the vast difference in land values over relatively small areas has caused a farming system where many of the holdings are split up. This means that the maintenance of machinery mobility is of great importance in our future work.

In this paper the intention is to concentrate on tractors and the machinery associated with them, since practically the only self-propelled machine, the combine-harvester, falls into a different category. Because of its very limited season of use, often shortened particularly in U.K. by weather conditions, the combine must have a very high output and be extremely reliable which must inevitably affect the cost considerably. Thus this machine can be considered a necessity which is not as justifiable economically as many of the other agricultural machines. A point

* Field Test Engineer, Massey-Ferguson (U.K.) Ltd.

to consider is that there may well be a future for a combine which, although self propelled, uses a prime mover which can be utilised during the remainder of the year.

Although it is often difficult to segregate tractors from implements, since they are so interdependent, let us first consider the tractor. When one thinks of the movement of labour from the land, the advisability of investing money in mechanical equipment rather than man power, the fact that on many farms the labour requirement fluctuates considerably during the year, and that the farm worker is entitled to as short a working week as his counterpart in any other industry, the word 'efficiency' springs to mind. The tractor is the prime mover connected with the vast majority of agricultural operations, and hence to some extent the number of people employed in the industry is proportional to the tractor population.

Until the time comes when one man can control more than one tractor at a time by remote means—at which time a good case could no doubt be put forward for reverting to machines very similar to those we know today—it would appear that we have two choices: (a) to increase the tractor's work output or (b) to ensure that it does more useful work. The latter is beyond the control of the tractor designer; it will rely on joint efforts of soil chemist, botanist and implement designer, will result from the development of new techniques and will be a gradual process since the time taken to see the results of new techniques is, comparatively speaking, very slow in an industry developing as fast as this one. Whilst continuing this long-term work, therefore, it is necessary to look at ways of increasing work output using associated implements which still produce the same results as we currently know and in many cases have known for decades and even centuries.

Power and Reliability

Assuming then that mechanical efficiency of the tractor/implement combination is unlikely to increase by a substantial amount, and that we are concerned with the overall efficiency, it follows that work output per man, and hence per tractor, employed, must be increased. This would inevitably mean that the tractor population would decrease, and hence reliability of the tractor would be of increasing importance. This can only be done by firstly giving the tractor more power, which sounds very simple but there is little point in giving a tractor power which cannot be used. The power of wheeled tractors has already increased steadily over the years until we have arrived at the point which causes severe headache to the tyre manufacturer. The crawler tractor still has its place in large acreage world agriculture, but is more difficult to justify due to its higher running costs and transport problems. It is impossible to say whether any significant break-through in the development of traction methods is likely in the near future, but the development of tractors must continue assuming that this will not happen, since it would still be possible to take advantage very quickly of any benefits which were forthcoming. The section of tractor tyres must not assume abnormally wide proportions to cater for increased power, since one must consider all operations. Whilst it may be possible to carry out operations on a wider portion of a rowed crop with increased power, the wheels must still travel between two adjacent rows, the optimum dimension between which is governed by the nature of the crop.

If it is intended to use the tractor's engine power by transmitting it to the ground via its wheels, then it must be advantageous to have all wheels driven in order to obtain maximum benefit from the weight of the tractor. However, a tractor designed to have all wheels driven should assume very different proportions from that using only one driving axle. Except for the amount required for steering purposes, there is no advantage in leaving weight on an undriven axle of a tractor when in work. On the other hand, optimum performance in terms of economical work output would be expected from a high-powered all-wheel-drive tractor when the weight distribution is proportional to the tractive capacity of the tyres, e.g. if all tyres are of the same size and type then all wheels should be equally loaded.

It has been stated that tyre sections should not assume enormous proportions, hence if more weight is to be carried by a tyre not only must the tyre be capable of withstanding it by operating at a higher pressure, but the consolidating effect on the soil may be detrimental. This is particularly important in row crop work where wheels often run continually in the same tracks due to the tendency to carry out post drilling operations on the same sets of rows to eliminate the problem of unmatched joins. Without adding weight to the driving wheels, one cannot obtain any increase in the maximum drawbar pull; hence if all power is to be transmitted in this way, the speed of the operation must be increased. This has certain advantages:—

(a) It allows the tractor to have increased power without increased weight, and weight is very expensive.
(b) Although certain changes to the design of many basic implements would be necessary, the cost should not increase greatly, e.g. the number of bodies on a plough would not change though the shape of them would change in order to perform the same operation at a faster speed.
(c) Implements could continue to be fully-mounted—in recent times one has seen the reverse trend to some extent, as indicated by the number of semi-mounted implements reaching the market.
(d) In certain cases it would not be advantageous to increase the size or capacity of an implement because of other considerations, e.g. if one plants a row crop six rows at a time, it is usually more satisfactory to carry out further operations on the same six rows only.
(e) By keeping weight to a minimum, power requirement is kept to a minimum.

As with many things in this world, this increase in speed also brings many disadvantages, viz:—

(a) implements need to be stronger
(b) many implements in their present form could not be operated at greatly increased speeds due to the limitation of the driver's steering ability.

In this connection it may well be opportune to recall that the tractor replaced the draught animal, and as such the prime mover and the implement remained in the same relative positions. Unfortunately for the driver, at this time he was transferred to ride on the tractor instead of riding on or walking behind the implement, with the result that the present-day conscientious tractor driver still spends about half his working time looking in the opposite direction to that in which he is travelling. One cannot satisfactorily associate this practice with increased operating speeds or efficiency.

