ROTHAMSTED
RESEARCH

Rothamsted Report for 1932

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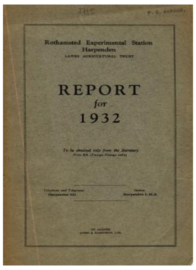

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Rothamsted Research (1933) *Default Title ;* Rothamsted Report For 1932, pp -1 - 228 **- DOI: https://doi.org/10.23637/ERADOC-1-64**

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for
1932

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The Rothamsted Laboratories for Soil and Plant Nutrition, Erected 1914-1916

REPORT
FOR
1932

Contents

Experimental Station Staff

JANUARY—DECEMBER, 1932.

Director : Sir E. John Russell, D.Sc., F.R.S.
Assistant Director : B. A. Keen, D.Sc., F.Inst.P.

The James Mason Bacteriological Laboratory—

Head of Department	H. G. Thornton, B.A., D.Sc.
Assistant Bacteriologist	Hugh Nicol, M.Sc., Ph.D., A.I.C.
Laboratory Assistant	Sheila Arnold
Laboratory Attendant	Molly Johnson

Botanical Laboratory—

Head of Department	Winifred E. Brenchley, D.Sc. F.L.S.
Assistant Botanist	Katherine Warington, M.Sc.
Laboratory Assistant	Kathleen Dellar
Laboratory Attendants	Marjorie Messenger Florence Luck

Chemical Laboratory—

Head of Department	E. M. Crowther, D.Sc., F.I.C.
Assistant Chemists	R. G. Warren, B.Sc. H. L. Richardson, M.Sc., Ph.D., A.I.C. Signe G. Heintze, Mag. Phil.
Post - Graduate Research Workers	A. Walkley, B.A., B.Sc. E. R. Orchard, B.Sc. (Agric.) B. S. Ellis, M.Sc. S. P. Aiyer, B.A.
Barley Investigations Institute of Brewing Research Scheme	L. R. Bishop, M.A., Ph.D. F. E. Day, B.Sc., F.I.C. Doris R. M. Marx, M.Sc.
Special Assistant	E. Grey
Laboratory Assistants	A. H. Bowden F. J. Seabrook G. Lawrence H. A. Smith J. W. Dewis
Laboratory Attendants	Muriel Russell Alice Kingham

Laboratory for Fermentation Work—

Head of Department	E. H. Richards, B.Sc., F.I.C. (Iveagh Research Chemist)
Assistant Chemist	S. H. Jenkins, M.Sc., Ph.D., F.I.C.
Post - Graduate Research Workers	A. G. Norman, D.Sc., F.I.C. J. G. Shrikhande, M.Sc.
Laboratory Attendant	Mabel Payne

Laboratory for Insecticides and Fungicides—

Head of Department	F. Tattersfield, D.Sc., F.I.C.
Assistant Chemist	J. T. Martin, Ph.D., A.I.C.
Laboratory Assistants	P. C. Bowes Irene Randall
Laboratory Attendant	Molly Johnson

General Microbiology Laboratory

Head of Department	D. Ward Cutler, M.A., F.L.S., F.Z.S.
Assistant Microbiologists	Lettice M. Crump, M.Sc., F.Z.S. N. W. Barritt, M.A. Annie Dixon, M.Sc., F.R.M.S. Jane Meiklejohn, Ph.D.
Post-Graduate Research Worker	J. D. Newton, Ph.D.
Laboratory Assistant	Mabel Dunkley
Laboratory Attendant	Constance Hull

Physical Laboratory—

Head of Department	B. A. Keen, D.Sc., F.Inst.P.
Colloid Physicist	R. K. Schofield, M.A., Ph.D. (Empire Cotton Growing Corporation Soil Physicist)
Assistant Physicists	G. W. Scott Blair, M.A. (Goldsmiths' Company Physicist) G. H. Cashen, M.Sc. E. W. Russell, M.A.
Post - Graduate Research Worker	J. M. Albareda
Assistant	Jessie Walker
Laboratory Assistants	W. C. Game R. F. S. Hearmon
Laboratory Attendants	H. Gibson Stella Ward

Statistical Laboratory—

Head of Department	R. A. Fisher, M.A., Sc.D., F.R.S.
Assistant Statisticians	F. Yates, B.A. A. Margaret Webster, B.A.
Post-Graduate Research Workers	R. S. Koshal, M.Sc. C. Stuart Christian, B.Sc.
Assistant Computers	A. D. Dunkley Florence Pennells Kitty Rolt

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Head of Department	C. B. Williams, M.A., Sc.D.
Assistant Entomologists	H. F. Barnes, M.A., Ph.D. H. C. F. Newton, B.Sc., A.R.C.S.
Laboratory Assistant	Edith Cooper
Laboratory Attendant	Elizabeth Sibley
Bee Investigations—	
Apiarist	D. M. T. Morland, M.A.
Apicultural Assistant	A. C. Rolt

Plant Pathology Laboratory—

Head of Department	J. Henderson Smith, M.B., Ch.B., B.A.
Assistant Mycologist	Mary D. Glynne, M.Sc.
Bacterial Diseases	R. H. Stoughton, D.Sc., A.R.C.S., F.L.S.
Virus Diseases: Special Staff — Empire Marketing Board Scheme:	
Physiologist	J. Caldwell, B.Sc., Ph.D.
Cytologist	Frances M. L. Sheffield, Ph.D., F.L.S.
Entomologist	Marion A. Watson, Ph.D.
Glasshouse Superintendent	Margaret M. Browne
Post-Graduate Research Worker	C. Joan Gibson, B.A.
Laboratory Assistant	Edna Evenett
Laboratory Attendant	Elsie E. Hunt
Glasshouse Attendant	Nancy Moules

FIELD EXPERIMENTS

Guide Demonstrators	H. V. Garner, M.A., B.Sc.
	E. H. Gregory
Plant Physiologist	D. J. Watson, M.A., Ph.D.
	Prof. W. Southworth
Field Superintendent	B. Weston
Assistants	G. F. Cole
	S. A. W. French
	G. Wilcock
Plant Physiologists for Special Experiments (Imperial College of Science and Technology)	F. G. Gregory, D.Sc.
	A. T. Legg
	F. J. Richards, M.Sc.
Field Assistant	G. W. Messenger
Laboratory Attendant	Kathleen Keys

FARM

Director	H. G. Miller, B.Sc.
Assistant	J. R. Moffatt, B.Sc., N.D.A.
Bailiff	H. Currant
Ploughmen	F. Stokes
	F. A. Lewis
Shepherd	T. Dow
Stockmen	J. McCallum
	A. J. Smith
Pig Experiments	T. J. Lewis
Tractor Driver	J. Underhill
Labourers	W. Holland
	H. Hewitt
	J. Cain

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Librarian	Mary S. Aslin

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Assistant Secretary	Constance K. Catton
Director's Private Secretary	Annie E. Mackness
Senior Clerk	Beatrice E. Allard
Junior Clerks	Nora Leverton
	Rose Robinson
	Olive Munt

Photographer	V. Stansfield, F.R.P.S.
Laboratory Steward and Storekeeper	A. Oggelsby
Engineer and Caretaker	W. Pearce
Assistant Caretaker	F. K. Hawkins

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Woburn Experimental Farm

Hon. Local Director ..	J. A. VOELCKER, C.I.E., M.A., Ph.D.
Assistant Director ..	H. H. MANN, D.Sc., F.I.C. (Kaisar-i-Hind Gold Medal)
Chemist	T. W. BARNES, M.Sc.
Laboratory Assistant ..	R. DEACON

FARM STAFF

Assistant Manager ..	T. C. V. BRIGHT
Ploughman	G. TYLER
Stockman	W. McCALLUM
Assistant Stockman ..	D. McCALLUM
Labourers	K. McCALLUM W. McCALLUM

Members who have left between 1st January and 31st December, 1932, and the Appointments to which they proceeded

W. B. BRIERLEY, D.Sc., F.L.S.	Professor of Agricultural Botany, Reading University

TEMPORARY WORKERS, 1932

In addition to those temporary workers recorded in the list of staff, the following sent officially by Governments or Universities, or coming on their own resources, have worked at the Station for various periods during the year 1932:

(1) FROM THE EMPIRE:
Colonial Office Agricultural Officers: Dr. Ian A. Black (Nyasaland), F. McNaughtan (Kenya), R. K. S. Murray (Ceylon) P. E. Turner (Trinidad).
Canada: J. W. Hopkins, D. MacClement.
Ceylon: T. Eden.
India: J. A. Daji, R. J. Kalamkar, T. R. Narayan, P. N. Sahai, Dr. V. S. Sharga, J. Singh.

(2) FROM FOREIGN COUNTRIES:
Denmark: G. T. Detlefsen, F. C. Ravnkilde.
Egypt: R. E. Chapman.
Finland: A. Jänetti.
Germany: Miss S. de Regel.
Holland: M. Rosanoff, W. C. Visser, J. B. H. Ydo.
Sweden: I. Backér, Dr. J. Rasmussen.
United States of America: Dr. S. A. Stouffer.

(3) FROM BRITISH ISLES:
H. B. Bescoby, H. J. Buchanan-Wollaston, W. G. Eggleton, E. H. Gridley, R. O. Iliffe, B. Rees Jones, E. V. Knight, L. M. J. Kramer, G. C. Marshall, Miss G. W. J. Martyn, G. B. Masefield, J. C. G. Mellars, Dr. Margot E. Metcalfe, J. E. T. Morris, G. W. Otter, R. A. Taylor.

Imperial Bureau of Soil Science

Director: Sir E. J. Russell, D.Sc., F.R.S.

Deputy Director: G. V. Jacks, M.A., B.Sc.

Scientific Assistants: A. J. Lloyd Lawrence, M.A., Helen Scherbatoff.

Assistant Abstractor: Janet N. Combe

Private Secretary: Mona B. Staines

Clerk: Lucy Arnold

The function of the Bureau is to assist workers in soil science throughout the Empire by providing technical information, by promoting contact between them, and by rendering any technical assistance possible when they are in this country. To facilitate its work, the Bureau seeks to be well informed as to the personnel engaged in soil work in the Empire and the problems on which they are engaged. Each Government has been requested to nominate one of its staff as Official Correspondent to the Bureau, who will act generally as liaison officer in Bureau matters and assist in the collection and distribution of information. The issue of technical information is not confined to Official Correspondents, but extends to all workers in soil science who ask the assistance of the Bureau. Special arrangements have been made to get in touch with Forest Officers interested in soil problems.

Publications of the Rothamsted Experimental Station

For Farmers

"MANURING FOR HIGHER CROP PRODUCTION," by Sir E. J. Russell, D.Sc., F.R.S. 1917. The University Press, Cambridge. 5/6.