(c) In certain work, the forward speed must be relative to a power- or land-driven machine speed and it may be unwise to increase the machine speed to any marked extent.

(d) In some areas, the presence of stones etc., would prohibit operation at high speeds.

Whether the weight of the tractor is increased so as to operate higher draught implements or whether the speed is increased whilst operating virtually current implements, it would be necessary to provide quick-release safety devices for protection of soil engaging implements when striking hidden obstacles. The quick hitches currently being developed for mounted equipment could well be adapted to provide this sort of protection. Trailed machines are more readily catered for in this respect.

Tractor Transmissions

Having now reviewed the possibilities of tractor development to suit the current types of implement, perhaps in an enlarged form in the one case, the problem of tyre adhesion remains, since it will always be advantageous to keep weight to a minimum to reduce power requirements. Thus it would seem logical that power should be transmitted from the prime mover by other methods as far as possible. Wider use of the standard p.t.o. shaft, and the development of implements to use hydraulic or electric power supplied by pump or generator mounted on the tractor would seem beneficial. Stepless transmission systems, covering a wide speed range to enable the engine power to be fully utilised, are obvious ultimate requirements, particularly if increased use is to be made of methods of transmitting power to implements other than through the tractor wheels. This is because under such conditions one cannot use engine speed change to vary forward speed. Over the years, the number of gear ratios provided in tractors has increased steadily and hence the machine has become far more adaptable to varying requirements. Generally speaking, these extra speeds have been obtained by employing multiples of gear ratios with the result that in certain cases three gear levers or other speed change controls are provided. Unfortunately, in using this system it is necessary to overlap the ratios if a high top speed is to be provided. With the use of a larger number of ratios, however, it becomes increasingly important that this overlap should not be present, but that all gears should run in sequence.

Recently we have seen the introduction of a British tractor equipped with hydrostatic transmission. This unit by no means indicates all advantages of this type of transmission, but represents the cheapest and hence the most logical first step into a new era. Further development of this could lead the way to revolutionising the accepted layout of the tractor, enabling, if necessary, a variable layout to be available which could broaden considerably its potential as a prime mover.

Inevitably, no matter how powerful a tractor may be, it will be called upon to perform duties well within its capabilities. For this reason, to enable it still to work with as high an efficiency as possible, it is essential to keep its basic weight to a minimum. Any additional weight should be capable of being added very quickly, preferably in the form of out-of-season implements.

Implement Design

Today's tractor is one of the farming industry's most easily justified pieces of equipment. Further development will undoubtedly increase its cost very considerably but due to the decrease in population and increase in potential it should still command a similar position. Let us now turn to look at the possible development of the associated implements.

One can see the application of ploughs and cultivators designed or developed to operate at much faster speeds than we have hitherto known. The continued development of the reversible plough may well be directed along these lines, since it is a costly piece of equipment and, because of their weight, multi-furrow versions do not lend themselves to being fully rear-mounted on conventional single-engined tractors. Wider use of machines such as rotary cultivators and the development of others where the soil-engaging parts are driven instead of being pulled, must represent a convenient means of absorbing considerable engine power. The design of these machines, however, must be such that traction does not emerge once more as the limiting factor, which can happen if the tractor itself has to provide the necessary reaction to ensure that the implement operates satisfactorily.

It is usual that conditions which, because of hidden obstructions, are unfavourable for the application of high speed draught work are equally unfavourable for the application of power-driven soil-engaging equipment. In such cases there will be a need for the continued use of high-draught slow-moving implements. These could be mounted, semi-mounted or trailed and, whilst remaining essentially draught implements, could be propelled via their own wheels by power supplied from the p.t.o. shaft of the tractor, or by hydraulic or electric motors as previously mentioned. In the case of mounted and semi-mounted machines, the provision of steel power-driven wheels equipped with spuds would considerably alleviate tractor traction problems without causing any transport difficulties. Even with trailed equipment the transport problem could be overcome quite readily, and of course it is true to say that the majority of heavy draught trailed implements with which we are familiar today do not readily lend themselves to continual transporting.

Further development of certain land wheel- and power-driven machines could improve their efficiency, e.g. when considering the conventional manure spreader, it is advisable to retain land wheel-drive for control of the feed rate, but the difficulty in moving the whole load, when spreading commences, often causes unnecessary traction problems for both tractor and implement tyres. Without going into all machines in detail, it would be reasonable to expect the development of increased capacity balers, forage harvesters, trailers and other machinery to utilise the increased power available.

Fundamental Re-Thinking

During recent years it has been appreciated that, although it is often possible to develop complicated machinery to cope with seemingly difficult applications, on many occasions the better way of tackling the problem is to change that application. By way of examples, one has seen the sugar beet singling problem alleviated very considerably by the introduction of precision seeders and the use of rubbed and graded seed. Improved cultivation methods prior to planting potatoes and the use of aerial spraying to effect weed control and protection against disease after planting instead of consolidating the ground by use of tractors for these operations, have shown that the application for which the mechanical harvester must be designed can be simplified. The amount of soil being handled by such machines can be reduced not only by improvement in lifting techniques, but by the development of plant varieties having a tendency to grow within an area to the shape of which the mechanical lifting mechanism can be more closely matched.

Having looked at some aspects of tractor and implement design and methods of improving these functions, one must not assume that it is time to sit back except it be to think further.