"ARTIFICIAL FERTILISERS IN MODERN AGRICULTURE," by Sir E. J. Russell, D.Sc., F.R.S. Bulletin No. 28, Ministry of Agriculture and Fisheries, Second Edition revised 1933. H.M. Stationery Office, or from the Secretary, Rothamsted Experimental Station, Harpenden. Cloth, 4/6 post free ; or paper cover, 3/5 post free.

"WEEDS OF FARMLAND," by Winifred E. Brenchley, D.Sc., F.L.S. 1920. Longmans, Green & Co., 39 Paternoster Row, London, E.C.4. 12/6.

ROTHAMSTED CONFERENCE REPORTS ; being papers by practical farmers and scientific experts. Obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

"THE MANURING OF POTATOES." 1/6.
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Numbers 1 to 15 inclusive are also published in book form :— Vol. I (1-5), Vol. II (6-10), Vol. III (11-15), 10/- each, postage extra.

*Out of print in separate copies.

For Students and Agricultural Experts

"THE ROTHAMSTED MEMOIRS ON AGRICULTURAL SCIENCE." Octavo Series, vols. 1-7 (1847-1898), 30/- each. Royal octavo, vol. 8 (1900-1912), vol. 9 (1909-1916), vol. 10 (1916-1920), vol. 11 (1920-1922), 32/6 each, vol. 12 (1922-1925), vol. 13 (1925-1927), 33/6 each, vol. 14 (1928-1930), 35/-, vol. 15 (1922-1931), vol. 16 (1922-1932), 36/- each. Postage extra. Obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

"The ROTHAMSTED MONOGRAPHS ON AGRICULTURAL SCIENCE," edited by Sir E. J. Russell, D.Sc., F.R.S.

"SOIL CONDITIONS AND PLANT GROWTH," by E. J. Russell, D.Sc., F.R.S. Sixth Edition. 1931. Longmans, Green & Co., 39 Paternoster Row, London, E.C.4. 21/-.

"THE MICRO-ORGANISMS OF THE SOIL," by E. J. Russell and Staff of the Rothamsted Experimental Station, 1923, Longmans, Green & Co., 39 Paternoster Row, London-E.C.4. 7/6.

"MANURING OF GRASSLAND FOR HAY," by Winifred E. Brenchley, D.Sc., F.L.S. 1924. Longmans, Green & Co., 39 Paternoster Row, London, E.C.4. 12/6.

"A LIST OF BRITISH APHIDES" (including notes on their recorded distribution and food-plants in Britain and a food-plant index), by J. Davidson, D.Sc., F.L.S. 1925. Longmans, Green & Co., 39 Paternoster Row, London, E.C.4. 12/6.

"THE PHYSICAL PROPERTIES OF THE SOIL" (with illustrations and diagrams), by B. A. Keen, D.Sc. 1931. Longmans, Green & Co., 39 Paternoster Row, London, E.C.4. 21/-.

"PLANT NUTRITION AND CROP PRODUCTION" (being the Hitchcock Lectures, 1924, University of California), by E. J. Russell, D.Sc., F.R.S. The University of California Press and the University Press, Cambridge. 12/6.

"INORGANIC PLANT POISONS AND STIMULANTS," by Winifred E. Brenchley, D.Sc., F.L.S. Second Edition, revised and enlarged, 1927. The University Press, Cambridge. 10/6.

"RECENT ADVANCES IN ENTOMOLOGY," by A. D. Imms, M.A., D.Sc., F.R.S. (with illustrations), 1930. J. & A. Churchill, 40 Gloucester Place, London, W.1. 12/6.

"A GENERAL TEXTBOOK OF ENTOMOLOGY," by A. D. Imms, M.A., D.Sc., F.R.S. Second Edition, revised, 1930. Methuen & Co., Essex Street, Strand, London, W.C.2. 36/-.

"SOCIAL BEHAVIOUR IN INSECTS," 1931, by A. D. Imms, M.A., D.Sc., F.R.S. Methuen's Monographs on Biological Subjects, 3/6.

"STATISTICAL METHODS FOR RESEARCH WORKERS," by R. A. Fisher, M.A., Sc.D., F.R.S. Fourth Edition, revised and enlarged, 1933. Oliver & Boyd, Edinburgh. 15/-.

"THE COMPOSITION AND DISTRIBUTION OF THE PROTOZOAN FAUNA OF THE SOIL," by H. Sandon, M.A. 1927. Oliver & Boyd Edinburgh. 15/-.

The following are obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts :—

"Agricultural Investigations at Rothamsted, England, during a Period of 50 Years," by Sir Joseph Henry Gilbert, M.A., LL.D., F.R.S., etc. 1895. 3/6.

"Guide to the Experimental Plots, Rothamsted Experimental Station, Harpenden." 1913. John Murray, 50 Albemarle Street, W. 1/-.

"Guide to the Experimental Farm," Rothamsted.

"Guide for Visitors to the Farm and Laboratory." Woburn. 1929.

"Catalogue of Journals and Periodicals in the Rothamsted Library." 1921. 2/6.

"A Descriptive Catalogue of Printed Books on Agriculture from 1471 to 1840, contained in the Rothamsted Library" (including Biographical notices of the author and short descriptions of the important books). 1926. 331 pp. 22 illustrations. Cloth cover, 12/- ; paper cover, 10/-. Packing and postage extra :—British Isles, 9d. ; Overseas, Dominions and other countries, 1/3.

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For use in Farm Institutes

"A Student's Book on Soils and Manures," by E. J. Russell, D.Sc., F.R.S. The University Press, Cambridge. 8/-.

For use in Schools

"Lessons on Soil," by E. J. Russell, D.Sc., F.R.S. 1926. The University Press, Cambridge. 3/-.

For General Readers

"THE FARM AND THE NATION," by E. J. Russell. 1933. George Allen and Unwin, Ltd. 40 Museum Street, London, W.C.1. 7/6.

"THE FERTILITY OF THE SOIL," by E. J. Russell. The University Press, Cambridge. 4/-.

"THE POSSIBILITIES OF BRITISH AGRICULTURE," by Sir Henry Rew, K.C.B., and Sir E. J. Russell, D.Sc., F.R.S. 1923. 1s. Obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts,

"PERSONAL REMINISCENCES OF ROTHAMSTED EXPERIMENTAL STATION," 1872-1922, by E. Grey, formerly Superintendent of the Experimental Fields. 5/-. Obtainable from the Secretary Rothamsted Experimental Station, Harpenden, Herts.

Other Books by Members of the Staff

"EVOLUTION, HEREDITY AND VARIATION," by D. W. Cutler, M.A., F.L.S. 1932. Christophers, 22 Berners Street, London, W.1. 4/6.

"THE GENETICAL THEORY OF NATURAL SELECTION," by R. A. Fisher, M.A., Sc.D., F.R.S. 1930. Clarendon Press, Oxford, 17/6.

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Mezzotint Engravings of Portraits of the Founders of the Station, Sir J. B. Lawes (H. Herkomer) and Sir J. H. Gilbert (F. O. Salisbury), by Julia Clutterbuck, A.R.E.

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Plans and Drawings of the old Rothamsted Laboratory, 1852

These drawings show the old Rothamsted Laboratory erected in 1851, the first important laboratory devoted to agricultural science, and the one in which much of the classical work of Lawes and Gilbert was done ; it survived till 1914.

The size of the volume is 21½ in. by 14½ in. ; it consists of four full page lithographs made from drawings by Charles Lawes, son of Sir J. B. Lawes. £1 per copy (post free).

INTRODUCTION

The Rothamsted Experimental Station was founded in 1843 by the late Sir J. B. Lawes, with whom was associated Sir J. H. Gilbert for a period of nearly 60 years. Lawes died in 1900 and Gilbert in 1901 ; they were succeeded by Sir A. D. Hall from 1902 to 1912, when the present Director, Sir E. J. Russell, was appointed.

For many years the work was maintained entirely at the expense of Sir J. B. Lawes, at first by direct payment, and from 1889 onwards out of an annual income of £2,400 arising from the endowment fund of £100,000 given by him to the Lawes Agricultural Trust. In 1904, the Society for Extending the Rothamsted Experiments was instituted for the purpose of providing funds for expansion. In 1906, Mr. J. F. Mason built the Bacteriological Laboratory ; in 1907, the Goldsmiths' Company generously provided a further endowment of £10,000, the income of which—since augmented by the Company—is to be devoted to the investigation of the soil. In 1911, the Development Commissioners made their first grant to the Station. Since then, Government grants have been made annually, and, for the year 1932-33, the Ministry of Agriculture has made a grant of £26,380 for the work of the Station. Lord Iveagh has generously borne the cost of a chemist and a special assistant for field experiments for studying farmyard manure, both natural and artificial ; while other donors have, from time to time, generously provided funds for special apparatus and equipment. The Fertiliser Manufacturers' Association and the United Potash Company provide considerable funds for the rather expensive field work. Imperial Chemical Industries help to defray the cost of a Guide Demonstrator for the field plots besides helping with the actual cost of the work. In addition, Beet Sugar Factories Committee of Great Britain, Beet Sugar Factories—Anglo-Dutch Group, British Basic Slag, Basic Slag and Phosphates Companies, Messrs. George Monro, the Empire Marketing Board, the Royal Agricultural Society, the Institute of Brewing and the Department of Scientific and Industrial Research make grants for specific purposes. The result is that the Station is able to deal with problems affecting modern farming in a far more complete manner than would otherwise be possible.

The main block of laboratories was opened in 1919, and is devoted to the study of soil and plant nutrition problems ; another block was erected in 1924 for plant pathology at a cost of £21,135 provided by the Ministry of Agriculture out of the Development Fund ; and Red Gables, the house adjoining the laboratories on the north side, has been converted into an Administration Building to hold the Imperial Soil Bureau, part of the Records and Statistical Department, Staff Common Room and Conference Room.

Large glasshouses, including special insect-proof houses for Virus studies, were added in 1926, 1928, and 1931 by aid of generous grants from the Rockefeller Foundation, the Empire Marketing Board and the Ministry of Agriculture.

From 1926 onwards great changes took place on the farm. New and greatly improved methods of field experimentation were adopted n 1926 on all but the classical plots, which remain essentially unchanged; and the non-experimental farm was reorganized in 1928, considerable numbers of live stock being introduced, and much of the land being laid down to grass. The farm buildings were considerably enlarged in 1930 with the aid of a grant of £1,700 given by the Ministry of Agriculture and a new block of buildings containing the demonstration room, work-rooms for the experimental staff, office and store-rooms was erected in 1931-32 at a cost of £1,300 collected by public subscription.

During 1932, the farm was well equipped with electrical appliances, thanks to generous assistance by the General Electric Company and the North Metropolitan Electric Power Supply Company. The Dunlop Rubber Company also provided rubber equipment, including a rubber road, rubber flooring for cattle and pig pens and rubber tyres for cart and tractor.

The Library is steadily growing, and now contains some 24,000 volumes dealing with agriculture and cognate subjects. The catalogue of the old printed books on agriculture was published in 1926, and every effort is made to obtain any that we do not possess. A collection is also being made of prints of farm animals, of old letters on agriculture, and farm account books. Many of these lie in farmhouses, unused and inaccessible, not in themselves valuable, but often of great help to students of agricultural history and economics when brought together as we are doing. Gifts of books and documents to the Library will be greatly appreciated.

The extension of the experiments to various outside centres in Great Britain, begun in 1921, has proved so advantageous that it has been developed. Not only is useful information spread among farmers, but the Station itself gains considerably by this closer association with practical men. As part of this extension, the Station, in 1926, with the consent of His Grace the Duke of Bedford, took over from Dr. J. A. Voelcker the lease of the Woburn Experimental Farm, so that this now becomes a part of the Rothamsted organization, allowing us to make experiments simultaneously on a light and on a heavy soil: a very advantageous arrangement. Through the generosity of His Grace certain necessary changes have been made in the farm equipment, and the grass fields have been grouped and watered for intensive grazing. The Agricultural and Road Machinery Manufacturers' Association also rendered assistance. Harold H. Mann, formerly Director of Agriculture, Bombay Presidency, India, and Agricultural Adviser to H.E.H. the Nizam's Government, Hyderabad, India, is Assistant Director, with T. W. Barnes as Chemist, and the laboratories, pot-culture station and meteorological station have been re-equipped and reorganized. A grant from the Royal Agricultural Society of England has enabled us to appoint an additional assistant in the Statistical Department to prepare the material for a full summary and discussion of the results of the last fifty years of experiments there.

The activities of Rothamsted, however, are not confined to the British Isles, but are gradually spreading out to the Empire and other countries abroad. The International Education Board sends workers from all parts of the world to study in these laboratories. The Empire Cotton Growing Corporation has, since 1923, made a grant of £1,000 per annum for the development of investigations in Soil Physics, while the Empire Marketing Board has recently invited the co-operation of the Station in solving certain agricultural problems of great importance to the Empire.

At the invitation of the proper authorities, the Director and other members of the staff have already visited the Sudan, Palestine, Australia, New Zealand, South Africa, Nyasaland, Tanganyika, and Canada to discuss agricultural problems and possibilities of co-operation ; in addition, visits are paid to the United States and to European countries, including Russia, to discuss problems and methods with experts there, and generally to improve the equipment of the Institution and widen the knowledge and experience of the staff.

More and more workers are coming from the overseas Dominions to carry on their studies at Rothamsted. None but University graduates are eligible, and most are, or are about to be, on the staffs of Government or other Agricultural Departments : men who will become leaders in the agricultural communities of their respective countries. To our great regret, lack of accommodation has compelled us to refuse some who wished to come.

The most important of all these Empire developments was inaugurated in 1929. At the Imperial Agricultural Conference of 1927 it was decided to set up in this country a series of Bureaux to act as central clearing houses of information and to promote interchange of ideas and methods between the agricultural experts of the different parts of the Empire. The Soil Bureau is located at Rothamsted and began operations on May 1st, 1929. A. F. Joseph, late Chief Chemist to the Sudan Government, was appointed Deputy Director ; with H. Scherbatoff and A. J. L. Lawrence as Scientific Assistants. In 1931 A. F. Joseph resigned and his place was taken by G. V. Jacks.

In view of the great expansion of the work in the last ten years, the Committee has deemed it advisable to acquire the sites adjoining the laboratory in readiness for the time when further accommodation will be necessary.

REPORT FOR 1932

The reader may be tempted to ask: why, when farmers are suffering from such a glut of overproduction is it necessary to make further experiments in agriculture? Why cannot we call a holiday from scientific investigation till there is again the possibility of a shortage of food such as always existed till the present time?

The answer is that scientific investigations in agriculture are primarily for the purpose of obtaining information, and this will always be needed so long as farming continues. It is in times of difficulty that exact information about soil, crops and animals is most valuable to farmers, for it enables them rapidly to alter their methods in accordance with the rapidly changing economic conditions. At the present time the need is greater than ever, for the community has now given to farmers a measure of assistance which they have never had before, and it is rightly expected that a high standard of efficiency should be maintained in return.

The Rothamsted experiments have always had as their main purpose this search for information about soils and crops: the work, however, is carried a stage further, and efforts are made to put the information in a form in which it can be used by good farmers, experts, teachers and others interested in the improvement of country life.

The work is done in the laboratories, in the pot culture and glass houses, and on the two farms, the heavy-land farm at Rothamsted and the light-land farm at Woburn. In spite of some curtailment of the Government grant and a fall in subscriptions and donations, it has been possible to continue the work without loss of efficiency, though some important investigations have had to be deferred till the necessary financial provision can be assured. The congestion in the laboratories still remains a serious problem, and the erection of an additional storey for which the architect provided is badly needed.

THE FARM

The arrangements for experimental work at the farm have been greatly improved by the facilities afforded by the new buildings and the new demonstration room has been much appreciated.

The electrical installation at the farm is, for the present, complete. It was formally inaugurated by Sir John Gilmour, Minister of Agriculture, on June 21st, 1932. The scope of the work now in hand is described in the 1930 Report, p. 21.

A sub-station has been erected in the farm buildings, and the high tension supply of electricity led into a 30 K.V.A. transformer. The supply in the buildings is 400-440 volts, three-phase, 50 cycles, used for large-power applications ; and 230 volts, single-phase, used for lighting, heating and small-power applications up to 1 h.p.

The actual equipment, in addition to the complete lighting installation supplemented by two portable electrical lanterns, is as follows :

20 h.p. G.E.C. Witton Portable motor.
5 ,, ,, ,, Drumotor.
2 ,, ,, ,, Fixed motor for sack hoist and cake-breaker.
½ ,, ,, ,, Portable motor.
Direct-driven grinding mill by Harrison McGregor, direct-coupled to a 10 h.p. G.E.C. Witton motor.
Liquid manure pump driven by ½ h.p. G.E.C. Witton motor.
4 h.p. G.E.C. Witton motor, fixed for pumping water ; by means of a float, pumping automatically stops when the tank is full.
Portable groomer and cleaner.
Sterilizing outfit.
Alfa-Laval milking machine, with ½ h.p. motor.
Water-heaters for piggery and sterilising room.
Several special meter-boards for taking consumption readings.

Measurements are now being taken of the number of units of electricity required to do particular operations as compared with the amounts of fuel consumed by internal combustion engines doing the same work. The electrical equipment for this purpose was generously provided by the General Electric Company, while the Royal Agricultural Society made a grant towards the cost of recording.

Observations have been begun on the possible uses of rubber on the farm. Rubber tyres have been fitted to one of the carts ; they so facilitate working that some 50 per cent. additional load is easily carried ; further, they do not cut up the farm roads as the old iron tyres did. Rubber tyres are now being fitted to the tractor. A rubber road has been made in front of the farm buildings ; it has the advantage that it can readily be made clean, and it would set off a model dairy very well. Rubber flooring is being installed in some of the pig sties, cattle stalls and stable.

The head of stock during the past four years has been approximately :

	1929		1930		1931		1932	
	Sep. 30	Sold in last 12 months	Sep. 30	Sold in last 12 months	Sep. 30	Sold in last 12 months	Sep. 30	Sold in last 12 months
Sheep ..	303	85	499	177	447	296	433	336
Pigs ..	99	133	215	78	192	237	286	201
Cattle ..	33	13	27	20	63	24	100	16

For the better provision of food an additional 42 acres of grassland has been rented from the estate.

The farm now consists of 322 acres, used as follows :

Arable.		
	Classical experiments.	29½
	Other permanent experiments.	15½
	Temporary experiments. ..	11
	Non-experimental.	68
Permanent Grass.		
	Classical experiments	7
	Other Grass.	165
	Used for buildings, roads and other purposes	26
	Total	322

During the past five years under H. G. Miller's management there has been a marked improvement in the general appearance of the farm, and in the condition both of the arable and the grass land. Although they are only four or five years old, the new grass fields have already attained a high degree of productiveness, largely as the result of proper grazing and feeding of meal or cake.

The great expansion in the field experimental work is shown by the growth in the number of plots; they were as follows:

1911-12.	1921-22.	1931-32.
250	638	1,408

In addition there are considerable numbers at Woburn and at the outside centres.

STATISTICAL CONTROL OF THE EXPERIMENTS

During its fourteen years of existence the Statistical Department under Dr. R. A. Fisher has had as its chief function the giving of assistance to other departments in the design of experiments and the interpretation of results. Its influence has not only permeated the whole Institution, but has spread far beyond, so that a constant stream of workers from other institutions come here to study the methods and to seek advice about applying them to their problems.

It is perhaps in the field work that the influence of the Department has been most profoundly felt. Three difficulties had always been serious and apparently insuperable: the irregularities of the land on which the experimental plots were set out; the large experimental error attaching to the results; and the fact that the magnitude of the error was unknown. Dr. Fisher has been able to devise experimental methods which are free from these difficulties and yet are practicable; and these methods are now used not only in all the new work at Rothamsted and at Woburn, but in a large number of other field investigations at home and overseas. Several important agricultural colleges and departments now include courses on statistical methods.

Contrary to the earlier belief, it is found that a complex experiment involving a number of questions, gives better results than a single experiment involving one question only: a modern field experiment may include 80, 100 or even more plots. Much theoretical work has had to be done on the principles of experimental design and on the significance of results, as well as on such details as the proper procedure to be adopted when, as occasionally happens, one or more plots in a large set is for some reason spoiled.

Considerable work has been done in tracing relations between crop data and weather conditions. The results are of great scientific interest and of considerable potential value, for they open up the possibility of forecasting yield and quality of crop some long time before the crop is ready for harvesting.

THE MANURING OF CROPS

The new complex field experiments are more laborious and costly to carry out than the old ones, but they give more precise information about fertilisers. Much of this has been embodied in a volume published by the Ministry of Agriculture, entitled *Artificial Fertilisers*. The demand for information on this subject is so great that the first edition was rapidly exhausted, and a second edition has now been prepared.

There is no doubt that farmers, by more judicious use of fertilisers, could obtain larger yields without incurring appreciably more expenditure than they do at present.