It may be necessary to cultivate the soil to considerable depths for aeration purposes and to release 'locked-up', beneficial elements, but it is not clear why, when this operation is carried out by use of the conventional plough, it should be necessary at the same time to bury valuable organic material at the bottom of a deep furrow where it could well prove to be of little value to the subsequent crop and probably helps to ensure that the elements which have been released are encouraged to revert fairly quickly to an even greater depth. These are problems for the agronomist and from the results of his work new applications will evolve demanding the skill of the agricultural engineering profession to provide the necessary mechanical equipment.

In conclusion, the writer wishes to state that all opinions expressed are entirely personal and in no way intended to represent the views of his company.

Branch Papers

In this issue of the *Journal*, two lectures appear that were first presented at Branch Meetings of the Institution during the 1963-64 Session. Many other excellent papers have been given at Branch meetings throughout the country but it is impossible to reproduce them all in these pages. The texts are, however, available on loan to members from the Institution Library.

One example is a paper delivered to the Western Branch on 18th March 1964 entitled: '*Farm Wiring and Installation of Electrical Equipment*' by R. A. Bayetto, M.I.AGR.E., of the Electrical Development Association. The transmission to farms of electricity as 3-phase and 1-phase supplies is briefly described, together with factors to be taken into account in planning the distribution of electricity within the farm. Attention is drawn to the special conditions of dampness and the presence of corrosive chemicals on farms, in relation to systems and types of wiring. The use of plastics materials for insulation is discussed in relation to cost and modern wiring practice, and the safety aspects of electrical installation work on farms are emphasised.

The paper by W. F. Williamson which appears on pages 131-133 of this issue is one of several lectures delivered at the Annual Conference of the East Anglian Branch in November 1963. Some of the others, each covering an aspect of 'Grain Handling and Storage', can be borrowed by members from the Library. The titles are:

'*Bin Storage and Drying*' by W. G. Cover, M.I.E.E., M.A.S.A.E., M.I.AGR.E. of Simplex Dairy Equipment Co. Ltd.

'*Floor Storage and Drying*' by W. L. Wilkinson, A.M.I.AGR.E., County Farm Mechanization Advisor, National Agricultural Advisory Service.

'*Grain Storage in Polythene Sacks and Sheeting*'—An Interim Report from the Agricultural and Horticultural Technical Advisory Department of British Visqueen Ltd.

Enquiries concerning the above or any other Papers in the Library should be addressed to the Institution Secretary.

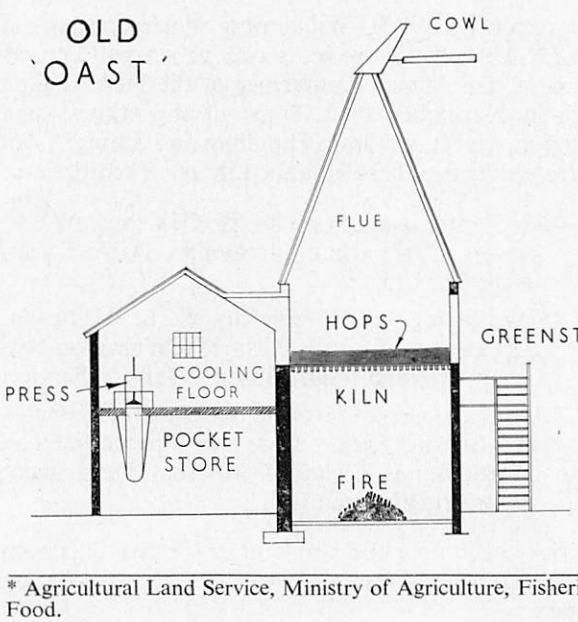
THE MECHANIZATION OF HOP DRYING

by L. WRATHALL, A.R.I.C.S., A.I.AGR.E.*

The colour and romance of the old hop harvest has gone; the gypsies and others who used to crowd the yards to pick the crop by hand are seen no more. Hop picking machines have taken over, reducing the numbers of workers in the fields to a handful. So too in the oast-house or hop kiln mechanization has come to stay and although a few quaint reminders of the old days still remain, for instance the ritual of lighting the sulphur in the kiln with a red-hot horseshoe (what chance of a sweet hop otherwise?) the new order is now almost complete.

Drying in former times

Because the hop plays a vital part in the brewing process, it must be dried uniformly and at precisely controlled temperatures and humidities without damaging the delicate cone or impairing the quality of the leaf. The original oasts were extremely simple, being designed to do the job in a remarkably straightforward manner. Heat was provided by open wood or charcoal fires at ground level—later replaced by coal stoves. Some 14 ft above these were set the slatted timber drying floors with overlaid woven horsehair mats and smaller cloths of goat hair on which the hops were placed. There was always the risk that the hops and the drying floor would ignite if they were placed any lower, and a further advantage was that the height of the drying floor increased the diffusion of heat across the full width of the building besides increasing the draught. This need for a steady upward draught led to the adoption of the tall chimney and cowl as part of the design. For cooling and curing a large room was provided adjacent to the kiln, often at a slightly lower level for convenience when emptying it. (Fig. 1)

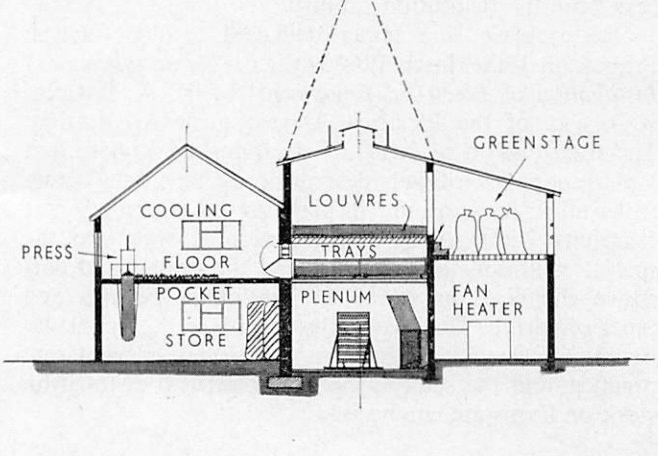


Natural convection produced the air current, but this was often rather too variable and slow for satisfactory drying. In the older type of kiln the hops were brought in from the yard in sacks or 'pokes' and placed for temporary storage on an elevated slatted platform known as the 'green stage'. They were then shaken out on to the floor of the kiln for drying.

When drying was complete (after about 10 hours) the hops were shovelled out of the drying chamber through a wide internal doorway and spread for cooling and curing in the cooling room. Finally, the floor was cleared by hop shovels into a pressure release type of press. This was used to fill the large sacks known in the trade as 'pockets'. A cool, dry room was set aside on the ground floor where the pockets were stored to await collection.

Many early attempts were made to mechanize the handling of the hops from the drying chamber; for example, by the provision of a roller for the hair mat, so that as a handle was turned the mat rolled away and spilled the hops on to the cooling floor.

It is from this early start that the first of the two recent types of kiln has developed. The new 'oast' consists of a building somewhat similar in size and layout to that described above, but two floors have now replaced the single drying floor, one above the other. (Fig 2).



* Agricultural Land Service, Ministry of Agriculture, Fisheries and Food.

The upper floor consists of a series of narrow mesh-covered frames which, when set in the horizontal position, form a smooth perforated platform but when turned to the vertical position allow the partially dried hop load to drop through to the trays forming the second floor below. The hops are therefore dried in two stages. They remain on the louvred floor for approximately 3-4 hours and in the trays for a further $2\frac{1}{2}$ hours. The air temperature at the top is about 110°F and that at tray level about 150°F. The light metal trays are on castors so that after drying they can be rolled out on to the cooling floor to be tipped. The problem of providing a lining through which the hot air can pass when the trays are in the kiln, but which would not affect the natural aroma of the hop, is solved by using a specially treated fine nylon mesh. This is chemically inert, stands up well to the fumes and high temperatures and does not rot.

A gas-oil burner outside the plenum chamber is used to fire the kiln and keeps the plenum at a constant temperature of 150°F during the drying period. 'Brimstone' or rock sulphur is burnt in trays for the purpose of modifying the colour of the hops and improving the aroma. With the two-tier system, it is possible to dry nearly twice the quantity of hops in the same time, compared with a single floor kiln of equal size—with consequent savings in fuel costs.

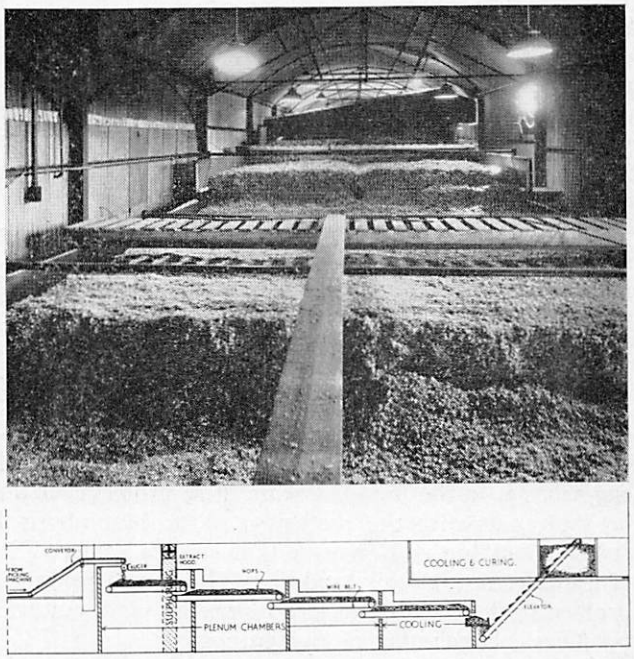
At the Guinness Farm, near Worcester 900-1,000 bags of hops per day are dried, using a single kiln designed on the two-tier system. Previously five to six single-floor kilns of the same size were needed. The cost of the new building, complete with machinery, oil tanks, etc., was around £13,000.

Continuous Drier

No account of the new type of hop kilns would be complete without mentioning the continuous drier. (Fig. 4). It is a series of 20 ft wide roller conveyors on four different levels, forming a cascade. The conveyors are made up of steel wires running the full width, the wires being $\frac{1}{16}$ in diameter and moving very slowly (about 10 ft/h) over three drying chambers and one cooling chamber. The warm, dry air rises between the wires and through the hop load. Temperature regulation is assisted by tube thermometers moving backwards and forwards over the hop bed so as to obtain true average readings. Each separate plenum chamber is heated by its own fan and heater unit, housed in a lean-to at the side of the drier, and it is, therefore, possible to supply air at different temperatures and velocities at the various stages of the drying process.

Because a cooling section is incorporated in the cascade, a separate cooling floor is not necessary with this type of drier. At the end the hops are elevated straight from the drier to an upper floor, where they are stored in timber and hessian bins about 10 ft square for curing. When curing, the remaining moisture in the hop cone spreads back from the strig (or stalk) into the leaf to equalise the distribution, and a certain amount of moisture redistribution also takes place from one part of the hop load to another.