SUGAR BEET

A serious effort is being made to improve the position in regard to sugar beet. The present average yield of about 8.5 tons per acre is unnecessarily low, and unless it is improved the industry can hardly survive. Hitherto it has been impossible to make adequate investigations into the manuring and cultivation of sugar beet ; the first stages of a scheme have now, however, been worked out jointly with the factory representatives, and it is hoped that this may be put on a permanent basis.

A usual yield of sugar from sugar beet is 1-1½ tons per acre. On the other hand, a usual crop of mangolds (25 tons per acre) contains 2 tons of sugar per acre, and it is quite easy to push up the yield so as to produce 3 tons of sugar per acre. Seeing that the sugar beet is supposed to be a better source of supply than the mangold, it looks as if there is still plenty of scope for improvement.

At present, unfortunately, we have no indication as to which way the improvement is likely to come. Few trustworthy experiments have been made, and the method adopted till recently of bringing foreign experts over to teach our farmers the Continental cultivations has only limited value because of the wide difference between Continental and British conditions. Straightforward manurial experiments do not get us very far ; indeed, in a number of tests last year the standard dressings based on the earlier guidance did not prove very effective. Sugar beet does not respond in the same way as mangolds to manure ; we still have to discover the proper way of treating the crop so as to get the best results. Some points have already emerged. Nitrogenous manures increase the weight of leaves, a valuable consideration for the stockman, but they do not correspondingly increase the weight of the roots, and they decrease the percentage of sugar, but increase the total weight per acre. Phosphates have less effect than one might expect. Potassic fertilisers are less effective than on mangolds. Salt is beneficial. The effect of fertilisers is summarised in Table I, which includes all the experiments made at Rothamsted, Woburn and the outside centres during the seven years 1926-1932.

TABLE I.—Effect of fertilisers on yield of Sugar Beet : all Centres, 1926-1932.

Nutrient.	Number of Experiments.	Number of Significant		Per cent. of Experiments	
		Increases.	Decreases.	Increases.	Decreases.
Nitrogen—Roots	42	26	0	62	0
Tops	37	27	0	73	0
Sugar %	30	1	17	3	57
Potash—Roots ..	28	11	1	39	4
Tops ..	26	5	0	19	0
Sugar %	24	5	0	21	0
Phosphate—					
Roots ..	19	3	0	16	0
Tops ..	17	1	0	6	0
Sugar % ..	16	0	0	0	0
Salt—Roots ..	9	5	0	55	0
Tops ..	6	3	0	50	0
Sugar % ..	9	2	0	22	0

Average response to fertilisers

	Per cwt. N (as S/A)	Per cwt. P_2O_5 (as super)	Per cwt. K_2O (as muriate)	Salt (per cwt. Cl)
Roots (washed) tons per acre	+2.31	+0.46	+0.51	+0.59
Sugar percentage	−0.56	+0.12	+0.14	+0.22
Total Sugar cwt. per acre ..	+6.9	+1.3	+2.0	+2.6

All the responses are small, showing that the factors we at present control do not play the chief part in determining the crop. This was well brought out in the Rothamsted experiments in 1932, one of which was made in Long Hoos and one in Great Knott field ; both yielded almost exactly the same weight of tops, yet the crop in Great Knott gave nearly double the yield of roots obtained in Long Hoos. The averages for all the plots were :

	Rothamsted.		*Woburn.*	
	Long Hoos.	Gt. Knott.	Stackyard.	Butt Close.
Tops, tons per acre	14.9	14.6	6.33	15.8
Roots, washed, tons per acre	7.2	13.5	6.08	11.9
Roots, per ton of tops ..	0.48	0.92	0.96	0.75
Date of sowing	May 19th	May 19th	May 10th	May 6-12th
Response per cwt. Nitrogen				
Roots, tons ..	−2.01	1.97	−2.04	1.63
Tops, tons ..	0.22	4.84	−3.01	5.58

The two fields are not far apart, and Great Knott is not noticeably better than Long Hoos ; indeed, if there is a difference it is rather the other way ; the same seed was used, and it was sown the same day in both fields ; yet the one crop is the average which we recognise as below what is permanently possible for a successful industry, and the other represents a level that would bring a profit both to the farmer and the factory even if the subsidy should disappear. An attack of wireworm in Long Hoos, necessitating late patching, may account for much of the difference.

At Woburn the results are very similar excepting that the weight of tops on Stackyard is only 6.3 tons per acre ; the two fields are further apart and the soils differ, but we are unable to say what should be done to Stackyard to make it give the same yield of sugar beet as Butt Close.

Where to look for the difference we frankly do not know. Both experiments included a number of variants, but none caused any more than minor differences. In Long Hoos and in Stackyard the manurial dressings per acre are the same ; they varied in the different plots between 0 and 0.6 cwt. nitrogen, 0 and 1.0 cwt. K_2O and 0 and 0.6 cwt. P_2O_5 : 13 different combinations were tried, but all without effect. In Great Knott and in Butt Close the treatment is also the same ; the experiment consists in variations in time of applying the nitrogenous and the other manures, and also variations in the intensity of cultivation. The nitrogenous manures were effective in raising yields, but it was immaterial whether the manures were applied at sowing or three weeks beforehand, or whether half the nitrogen was kept back till the time of singling, though in this case the weight of tops suffered. Intensive cultivation —hoeing every 10 days between the rows—so far from benefiting the crop, reduced the weight both of roots and of leaves, the roots being reduced 1.2 tons and the tops 2.5 tons per acre. No more cultivation was needed beyond that required for keeping down the weeds. Clearly some new kind of experiment is needed different from the old fertiliser trial, and new methods are now being tried at Rothamsted, which if we can obtain the funds to continue them, will, we hope, prove more successful.

One cause of low yields stands out clearly : sugar beet will not tolerate soil acidity. On acid soils the yields are low, and they are raised by the use of calcium carbonate. A spectacular increase was obtained at Tunstall, and one that is perhaps more normal at St. Albans.

	No Chalk	*Chalk, per acre.*				
		1 ton.	2 tons.	3 tons.	4 tons.	S.E.
Tunstall—						
Roots, tons per acre	1.82	12.61	14.30	14.27	14.74	0.432
Tops, tons per acre	1.44	11.79	12.01	13.50	13.32	0.557
Sugar, per cent. . .	18.74	18.72	18.84	18.65	18.79	0.114

	No Chalk.			*Chalk.*	
	No Phosphate	Basic Slag	Super-phosphate	Super-phosphate	S.E.
St. Albans—					
Roots, tons per acre	5.25	6.58	6.68	8.94	0.571
Tops, tons per acre	6.34	7.53	7.67	10.19	0.614

In spite of the acidity of the soil, basic slag was no better than superphosphate, and it was much inferior to superphosphate *plus* chalk.

TABLE II.—Yield of Potatoes in Tons per acre.

		Sulphate of Ammonia			Sulphate of Potash			Superphosphate		
		None.	Increase with.	Quantity of fertiliser used. cwt.	None.	Increase with.	Quantity of fertiliser used. cwt.	None.	Increase with.	Quantity of fertiliser used. cwt.
Potton (earlies) ..	Sand .. (Nitrate of Soda)	5.07	**1.20**	2½	5.56	0.21	2	5.67	0.0	3
Wisbech	Silt ..	11.90	**0.53**	2	12.19	−0.27	2			
			−0.75	4		−0.03	4			
Stanford ..	Gravel ..	11.89	**0.61**	1½	12.26	0.12	1½	12.32	0.14	3
			0.28	3		0.15	3			
	Sand ..	7.26	**1.61**	3	3.95	**4.11**	3	5.88	0.26	4
Little Downham	Fen ..	9.29	**2.07**	2	10.32	0.02	2	8.37	**2.19**	5
									1.49	10
March	Fen ..	3.96	**0.60**	2	4.02	**0.48**	2	3.60	**1.92**	2
Kingennie.. ..	Loam ..	13.58	**0.37**	1						
			0.45	2						
			0.20	3						
Owmby Cliff ..	Limestone				3.79	**1.82**	1			
						0.77	2			
						−0.35	3			

The figures in heavy type are significant. In cases where two or more levels of a fertiliser were applied, the second increment of yield shown is the additional increment given by the heavier dressing as compared with the lighter.

Dung has been given at Potton, Wisbech and Stanford, but not at the other centres.

POTATOES

In the experiments at Rothamsted, Woburn and the outside centres up to the present good results have commonly been obtained with a mixture corresponding to 1 N : 1.5 P_2O_5 : 2.5 K_2O with increased phosphate where the soil is known to be deficient in this substance. In the 1932 experiments at the outside centres the most general response was, as usual, to nitrogen. The average increase in yield given by 1 cwt. sulphate of ammonia was 0.35 tons potatoes per acre, *i.e.* 1 ton of additional potatoes was obtained by an expenditure of 19/- on sulphate of ammonia. All the soils tested, even the fen soils, responded. Most of them responded also to potash ; indeed, on the sandy soil at Stanford nitrogen acted only when potash also was given. The response to phosphate was less general, but it was well marked on the fen soils when, indeed, responses were obtained up to 10 cwt. super per acre, and nitrogen was more effective when phosphate was applied as well. (Table II.)

FODDER CROPS

Fodder mixtures of oats and vetches. The results in 1932 confirm those of previous years that the nitrogenous manure favours the oats and depresses the vetches. The relations are shown in Fig. 1 ; the full details are given on pp. 148-149.

The total nitrogen content of the crop is not appreciably altered by the application of nitrogen. The total dry matter reaches a maximum with a seeding rate of 110 lb. oats and 90 lb. vetches per acre where no nitrogen is given, and with a mixture somewhat richer in oats when nitrogen is given. The total nitrogen content is a maximum with a mixture of 50 lb. oats and 150 lb. vetches per acre irrespective of whether nitrogen is given or not.

Kale. Our experience with kale is very promising. The crop is hardy, easy to grow, convenient in use and much liked by stock ; its leaves are rich in protein, and its yield is easily increased by nitrogenous manuring. On the light soil at Woburn we have been able to push the yields up to 28 tons per acre, and even higher yields may be possible (Fig. 2) ; indeed, kale appears to be one of the most suitable crops for converting cheap fertilisers into animal food.

Thinning and cultivating beyond what is necessary for keeping down weeds were not only unnecessary, but reduced the yield about 2 tons per acre. The results were :

	Unthinned	*Thinned*
Number of plants per acre, about	55,000	14,500
Yield, tons per acre :		
Ordinary cultivation .	27.65	25.18
Intensive cultivation .	25.51	23.63

Samples of the crop were taken each month from November to March : analysis showed that the content of nitrogen increased up to mid-January ; there was no gain in dry matter after mid-November, but also there was no loss. After February both dry matter and nitrogen fell off as the result of the withering of some of the leaves. (Table III.)