Sulphuring of the hops in this drier is carried out in the first section, and a light metal or timber hood is put over this to carry away the fumes. The hops are fed across the width of the drier by means of an oscillating belt conveyor working at right-angles to the elevator, which lifts the hops from the green stage.



CONTINUOUS DRIER
Fig. 4

A Job for the Engineer

Throughput is geared quite rigidly to the output of the picking machine, which is designed and housed in conjunction with the drier usually in a Dutch barn type building. Although both picking machine and drier are designed to run continuously this is seldom possible in practice as the picking machine has invariably to be stopped once or twice during the day to clear obstructions and the machine is not usually run at night. It follows, therefore, that the drier cannot normally be operated continuously for long periods, and this rather detracts from its efficiency.

The responsibility for running the kilns has to be in the hands of a trained engineer. Very little is left to chance and, with a crop as valuable as this, only the best is good enough.

SOME AGRICULTURAL ENGINEERING ASPECTS OF THE WESTERN NIGERIA FARM SETTLEMENT SCHEME

(*Condensed Paper)

by A. SEAGER, B.SC. (AGRIC.) A.M.I.AGR.E. †

The Land Settlement Scheme

Nearly 90% of the population of Western Nigeria is engaged on the land, mainly in little more than subsistence farming, although also in producing cash crops such as cocoa, rubber and palm oil. The Land Settlement Scheme was launched by the Government in 1959-60 to establish a number of well-run demonstration farms to act as foci for future development and to show that farmers can attain a standard of living in every way comparable with town life. In this way it is hoped to help arrest the flood of school-leavers of 8-10 years basic education competing in the towns for white-collar jobs.

Thirteen widely-separated sites were chosen as demonstration farms, to cover as wide an area as possible, notwithstanding the problems of remoteness and lack of access roads. Five Farm Institutes were set up to provide craft training for the workers required to staff the new developments.

In planning this work the Food and Agriculture Organisation (F.A.O.) team called in to advise encountered many problems having a bearing on agricultural engineering. In the broadest sense these problems could be said to involve the provision of the best physical environment for crop growth that can be achieved in given climatic and soil conditions. The allied range of problems of selection of crop varieties and cultural practices is largely that of the agronomist.

The problems with which the agricultural engineer is concerned can be listed as follows:—

1. Selection of the most suitable land for the crops chosen, under given conditions.
2. Selection of methods and equipment for the initial clearance of land.
3. Selection of methods and equipment for cultivation of the crops concerned.
4. Protection of the land, under the conditions of its use, from erosion and degradation.
5. Selection of techniques and equipment for crop protection, weed control and the maintenance of fertility.
6. Problems of harvesting, transport and storage.
7. Training personnel in the operation, maintenance and repair of the mechanical equipment to be used.
8. Selection of and installation of whatever grading and processing equipment may be commercially desirable to enable the settlement community to earn the maximum income.

Many other factors of farm management, Government policy or of a social or economic nature have also to be considered by the planning team, but are outside the scope of the agricultural engineer.

In the case under discussion the average farm size was 20 acres where tree-crops were to be grown and two tree-crops only were permitted on each settlement. Arable settlements were of about 70 acres, including some 20 acres of communal fuel plantations and grazing land.

The Selection of Land for Settlements

Land offered by communities, for development by settlers from the community concerned was first surveyed from aerial photographs. The topography was determined from these and the soil types were grouped, to be confirmed by investigation on the ground. If these preliminary investigations showed promise a detailed soil survey was carried out where possible, maps were prepared and the land classified as to its suitability for crops. The size of farms and number of potential holdings could also be assessed, as well as the number of settlers for which it would provide, and the size and site of a village to accommodate them. The latter should be as central as possible, subject to the availability of water supplies. In some other African countries farmers tend to live on their farms, but the village system fits better into the Western Nigerian social framework and a village size of not less than 75 settlers was adopted, with a maximum of 200. Transport to the farms would be provided by tractor and trailer.

After selecting the village site, the road network is designed. Wherever possible roads were placed on watersheds to minimise the need for culverts and bridges. Maintenance should be within the scope of a farm tractor and grader. The road system forms a useful skeleton for subdivision of the land into farms, which should, as far as possible, be in consolidated blocks. For some crops, however, such as irrigated citrus or marginal oil palm areas, conditions may not be suitable for consolidation. Once the farms are designated, the boundaries of the areas for different tree crops are laid down, in relation to soil type and topography. These boundaries must be checked carefully on the ground, and marked accordingly.

Selection of Equipment for Land Clearance and Cultivation

Land clearance requirements vary according to the type of crop to be grown:—

ARABLE crops:
Complete clearance and stump removal

CITRUS crops:
Clear felling at ground level and removal of all felled material, followed by establishment of a leguminous cover crop.

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* The original may be obtained on loan from the Institution's Library.

† Formerly F.A.O. Agricultural Engineering Specialist on the Western Nigeria Land Settlement Team.

COCOA:

Partial clearance and burning of cleared material (it is not necessary to remove all tree trunks).

OIL PALM OR RUBBER:

Clear fell, remove as much trash as possible and establish leguminous cover crop.

While clearance for arable crops would appear to be the most expensive of these processes, in fact this was not so since it was only in sparsely-wooded savannah country that such crops could become main enterprises. Elsewhere no more than 2 or 3 acres of arable crops would be grown by each settler. Much of the clearance of areas for arable crops could be done by a large crawler tractor with a bulldozer blade. Where there is no grass cover, as under secondary bush, a bulldozer blade does not pile up the topsoil. A few large trees should be left for shade in any case, but if necessary tree roots can be dug out and the tree uprooted with the same equipment.