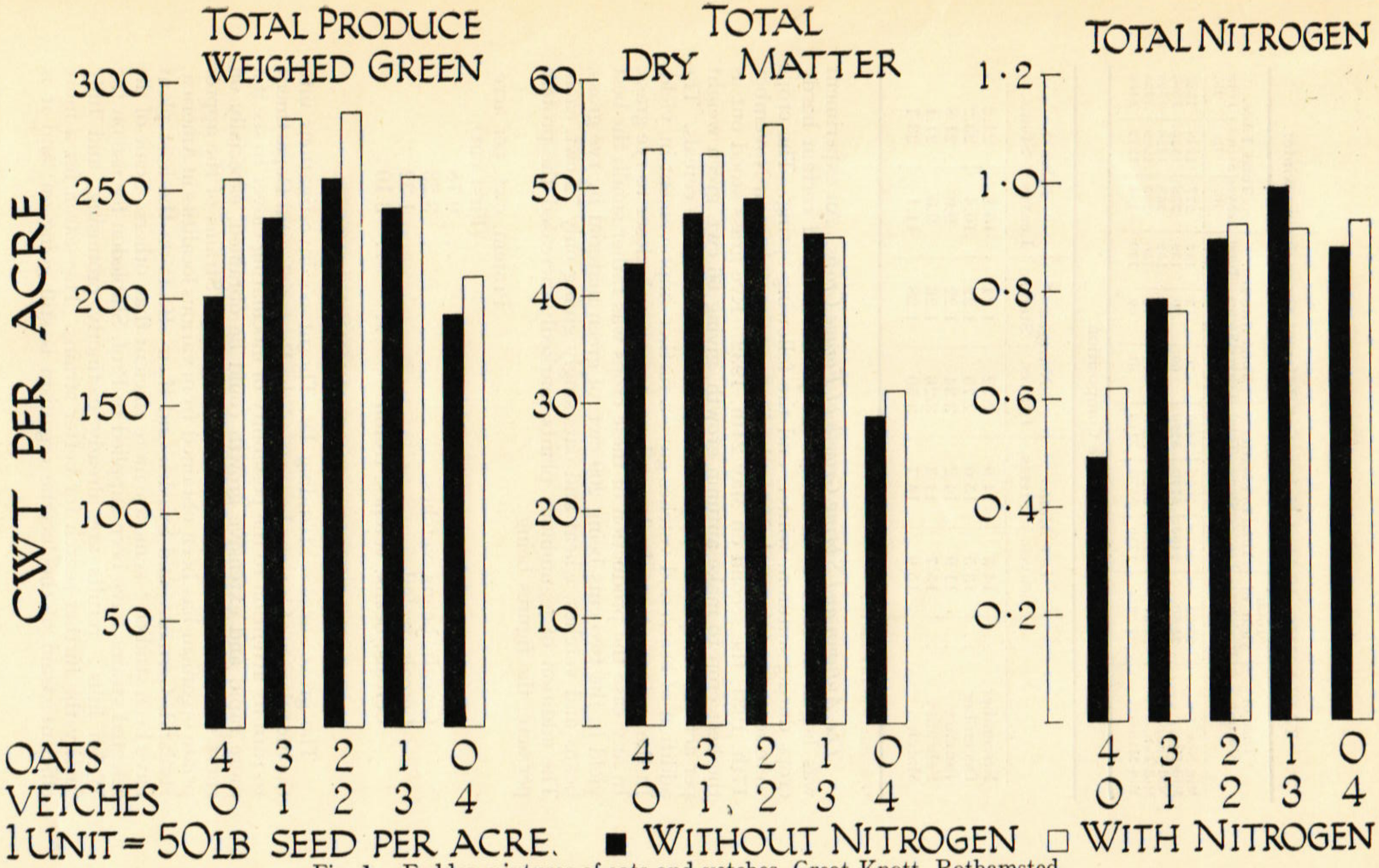

Fig. 1. Fodder mixtures of oats and vetches, Great Knott, Rothamsted.

TABLE III.—Yield of Kale cut at different times during winter.

Time of Cutting.	Total yield of fresh material, tons	Total Dry Matter. Leaves lb.	Total Dry Matter. Stems, lb.	Total Dry Matter. Total, lb.	Total Nitrogen. Leaves lb.	Total Nitrogen. Stems, lb.	Total Nitrogen. Total, lb.	Total Fibre. Leaves lb.	Total Fibre. Stems, lb.	Total Fibre. Total, lb.
Mid-Nov. ..	25.68	2570	5890	8460	70	73	143	277	1248	1525
Mid-Dec. ..	25.30	2450	5770	8220	69	70	139	258	1336	1594
Mid-Jan. ..	27.50	2400	5890	8290	80	72	152	238	1286	1524
Mid-Feb. ..	24.37	2180	5820	8000	71	79	150	209	1229	1438
Mid-March ..	21.22	1740	5370	7110	61	69	130	194	1272	1466

Percentage Composition.

	Dry Matter Leaves.	*Dry Matter* Stems.	*Nitrogen* * Leaves.	*Nitrogen* * Stems.	*Fibre* * Leaves.	*Fibre* * Stems.
November ..	14.3	14.9	2.72	1.24	10.8	21.2
December ..	13.5	15.0	2.79	1.22	10.4	23.2
January ..	11.9	14.2	3.34	1.22	9.9	21.8
February ..	15.7	14.3	3.26	1.26	9.6	21.1
March ..	15.9	14.7	3.50	1.28	11.1	23.7

*Percentage in Dry Matter.

The Autumn and Spring Growth of Forage Crops. An experiment was begun in 1931 to ascertain the productivity of certain hardy crops during autumn, winter, and the following spring. The crops were sown on July 23rd, 1931, the first cut was taken on November 17th, 1931, the second on May 24th, 1932. Rye grass stood out as the best crop to make autumn growth, giving 66 cwt. green weight per acre as compared with 23 cwt. for the mean of the cereals. The addition of beans and vetches gave a further improvement in yield. In the spring cutting, barley and rye came much closer to rye grass. In any case the production of these crops was rather small, the best yield in the two cuts being 209 cwt. of green material by rye grass, beans and vetches, wheat and oats singly giving only 72 cwt. each. The addition of leguminous plants markedly increased the protein per acre, the figures being :

	Protein, cwt. per acre. (First cut)
Cereals alone	0.78
Cereals, beans, vetches	3.23
Cereals, trefoil	1.32
Cereals, beans, vetches, trefoil	3.10

INOCULATION OF LEGUMINOUS CROPS

The great success attending Dr. Thornton's investigations into the inoculation of lucerne has caused the Bacteriological Department to turn its attention to the possibility of inoculating clover to see if a more rapid and extensive growth could be obtained, especially on those soils where it does not thrive naturally. Strains of the appropriate organism has been obtained from various localities in America, Holland, Germany and Sweden and their effects on the host plant have been studied ; some are more efficient than others. Some of the selected strains have been supplied to Prof. Stapledon for use on the Welsh hills ; results are already distinctly promising, and fully justify the further search for better strains. The search for a more efficient strain of the lucerne organism is still going on, and it is

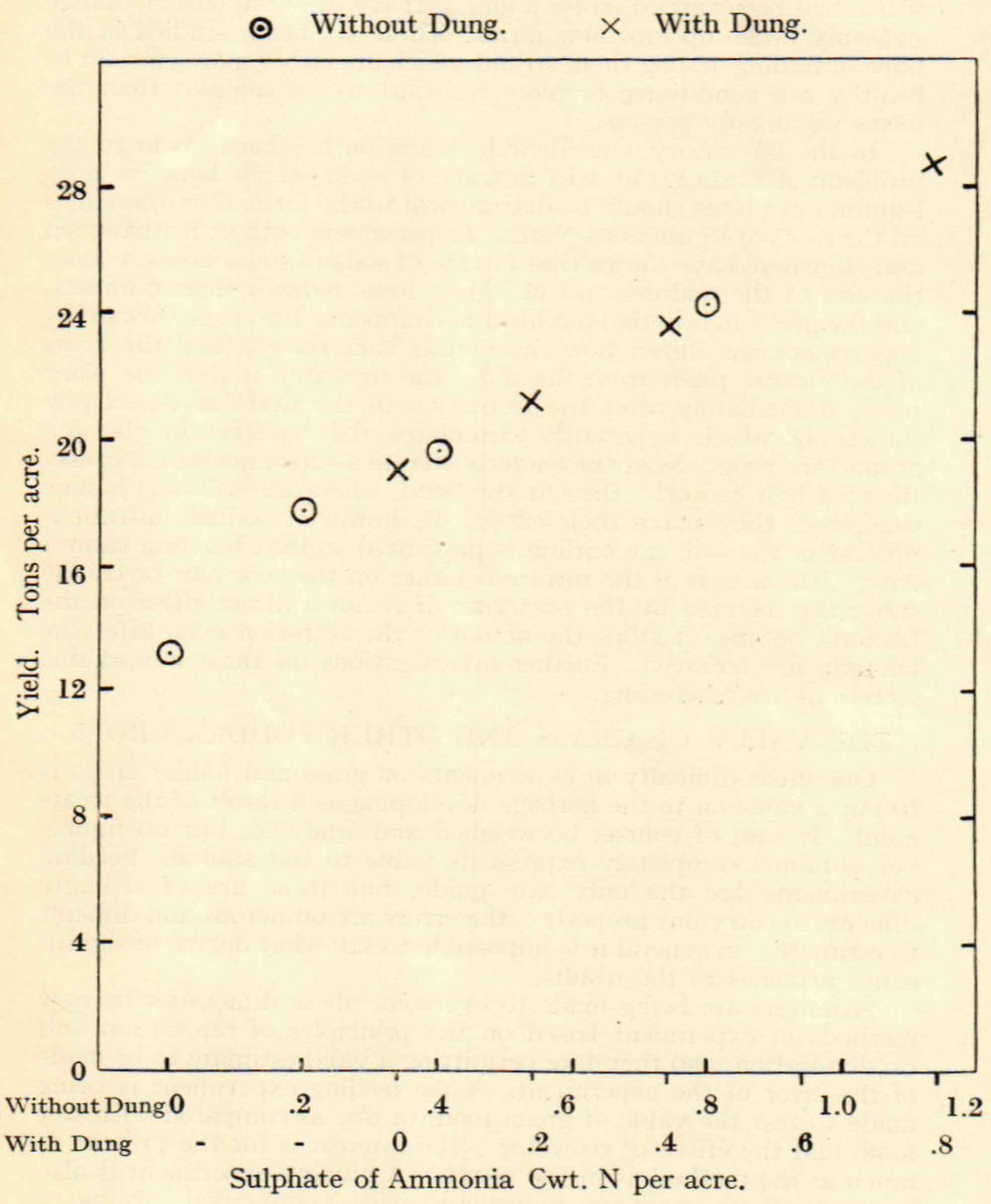

Fig. 2. Relation of Yield and Nitrogenous Dressing in Kale, Woburn, 1932.

The yield of the plots receiving dung (which, like the undunged plots, received 0, 0.2, 0.4, and 0.8 cwt. N as Sulphate of Ammonia) are plotted on the assumption that the dung applied is equivalent to 0.34 cwt. N per acre. This figure was chosen as being the one which most nearly brings the dunged and undunged yields on to the same straight line on the graph. The chemical analysis of the dung gave a total nitrogen content of 1.51 cwt. N per acre so that the results indicate a 22°/₀ availability of N in the dung.

encouraged by the discovery in our laboratory that some cultures which had been carried on for a long period without apparent change suddenly broke up into new forms. These are being studied in the hope of finding among them strains which are either more efficient in healthy soil conditions, or more resistant to soil acidity, than the forms we already possess.

In the laboratory, considerable attention has been given to the problem of finding out why nitrate of soda which benefits non-leguminous plants should be detrimental to the formation of nodules on the roots of leguminous plants. Experiments both at Rothamsted and elsewhere have shown that nitrate of soda in small doses reduces the size of the nodules and in larger doses reduces their numbers, and the problem is to find out how this happens. Previous work in the department has shown how the nodule bacteria get into the roots of the lucerne plant from the soil ; the first step is that the plant roots, immediately after the formation of the first leaves, excrete something which apparently stimulates the bacteria in the soil around the roots. Next the bacteria secrete a substance which causes the root hair to curl : then at the bend, where the cell wall is now weakened, they make their entry. If, however, sodium nitrate is present in the soil, the curling is prevented so that bacteria cannot enter. The action of the nitrate is either on the root hair or on the substance secreted by the bacteria ; it is not a direct effect on the bacteria because it stops the action of the secretion even after the bacteria are removed. Further investigations on these remarkable secretions are proceeding.

THE VALUE OF GRASS AND OTHER FODDER CROPS

One great difficulty in experiments on grass and fodder crops is to put a value on to the herbage developing as a result of the treatment. It can, of course, be weighed and analysed, but no figures yet obtained completely express its value to the animal. Feeding experiments are the only safe guide, but these are exceedingly difficult to carry out properly ; the errors are numerous and difficult to estimate ; in general it is impossible to say what degree of significance attaches to the results.

Attempts are being made to overcome these difficulties by new methods of experiment based on the principles of replication and randomisation, and therefore permitting a valid estimate to be made of the error of the experiment. A pig feeding experiment is being made to test the value of green food, of dry as compared with wet food, and the effect of crowding ; the interest is for the present as much in the method as in the results. A grazing experiment is also being made to compare indigenous with commercial strains of grasses ; sheep are used, tethered as in the Aberystwyth experiments.

THE SIX COURSE ROTATION

This rotation is : sugar beet, barley, clover, wheat, potatoes, fodder mixture (rye, vetches and beans) ; the purpose of the experiment is to test the effect of different combinations of nitrogen potash and phosphate on the yield of crops.

At Rothamsted the yields in 1932 were above those of 1930 and 1931, but the effect of fertilisers was in general less. Sulphate of ammonia benefited potatoes, clover hay and sugar percentage in beet; it had no significant effect on barley or the fodder mixture. It increased the straw but the yield of grain was reduced, probably owing to bird damage. Muriate of potash benefited potatoes, barley straw and sugar percentage in beet; it was without effect on the barley grain, clover and fodder crop. Superphosphate benefited none of the crops.

At Woburn the yields were all lower than before, but the response to fertilisers differed from those obtained at Rothamsted. Sulphate of ammonia benefited barley (grain only), potatoes and fodder crops, had no significant effect on sugar beet, barley straw or wheat grain or straw, but injured clover hay. Muriate of potash benefited sugar beet (roots and tops) and barley (grain and straw), but had no significant effect on clover, wheat, potatoes, or fodder crops. Superphosphate had no effect.

The average yields of all the plots and significant responses during the three years 1930-1932 have been:

	Mean yields		Fertilisers to which the crop responded significantly					
	Rothamsted	*Woburn*	*Rothamsted*			*Woburn.*		
			1930	1931	1932	1930	1931	1932
Barley—								
Grain, cwt. per acre	27.3	20.2	N	N	—	N	N	N, K
Straw, cwt. per acre	31.8	41.7	—	N	K	N	—	K
Clover Hay—								
Dry Matter, cwt. per acre ..	24.7	15.9*	N	—	N	**	—	N–
Wheat—								
Grain, cwt. per acre	24.6	8.2*	—	N	N–	**	N	—
Straw, cwt. per acre	55.9	27.4*	—	N	N	**	N, K–	—
Potatoes—								
Tons per acre ..	7.18	9.40	P–, K	K	N, K	N	—	N
Forage—								
Dry Matter, cwt. per acre ..	36.5	34.2*	N	N	—	**	N	N
Sugar Beet—								
Roots, tons per acre	6.80	5.58	—	N	—	N, P–	N, K	K
Tops, tons per acre	11.27	6.84	N	—	—	N, P–	K	K
Sugar percentage	17.15	17.09	—	—	N, K	N–, P	K	—

— No response.
– Negative response.
* Two experiments only (1931 and 1932).
** No experiment.

Wheat and potatoes thus appear at opposite ends of the test, for while Woburn is much the better for potatoes, Rothamsted excels for wheat; for clover hay, barley, sugar beet, and fodder crops there is not much to choose between the centres and manuring has smoothed out the differences due to soil type.

THE CEREALS

Corn Growing Under Mechanised Conditions

Further experiments have been made to discover how best to maintain fertility on a corn farm cultivated as far as possible by machinery and making little or no farmyard manure. The problems under investigation include the return of straw to the land, and the preparation of the land for the crop.

Return of Straw to the Land. In 1928 a four-course rotation experiment was set up in Hoosfield to find out whether straw could be effectively returned to the land in any form other than farmyard manure. Equal quantities of straw are :

(1) Converted into artificial farmyard manure and applied to one set of plots.

(2) Ploughed in along with the same amount of artificial fertilisers as are used in making the artificial farmyard manure.

A third set of plots receives farmyard manure, containing the same quantity of organic matter as is supplied by the artificial farmyard manure. The amounts of nitrogen, phosphate and potash thus introduced are equalised on all three sets of plots by addition of artificial fertilisers so that the only variant is the amount of organic matter.

The experiment is designed to show the effect of each manure not only in the year of application, but in the first, second, third and fourth years after application. It is not yet possible to say how far the results already obtained are significant, as the experiment is still in its preliminary stages.

THE VALUATION OF FARMYARD MANURE

Of all problems in scientific agriculture one of the most difficult is to put a value on farmyard manure. For artificial fertilisers the problem is simple : the cost of the plant food is known exactly ; the effect is measured in the increased crop yield immediately obtained ; no other effects are normally produced so that an account can easily be made up. Farmyard manure, however, presents much greater difficulties : its cost cannot be exactly stated and its effects are not measured simply by the increase immediately obtained ; it alters the soil and it persists for a longer period than one year.

In many of the experiments at Rothamsted and at Woburn farmyard manure is compared with artificial manures. When the comparison goes on for a number of years the cumulative effects come into the account so that the results are higher than those obtained after one year only ; even so they are not complete, as they do not include the whole of the residual effects.

Some of the figures obtained at Rothamsted and at Woburn are given in Table IV.

TABLE IV.—Comparative Value of Nitrogen in Farmyard Manure when that in Sulphate of Ammonia=100.

	Rothamsted.	*Woburn.*	*Oakerthorpe.*
One year only, 1932—			
Potatoes	12	—	—
Kale	—	22*	—
Mangolds, Roots	—	—	57
Leaves ..	—	—	52
Repeated annual dressings (approximate values)—			
Mangolds, Roots	56	—	—
Leaves ..	48		
Wheat grain	43	30	
Barley grain	28	35	

* See Fig. 2, page 29.

The low recovery of the nitrogen of farmyard manure in the crop is associated with a loss of nitrogen and also an accumulation of nitrogen in the soil, only part of which subsequently becomes available to the plant. Thus the fate of 100 parts of nitrogen applied to the soil in the farmyard manure is somewhat as follows :

	Woburn Continuous Barley.	*Rothamsted Continuous Barley.*	*Rothamsted Continuous Wheat.*
In Crop	30	20	20
In Soil	40	25	25
Lost	30	55	55

Each pound of nitrogen taken up from farmyard manure by the barley crop at Woburn is associated with the production of about 90 lb. of total produce and 60 lb. of grain. For nitrate of soda the figures for total produce are approximately the same, but the quantity of grain appears to be somewhat less.

LEYS AND FALLOW BEFORE WHEAT

In the 1932 experiment in Long Hoos (pp. 142-6), there was little difference in yield whether the wheat followed clover alone or clover mixed with rye grass, but the nitrogen content of the straw, as well as the slight superiority in yield, showed that clover left rather more nitrogen in the soil than clover and rye grass. It made no difference to the yield of wheat whether the clover or the mixture was left growing till autumn to furnish two cuts of hay, or whether it was cut in June and the ground immediately ploughed and given a bastard fallow. The young wheat at first appeared greatly to benefit by the bastard fallow, but it soon lost this early advantage.

So far as the farm is concerned, the clover and rye grass has the advantage that where the clover has failed the rye grass may succeed so that a crop can still be obtained. The rye grass has, however, the disadvantage that it shelters some of the insect pests of wheat, notably the Frit fly *Oscinella* (*Oscinis*) *frit* Linn., which may lead to a reduction in the wheat crop. It was indeed, for this reason that many Hertfordshire farmers gave up adding rye grass in spite of its other advantages.

The yields of hay in 1931 and of wheat in 1932 were :

	1 cut ley and bastard fallow.		*2 cuts ley, no bastard fallow.*		Standard Error.
	Clover.	Clover and Rye Grass.	Clover.	Clover and Rye Grass.	
1931 Seeds, Hay— Hay, cwt. per acre	39.8	37.3	52.3	53.4	—
1932 Wheat, cwt. per acre—					
Grain	26.6	26.0	27.6	27.2	0.96
Straw	52.2	50.2	53.1	49.5	1.20
Nitrogen, as per cent of dry matter—					
Grain	2.02	2.00	2.00	1.94	—
Straw	0.61	0.56	0.60	0.57	—

After neither ley did nitrogenous manuring increase the yield of grain, whether applied in autumn or in spring, indeed the autumn applications somewhat depressed the yield. The straw benefited from the spring applications but not from the autumn applications. Throughout the experiment calcium cyanamide showed a slightly less depressing effect than sulphate of ammonia in the production of grain.