After these general considerations affecting land clearance, the thoroughness of clearing will depend on the degree of mechanization required. This in turn depends on the labour distribution on the holding and on whether mechanization is required actually to replace manual labour or to enable it to be more efficiently used. Primary cultivations—ploughing and ridging—are mechanized both for reasons of technical efficiency and of time-saving, but on settlements with small areas of arable crops it has been shown that there is little need to mechanize planting and weeding since these operations take place when the labour demand from the associated tree-crops—cocoa, citrus and sometimes oil palm—is small.

Since land cleared by bulldozers tends to be littered with sharp broken-off stumps there is the risk of severe damage to pneumatic tractor tyres and to mounted implements, unless they are very carefully used. Inter-row work is impossible, but this is not important. Steel wheels or tracks may be used, together with trailer ploughs and spring couplings. With continued cultivation over a period of a few years, conditions improve so that tines and pneumatic tyres can eventually be used.

Primary forest can be cleared mechanically, but experience on the Lake Kariba project and in Nigeria has shown hand felling and burning to be cheaper; while a large labour force is required, this is not an objection in Nigeria.

Burning is only possible if it is carefully timed, and removal of the forest canopy, admitting light to areas of former gloom, encourages a tremendous growth of bush and scrub seedlings which would smother any comparatively sparsely-planted tree crop. This situation could be dealt with in several ways. One was to sow a leguminous cover crop such as a mixture of *Centrocima pubescens* and *Pueraria phaseolides*. Such a legume crop was well suited to the condition of the surface soil after a hot fire, when many weed seeds had been destroyed. It would spread and cover unburned tree trunks, keeping them damp and encouraging rotting. After ten years practically no trunks or dead stumps would be left. The only weeding required would be ring weeding of oil palms, and either ring weeding or clearing the avenues of rubber trees.

A second method was devised by Gunn at the West African Institute for Oil Palm Research (W.A.I.F.O.R.) near Benin. Since *Centrocima* and *Pueraria* are indigenous in Western Nigeria they can be encouraged by cultural practices. Gunn used a Marden roller at frequent intervals—an implement similar to a heavy, ribbed bracken crusher—to roll the avenues between the crop trees. In due course the indigenous legume cover establishes itself and the avenues become smooth enough to allow the use of tractors and trailers for palm fruit collection. The residue after burning must be piled between the avenues and trees must be cut off at ground level in the avenues to permit these operations. The only other problem is to devise frond lifters to lift the fronds of young palm trees clear of the roller[1].

Another weed control method, applicable to the early stages of growth of the tree crops, is to use the avenues for the growth of food crops such as ground nuts or cassava, or for the grazing of tsetse resistant cattle.

The preparation of land for citrus crops calls for similar measures. Provisions must be made for machinery and transport equipment to pass through from the earliest stages, as orchard sprayers, mounted on pneumatic tyres are required from the outset. Later on, heavily-laden trailers will be required to transport a crop of 10-15 tons/acre, all within a month. Since the quantities are much smaller, transport is not such an important problem with rubber or oil palm cultivation.

Land preparation in the savannah areas for arable crops presents quite different problems. Trees are smaller and sparsely distributed, the principal ground cover being tall or short grass: depending on the length of time since the land went out of cultivation. Some trees could be left for shade purposes: others were pulled out and stacked on the boundaries, but were soon used as fuel. The total cost of the necessary clearing and de-rooting in Nigeria was about £6 per acre.

The main difficulty in these areas is the disposal of the heavy grass cover. The soils are abrasive, and a heavy wheeled tractor pulling a heavy disc-harrow or plough-harrow is the most suitable equipment for disposal of the grass cover and preparation of the soil for arable cropping.

Prevention of Erosion and Soil Degradation

Soils in Western Nigeria are mainly open-textured and very permeable, and crop yields may be very low; maintenance of fertility is difficult. Bad soil structure is probably the major factor, and—in his role as soil conservationist—the agricultural engineer can only suggest long periods of rest under crops which will restore a desirable structure to the soil, such as grass—which must be grazed—repeated crops of sunhemp, which must be disced into the soil, or pigeon peas. Judicious fertiliser application is also beneficial.[2]

Soil degradation does not occur under tree crops, and yield will not diminish in the same way. Fertilisers can be used to increase yields, the limitations being economic rather than problems of soil management.

Soil loss due to erosion is not quite such an important factor. In Western Nigeria violent and prolonged storms are uncommon, and the risk of erosion where land use necessitates large exposed areas is reduced by the high percolation rate of soil.

A catenary field layout, with subdivision into as many strips as there are courses in the rotation—at present eight—will normally achieve complete prevention of erosion. Farm boundaries—running up the slope—are divided into eight equal lengths and catenary boundary lines are drawn across the slope to connect with corresponding points on the next farm boundary. Such lines of subdivision do not necessarily follow the contour lines, but are likely to follow soil boundaries sufficiently to provide uniform fields and also to allow implements to be used in long bouts, crossing farm boundaries.

Strips under cultivation will alternate with those planted with a resting crop, and skilled timing of operations should avoid having two adjoining strips bare at the same time. Any incipient erosion will be arrested in the strip immediately below.