Time when Fertiliser was given.	None	In autumn.	In spring.	In autumn & spring.	Standard Error.
Grain, cwt. per acre ..	27.6	26.3	27.8	25.8	0.56
Straw, cwt. per acre ..	48.7	49.6	54.2	52.2	1.00
Extra yield of wheat from cyanamide over that from sulphate of ammonia—					
Grain, cwt. per acre ..		+0.8	+1.2	+1.5	0.44
Straw, cwt. per acre ..		+0.7	−1.4	−0.3	0.62

This lack of response of wheat to differences in previous treatment and to nitrogenous manuring is probably associated with the circumstance that the yields are all high for Rothamsted (over 52 bushels per acre). The essential features of the experiment are repeated in 1933 in an experiment on Fosters Field, where the level of production is lower and where the conditions therefore approximate more closely to those of ordinary farming. The new experiment also includes a comparison of a dead fallow with the leys and bastard fallows.

The particular design adopted for these experiments has not proved satisfactory. The original treatments—ley and fallows in 1932-3—were in a few (16) large plots each of which was subsequently split up into eight small sub-plots. In spite of the large final number of plots there was low replication of the original plots, and the errors on the comparisons of the different ley effects were necessarily high.

EFFECT OF BASTARD FALLOW IN REDUCING WINTER KILLING OF WHEAT

Dr. Watson has made some interesting observations on the winter killing of wheat. As is well known, wheat plants begin dying soon after they appear, and the fall in number continues throughout the winter and the spring. It was, however, much less marked after a bastard fallow following clover or clover and rye grass cut once only and then ploughed in, than when the crop was allowed to grow so as to give a second cut. The numbers of wheat plants per metre row at the different dates are given in Table V.

TABLE V.—Number of wheat plants per metre row after different crops and manuring.

Date.	After Clover.		After Clover and Ryegrass.		No Nitrogenous manure in seed bed.	Nitrogenous manure in seed bed.
	Cut once.	Cut twice.	Cut once.	Cut twice.		
Jan. 22 ..	45.7	35.7	44.9	38.0	41.9	40.3
Feb. 25 ..	44.0	28.3	41.2	31.3	36.1	36.3
March 22 ..	38.7	27.6	36.8	33.3	33.6	34.6
Aug. 16-20	32.7	26.4	31.1	27.5	29.4	29.5

Approximate number of seeds sown : 60 per metre.

The effect does not appear to be due to the nitrate accumulated during the bastard fallow, since addition of sulphate of ammonia as fertiliser did not alter the numbers of plants. As the summer advanced certain differences set in which entirely compensated for the differences in plant number. The plants in the less densely populated plots tillered better, produced more ears per plant with more grains per ear than those on the more densely populated plots, with the result that at harvest there was no difference in yield between any of the four treatments, in spite of the initial differences in plant number. The later measurements are given in Table VI.

TABLE VI.—Further particulars of wheat plants of Table V.

		After Clover.		*After Clover and Ryegrass.*	
		Cut once.	Cut twice.	Cut once.	Cut twice.
Number of Shoots—					
Feb. 25	per metre ..	48.7	31.0	44.9	34.4
	per plant ..	1.11	1.10	1.09	1.10
Mar. 22	per metre ..	64.3	43.2	58.3	52.5
	per plant ..	1.66	1.57	1.59	1.58
April 29	per metre ..	78.7	69.1	71.9	69.6
	per plant ..	3.45	3.58	3.35	3.49
Number of ears at harvest—					
	per metre ..	45.5	44.7	43.5	41.5
	per plant ..	1.39	1.69	1.40	1.51
Weight of grain per ear, grams		1.136	1.198	1.161	1.204
Yield, cwt. per acre, grain	..	26.6	27.6	26.0	27.2

This compensation of winter killing by extra tillering has been observed before on our fields, and is one of the most important factors in steadying the yield of wheat.

BARLEY

Sowing barley late tends to lower the yield and the 1,000 corn weight and raises the nitrogen content. Experiments were made to see if treatment with sulphate of ammonia or superphosphate would mitigate these ill effects, but it did not ; neither fertiliser benefited the late sown crop. (Table VII.) A similar result was obtained some years ago with sugar beet ; indeed, up to the present we know of no way in which the harmful effects of late sowing can be overcome.

TABLE VII. Effect of date of sowing on properties of Barley Grain. (Plumage-Archer)

	No Fertiliser.	Sulphate of Ammonia	Super-phosphate.	Sulphate of Ammonia and Super-phosphate.
Yield, cwt. per acre.				
Sown—early	25.9	32.9	28.2	32.8
late	23.2	25.3	25.3	26.4
1,000 corn weight (grams) dry.				
Sown—early	47.0	47.2	47.4	46.5
late	44.4	44.2	44.4	44.7
Nitrogen per cent. on dry grain.				
Sown—early	1.70	1.68	1.67	1.70
late	1.80	1.90	1.82	1.84

For some years past experiments have been made to see whether the different varieties of barley responded in the same way to fertilisers or whether of two varieties one might be better under one fertiliser treatment and the other be better under another treatment. Spratt-Archer and Plumage-Archer were tested at Rothamsted, and Plumage and Archer at Woburn. No differential effects, however, were observed: Spratt-Archer was always the better at Rothamsted, except under potash starvation, when both were alike, and Archer was always the better at Woburn. (Table VIII.)

TABLE VIII.—Comparison of yields, Nitrogen content, and 1,000 corn weight. Spratt-Archer and Plumage-Archer, Hoosfield, Rothamsted—4 years, 1929-32.

Manurial Conditions.	Yield of Spratt-Archer when Plumage-Archer = 100.	*Spratt-Archer above* (+) *or below* (−) *Plumage-Archer* (¹).	
		Nitrogen per cent.	1,000 Corn weight gms.
Farmyard Manure 7-2	115	+0.046	−2
Complete Artificials 4A	117	−0.010	−3
Nitrogen starvation 4O	121	−0.035	−2
Potash ,, 2A	98	−0.006	−7
Phosphate ,, 3A	112	+0.029	−5
Complete ,, 1O	111	−0.054	−5

(¹) 1930 only.

Plumage and Archer. Stackyard Field, Woburn. Yield of Plumage when Archer = 100.

	1931.	1932.	pH.
Farmyard Manure 11b	82	86	6.28
Complete Artificials 5b	76	—	6.75
,, ,, 6	82	84	6.23
Nitrogen starvation 4a	90	—	5.80
Potash ,, 10a	83	59	5.81
Phosphate ,, 11a	75	70	5.87
Complete ,, 1	69	80	5.83

MALTING BARLEY

The recent reduction in the tax on beer and the promise of the brewers to use as much English barley as is possible, has caused many farmers to hope for an increased demand for malting barley, and therefore for a larger income from this source than they have enjoyed for a long time past.

During the last ten years the Institute of Brewing has been carrying out investigations on barley and much of the work has been centred at Rothamsted. Field experiments have been made here, and at Woburn, also on a number of barley-growing farms in different parts of the country; their purpose was to find how the yield, composition and market valuation of barley are affected by soil, season and manuring, and they have given a vast amount of information of great value to the agricultural expert and to the barley grower.

At the outset it must be emphasised that the demand for malting barley is limited. Agriculturists must not suppose that by learning to grow malting barley they will necessarily be able to sell it at a high price. Even before the recent fall in the consumption of beer the amount of barley used in British beer was little more than three million quarters per annum, and only between two-thirds and three-fourths of this (largely dependent of harvest conditions) was bought from English growers. There remains always the hope and the possibility that a good deal of the remainder could be grown here also, and indeed none of the laboratory investigations yet made has shown anything in the character of the extract obtainable from imported foreign barleys that English barleys lack in good seasons. Most practical brewers maintain, however, that they cannot obtain the results they want without a proportion of the more husky six-rowed barley to assist drainage in the mash tun, and it is for the research worker to discover whether such barleys cannot be economically produced here so as to satisfy all requirements. This work is still going on. Agriculturists should also remember in comparing the relative demands for English and for Californian barley, that Californian barley contains much less water than ours—only about 10 to 12 per cent. as against 15 per cent. in a good year and 18 per cent. in a bad year for English barleys. In consequence Californian barley not only yields some 6 or 7 per cent. more malt per quarter than ours, but being drier it can be held in store at the docks or elsewhere for two years without any treatment not only without deterioration, but with frequent improvement; while British barley usually has to be kiln-dried, which is a troublesome business.

Meanwhile, in view of the restricted demand, it is only courting disappointment to attempt anything like overproduction of malting barley.

The chief factors in determining quality are the soil and the weather. Certain fields will nearly always produce good malting barleys (harvest conditions being favourable) others only rarely do so. Medium to light loams are the most trustworthy soils, heavy loams and sands come next, and fen soils and clays are the least likely to give good samples. Of all these soils the sandy ones are the most speculative; our best and our worst samples have come from them.

Of the varieties tested, Plumage-Archer and Spratt-Archer are the best, giving about 5 to 10 per cent. more yield than most others; Plumage-Archer yields slightly less but its 1,000 corn weight is better, and its average valuation is slightly above that of Spratt-Archer.

In regard to cultivation, fallow has in our experiments been the best previous treatment of the land both for yield and quality. In practice a dead fallow would be out of the question, excepting on a mechanised grain farm, but autumn cultivation would be the next best thing. This could be given after a preceding grain crop or after a seeds ley. What form the cultivation should take must, of course, be determined by the actual conditions of the farm, but it should give as nearly as is possible the effects of a bastard fallow.

Against the benefits of the fallow must be set the loss of nitrogen involved, but it remains to be seen how far this would be made good by the clover in the seeds break. Barley will not tolerate acidity of the soil, and the Woburn experiments show that it suffers more easily from this cause than any of the other cereals. The first sign of acidity is patchiness in the crop ; the root crops and clover also tell the tale to those who can read it ; swedes get 'finger-and-toe' and mangolds and sugar beet fail to grow up ; they start into growth but do not develop. Clover dies in patches during winter. If the crops show these signs, lime should be added to the soil ; the County Organiser can arrange for a test to be made to show what would be a suitable quantity to add.

The sowing of the barleys should be as early as is practicable consistent with the getting of a good tilth and the likelihood of steady continuous growth afterwards. It is very important that the plant should suffer no check once it has started growing, and the sowing date must be so chosen that the barley can grow steadily on without being held up by a long spell of bad weather. In the Southern and Eastern counties, February or early March is the time at which to aim, but elsewhere later times may be better. This is one of the most important items in the spring management, and it explains why barley after roots folded to sheep is often less satisfactory in quality than barley after a corn crop. Whenever the folding has thrown the sowing late it prejudices the quality.