Cultivation methods have an important effect on soil erosion. If the tilth is too fine, which is often difficult to avoid, or if the land is not ridged before planting, rill erosion or even slight gulley erosion will occur on all but the flattest land. Ridging appears to provide a complete answer so long as the ridges lie across the principal slope. It is not essential for them to lie on the contour. Planting should therefore be done on ridged land, or land ridged up as soon as possible after planting. Ridges make mechanization of weeding operations more difficult and a balance must be struck between the danger of erosion of land that is unridged and the maximum control of weeds.

With tree crops there is no bare land and erosion is not anticipated. It could take place in rubber plantations if the avenues were planted straight up- and down-hill: this is not necessary; if it were, erosion could still be controlled by ring-weeding instead of clearing the whole avenue.

Crop Protection

More problems are encountered with cocoa than with citrus crops; arable crops are not normally subject to pest and disease attack. Control of the pests and diseases of citrus crops requires frequent applications with a standard orchard sprayer, at both high and low volume.

Cocoa must be sprayed with chlorinated hydrocarbons, at either low or high volume, to control capsids; this can be done by one man with a motorised knapsack mist blower at up to 15 acres per day. No settler is likely to have an area of cocoa larger than 15 acres, and therefore one carefully chosen day, at a period when weather conditions are normally suitable for spraying work, is all that is required.

For blackpod disease of cocoa, however, copper must be applied, at high pressures and high volume, during the height of the rainy season and at intervals not exceeding 3 weeks. With a manually-operated knapsack sprayer the application rate is only 2 acres/man/day; with a motorised low-volume mist-blower up to 6 acres/man/day can be treated, but with significantly poorer disease control and with consequent loss of marketable crop.

The mechanization of high-volume copper spraying is hampered by the low-branching habit of the currently-grown Amazon cocoa, grown in rows only 10 ft wide. A normal orchard sprayer, as used for citrus crops, cannot pass down these rows. One alternative is a low-clearance engine, pump and tank unit which is pulled manually or by a donkey along every sixth avenue. Two 30-ft spray lines are fitted, each mounted on a reel and manned by one operator. Each operator can spray three rows of trees on his side of the machine, covering six trees from one position of the unit, which is moved in 20-ft stages.

An alternative method is to use a much larger unit equipped with four 300-ft hoses, which would operate from a road or prepared track. Each of four operators could then deal with 30 trees each side of the machine, and tracks would be made in the coca every 600 ft, allowing a 20-ft alley for the machine.

Weed Control

Weed control is a problem with arable crops and with all tree crops, especially in the early stages of growth. Reference to control measures applicable to citrus crops, oil palm and rubber has already been made under the heading of land preparation. In cocoa plantations weeds consist mainly of regenerating undergrowth which must be slashed by hand twice a year in the early stages and then once annually. Eventually, when a full thick canopy is established and a mulch of fallen cocoa leaves accumulates, no further weeding is necessary.

With each farmer in arable areas growing up to 25 acres of arable crops, weed control can be a major task. Hand weeding of maize and sorghum in areas where the rainfall is under 35 in/annum is almost a thing of the past. A crop sewn on a clean seed-bed, or given a pre-emergence spraying, should require only ordinary after-cultivations with cultivator tines or 'L' and 'A' hoes.

In low-altitude wet tropical areas conditions are different. Except for the first crops planted after a burn, indigenous cultivators in these areas plant their crops on mounds or ridges. This is done to make the maximum use of the shallow topsoil and to give some protection against the leaching-out of plant foods. Although it is quite possible to grow crops without soil at all, by applying heavy dressings of fertiliser or organic manure, perhaps aided by irrigation, such methods are likely in Nigeria to be of future interest only.

At present it appears best to follow the traditional method as closely as possible and to plant on ridges, by hand if necessary, although many tool bar planters can be adapted for ridge work. It is interesting to note that this agrees with the requirements for erosion control mentioned earlier. Planting on freshly-made ridges is itself a weed control measure which, with attention to other points of detail such as well-lined and careful inter-row cultivations and moderate fertiliser use, enable acceptable yields of maize to be obtained. It is possible that sorghum grown for stockfeed under similar conditions could produce more starch equivalent per acre than maize—a point that requires further investigation.

Harvesting, Transport and Storage

It is only on arable crop settlements that mechanical harvesting can be considered. Maize crops of under 1 ton/acre are not easily gathered by currently available harvesters, due to the small cob size. Combine-harvesters with maize heads are likely to be adapted for sorghum and legume crops in the near future, as well as dealing with maize crops that are heavy enough.

Storing the harvested crop provides the major problem and on a settlement scale the quantities involved make artificial drying essential. Small quantities can be dried on the ground, or in cribs or in tray or in-sack driers: all these methods are slow, and the last two require operating skill to obtain drying to the correct level. Continuous driers now being installed are designed to give consistent results with the minimum of skilled attention. Simplicity and reliability are essential since the relative humidity in August, when the main crop is harvested, is 90% or more.

The engineering problems of harvesting tree crops are at present those concerned with transport. With citrus crops, up to 15 ton/acre has to be gathered each year, within a period of a month, and careful handling is required to avoid bruising. Rubber is not suited to mechanical harvesting; the trees yield continuously and are tapped on alternate days by the settlers, who carry the latex to collecting centres in the villages.

Oil palm yield under two ton/acre/annum, during a period of 10 months. Tractors and small trailers (to avoid bogging-down in soft conditions) can collect the crop either from farm boundaries or from the foot of the trees in the avenues, depending on the availability of hand labour for harvesting and transport. In the latter case the use of a knife roller for avenue maintenance is desirable.

Cocoa yields up to 10 cwt/acre of dry beans in two harvest peaks. Half the crop is harvested in October, a quarter in March and the rest in the period between October and March. The pods are normally fermented in the field and only the wet beans are carried home for drying—amounting to 1 ton/acre/annum, at most. A bicycle is a necessity for each settler, and a tradesman's bicycle fitted with a light container is ideal for small-quantity transport work and for carrying rubber latex. Such equipment enables the settler to move the cocoa crop without mechanical aid except during the October peak. Then, and perhaps at some other times of year with crops of 10 acres or more to deal with, a system of wooden boxes—clearly labelled with the farmer's name or number—and tractor and trailer transport from plantation to village, is adopted. Drying and sacking-up the dried beans is then carried out in the villages.

Use, Maintenance and Repair of Farm Machinery

An important and difficult task confronting the agricultural engineer is to train operators in the use and routine maintenance of farm machinery and to organise their repair and overhaul. The background of the people concerned is a vital factor in this.

The farmers of the world can be divided into those who use or have used animal power for cultivating their land and those who do it by hand—respectively, the nomadic stockman turned farmer and the forest-dweller—gatherer of fruits and roots—turned farmer. Because their country is covered by forest in which the tsetse fly still lives, the people of Western Nigeria belong to the latter group. They cannot keep working animals.

This simple distinction has a most important implication. The stockman has a feeling for things outside himself and his fellows—a feeling which did not have to develop in the forest-dweller. The concept of looking after things thus became part of the stockman's nature—unless he looked after his animals he faced starvation and death; whereas, when the forest-dweller broke the pointed stick which was his main farming tool, he could merely pick up another one.

At a later stage, the stockman's farm machinery consisted of a pair of oxen and a bar-point plough, together worth about £15 today. At the same time the forest-dweller took to the digging hoe, worth some 10/-. This gave him much less—in fact, 30 times less—incentive to look after his capital equipment than the stockman. To keep his equipment going the stockman required a certain amount of inventiveness and he developed a sense of feeling and care for his equipment to a very much higher pitch than the forest-dweller.

In present-day Nigeria the picture is different, at least on the surface. The people have had many years of proximity to modern life and the younger generation is almost universally educated. There is thus the basis for understanding the needs of modern equipment, on an intellectual level. But this is not so subconsciously; proper use and maintenance is not due to a feeling for the equipment, but to fear of superiors.

The problem is aggravated by the fact that the present machine operators are not settlers, who ultimately would have to bear the financial consequences of their actions. They are at present employed in the Government-run service, which will eventually be handed over to settlement co-operatives. At present no other solution is possible—even in the arable areas the scale of operation is not large enough to justify a settler purchasing any of the current machinery; nor are there any repair facilities except those in Government hands. One can only speculate on the trend of future development and on ways of creating in the mind of the man on the tractor seat the attitude to equipment which seems so essential.

One possible hope is on the lines of the 3-wheeled tractor recently developed by the National Institute of Agricultural Engineering. It might be justifiable for each arable settler to have a machine of this type, and for groups of settlers to own one in the tree crop areas. An alternative would be a Government, co-operative or private contracting service, which could provide the facilities required if it could be run cheaply enough. However, experience with co-operative ownership is not encouraging. It is interesting to note that in the whole Farm Settlement scheme it was in dealing with human or sociological factors that the agricultural engineer came nearest to despair, while problems concerning land, weeds or vegetation could be tackled successfully, it was in the field in which the most authoritative advice and recommendation could be given—the organisation, management and use of equipment—that most difficulty was encountered, especially in practical operation at the lower levels.

It seems clear that the Government must set up the maintenance and repair service and arrange for the necessary training of fitters; the drivers, trained by the Agricultural Engineering Division, carry out daily and weekly maintenance routines. While resident fitters are required in the arable areas, with their larger tractor populations, they are not yet necessary in the tree crop areas. A travelling inspection service is available for routine visits, carrying reconditioned replacement units which cannot economically be stored in the settlements. This service is backed by area workshops, which recondition such units and also take in complete machines for routine overhauls. An extensive base workshop undertakes major repairs.

In fact, for implements the replacement of worn parts is more often needed than repair, and can be done by the routine inspecting unit. For major repairs—e.g. welding—implements will be taken to the workshops.

The successful operation of this service depends on the twin factors of training and the goodwill of the trainees, backed by discipline, rather than simply on good organisation. Again sociological factors exert an overriding influence.

The task is a serious one. On the one hand, no corporate organisation can provide an uneconomic service indefinitely. On the other hand, the settler must not be compelled to lower his standards, or even fail in his enterprise, for reasons beyond his control—which would result from cessation of the services referred to.

Little other than an outline of a great and many-sided task has been described, and every single facet needs careful thought and has to be planned to the last detail. It involved close teamwork and co-operation, and the fact must be acknowledged that this was appreciated and was readily forthcoming from all the senior technical and administrative officers of the Nigerian Western Region Government.

The writer further wishes to thank Mr Lars Stenstrom of the Food and Agriculture Organisation for his many helpful suggestions in the production of this paper, and to thank F.A.O. for permission to publish it.

REFERENCES

[1] See 'World Crops', January and February, 1966.

[2] For a description of these conditions see Publication 12/13 of the International Training Centre in Aerial Survey, Delft, Holland, by W. C. Verboom.

Obituary

Council records with regret the death of the following members:

A. NEALE, M.I.AGR.E.

H. H. WILDER, M.I.AGR.E.

E. S. EKERS, A.M.I.AGR.E.
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West Midlands Branch of the Institution and served on the Committee
of that Branch during the last year

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