Winter sowing sometimes gives even better results than early spring sowing, but one cannot rely on this. As yet no two-rowed winter variety is entirely hardy, and although in favourable conditions the result is successful—in Essex autumn-sown Plumage-Archer barley has in some cases given a 50 per cent. better cash return than spring-sown—nevertheless the risk of failure is always there. Search is still being made for good reliable winter varieties, including good six-rowed sorts that might replace the imported six-rowed barleys. As winter-sown barleys ripen early, they are, however, liable to damage by birds.

Coming back to sowing, the rate of seeding is not very important, and 2½ bushels per acre usually gives as good a result as any other. The drills, however, should not be too wide ; the usual 7 inches between the rows is quite wide enough ; indeed, somewhat better yields, and equally good quality, were obtained at Sprowston by setting the drills only 4 inches apart. Widening the rows much beyond the usual width, however, has the effect of raising the nitrogen content of the grain which is undesirable.

Manuring if properly carried out raises the yield without injuring the quality ; indeed, it improves the valuation set on the grain by the buyer. The most important constituent is nitrogen, and the most useful quantity to add is 20 lb. per acre ; this corresponds to 1 cwt. sulphate of ammonia or 1¼ cwt. nitrate of soda given at the time of seeding. It used to be thought that nitrogenous manuring would injure the quality of the grain, and both agricultural experts and maltsters have in the past advised against it. There may have been some cause for anxiety in the old days with the old varieties, but with Plumage-Archer and Spratt-Archer there is little to fear ; they stand up to this quantity of manure and they commonly give in return an additional 5 or 6 bushels of grain with no loss of quality whatsoever. As between one nitrogeneous manure and another, there is little to choose : price and convenience in use are the deciding factors ; phosphatic and potassic manures, on the other hand, are more specialised in their value. There are many soils on which neither acts for barley, but on other soils they are needed. At the Norfolk centres superphosphate gave profitable increases in yield; at many of the other centres it did not. Barley needs phosphate more than wheat does, but the need for phosphate has hitherto been met by the large dressings given to the root crop which preceded it. With the reduction in the acreage under roots, however, these dressings will no longer be given, and then the need for supplying phosphate to the barley will become greater. Potassic fertilisers were effective on the light soils, but not on others.

In the harvesting and after-treatment of the crop it is of great importance to secure grain as dry as possible and of high germination capacity. Recently artificial drying of the grain has been practised on some farms; at present this is risky because the process cannot be fully controlled, and an excess of temperature may badly injure germination; it complicates things for the maltster, who in any case has probably to dry the grain again. Drying is of course quite safe for crops intended for feeding, but further experiment is necessary before it can be used generally for malting barley. It is, however, a promising line of development.

Effect of Season. The most important factors for the barley crop are the weather before sowing; the rainfall during March, April, May and June; the temperature during July; and (more important than either), the weather at harvest time.

The weather just before sowing determines the state of the seed bed and the date of sowing, and late sowing reduces yield, lowers the 1,000 corn weight and raises nitrogen content. Rainfall during March and April lowers yield considerably if it much exceeds the usual quantity, but drought during this period is also harmful. Rainfall during April, May and June lowers the nitrogen content of the grain and so tends to improve the valuation; on the other hand, drought during this period raises the nitrogen content and tends to lower the valuation. Temperatures above the average in July lower the yield and slightly raise the nitrogen content.

Thus, by the end of June the farmer should have a very fair idea of whether his barley is likely to be higher or lower in nitrogen than usual. If sowing has been delayed, if April, May and June have been drier than usual, other things being equal this may easily mean a lower valuation, unless indeed the harvest conditions are so good that his sample looks attractive in spite of its high nitrogen content. On the other hand, if the barley were sown early and went in well; if April, May and June have been moister than usual, the grain will contain less nitrogen than usual and so offers the possibility of making good malting barley.

It is, however, the conditions of harvesting that finally determine whether or not a crop of barley is either choice, or passable, or impossible malting material.

No pale ale brewer will buy " weathered " barley, or malt made from it and no brewer or maltster will buy any barley if its germinating capacity has been injured by either adverse weather during harvest or by the after-effects of stacking—always more serious when harvesting conditions are adverse.

When a large part of the home crop is injured as happens in exceptionally wet harvest seasons, maltsters and brewers naturally purchase a larger proportion of barley coming from those countries where the harvest weather was better than in this country.

THE COMPOSITION OF CROPS

BARLEY

Four crops have in recent years been studied in the chemical department: barley, sugar beet, potatoes and wheat—but the most extensive investigations have been with barley, carried out in association with the Institute of Brewing. The relation between the chemical composition of barley and its grade as assessed by the buyer is shown in Table IX.

TABLE IX.—Grades of Barley as assessed by the valuers, and their chemical composition.

			Barley.		*Malt.*	
Grade awarded by Valuer.	Type.	No. of Centre Averages.	Nitrogen per cent. in dry grain.	1,000 corn wt. gms.	Extract lb. per qr.	Diastatic Power.
I. ..	Pale Ale	2	1.558	42.6	100.0	35.1
II. ..		7	1.416	40.6	100.6	29.9
III. ..		11	1.486	40.2	99.7	33.6
IV. ..	Mild Ale	13	1.491	39.0	98.6	28.4
V. ..		24	1.554	38.5	98.5	39.6
VI. ..		25	1.686	38.1	97.6	44.0
VII. ..	Grinding	8	1.592	37.8	97.8	42.7

The close connection between the grading and the composition of the barley is very remarkable in view of the facts that the grading was done independently of the analysis and that it was greatly influenced by the degree of ripening of the barley which has nothing at all to do with the nitrogen content. Yet apart from Grade I (of which there are only a few samples) the grading becomes lower as the nitrogen content rises, and as the 1,000 corn weight decreases. Field experiments have been made to find out how the nitrogen content is related to the conditions of growth of the crop; these are dealt with on p. 35.

From the scientific point of view, perhaps the most interesting result is the close relation established by Dr. Bishop between the quantities of the different nitrogen compounds in the barley grain and the total nitrogen. The quantities of hordein, glutelin and of the other nitrogen compounds are always closely related to one another and to the total nitrogen. Barleys of the Plumage-Archer type contain, at 1.35-1.5 per cent. of nitrogen, about equal proportions of hordein, glutelin and salt-soluble nitrogen compounds in the fully mature grain.* Barleys of lower nitrogen content contain somewhat less hordein, but barleys of higher nitrogen content contain much more†, with correspondingly less salt-soluble nitrogen compounds.

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* i.e. after about three years' storage. In immature grain the percentage of salt-soluble nitrogen is higher, and of glutelin and hordein lower, than in mature grain.

† They are, as Dr. Beaven pointed out, frequently steely, but there is nothing to show that the steeliness is due to any special proportions of the individual proteins. An explanation based on physical properties is much more satisfactory.

Of all the many samples of barleys examined, none has ever been found to contain an abnormal proportion of hordein or of glutelin; the relations seem to hold invariably and to be characteristic of the variety. Similar regular relations apparently occur between the carbohydrates in the grain.

It appears, therefore, that each variety of barley is built up on a definite pattern, which can be altered by changes in conditions, but only within the limits set by the pattern, so that the variety always retains its distinctive character. Knowing the percentage of nitrogen in a particular sample, it is possible to state at once the whole composition of the grain as we know it at present.

Different varieties have different patterns and the differences are more marked among the six-rowed than among the two-rowed varieties, but in no conditions so far discovered do the patterns merge or lose their distinctiveness. The differences between different varieties constantly reappear in all the tests made under normal agricultural conditions, though there are some reversals of effects under conditions of abnormal starvation. The character of the pattern can by plant-breeding methods be changed within limits defined by the laws of genetics; within these limits new varieties having different proportions of the various nitrogen compounds and carbohydrates can be produced. Some of these varieties may be better suited than existing sorts to the special requirements of different groups of maltsters and brewers. There seems, however, to be no necessity for a large number of varieties, and it would probably be to the advantage of all concerned if growers, maltsters and brewers could agree to concentrate on a few standard sorts. Plumage-Archer and Spratt-Archer are distinctly superior to others in yield, low nitrogen content and high extract.

Another important result has been to confirm and extend an observation made at Rothamsted some 25 years ago, that the nitrogen content of the grain is determined in the early stages of the plant's life and does not appreciably alter during the later development of the grain. This is quite contrary to the general belief: the nitrogen content of the barley was supposed to be determined largely by the conditions in the later part of the plant's life; it was associated with the maturation; too rapid or delayed maturation was supposed to lead to high nitrogen content and *vice versa*. The recent results obtained in collaboration with the Institute of Brewing show that the nitrogen content of the grain is determined in the earlier part, and not in the later part of the plant's life, and that it is hardly affected by the maturation processes. Maturation of course still remains an outstanding factor in determining malting value, probably accounting for a large part of the missing factor that places Grade I barleys above the position to which their chemical composition would assign them. A barley grain rich in nitrogen does not normally mature as well, judged by the maltsters' standards, as a grain poor in nitrogen. Usually also an increase in the nitrogen content of the grain is associated with an increased proportion of immature grains. It has been stated that the carbohydrate of a high nitrogen barley is not so completely transformable into extract as that of a low nitrogen barley, and this has been taken as evidence of a connection between maturation and nitrogen content. The

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statement is true when the grinding is done by the standard method ; as the nitrogen content increases, barley gives progressively less extract than corresponds with replacement of the carbohydrate by the additional protein ; with finer grinding, however, the full amount of extract is obtained. The result suggests some sealing up or rendering inaccessible of carbohydrate in barleys of high nitrogen content.

Finally, the weather conditions determining the nitrogen content of the grain have been so fully worked out that predictions made at the end of June are found to be closely fulfilled when the grain is analysed after the harvest in August.

THE SOIL : PHYSICAL PROPERTIES

The main purpose of the work in the Physics Department is to study the physical properties of the soil, especially those related to water, air movements, temperature and formation of tilth. The water relations have been much studied by Dr. Keen, who has devised methods of investigation and shown how to interpret the results ; he is also studying the temperature relations. Plasticity is studied by G. W. Scott Blair and R. K. Schofield, and the crumb structure by E. W. Russell ; while Dr. Schofield is improving the methods for determining the quantity and kind of exchangeable bases in the ultimate clay particle, a factor now known to have great importance in determining soil properties.

Some of the applications of the work are in the direction of cultivation ; at present this is an art but hardly a science ; it is not nearly so advanced as the science of manuring. Experiments on the farm have shown some of the advantages and some of the disadvantages of rotary cultivation as compared with the older methods; these are dealt with in previous reports. Other experiments are made with intensive as against ordinary cultivation. Last year's results (1932) show that neither potatoes, sugar beet, nor kale responded to cultivation more intensive than was necessary to keep down weeds ; indeed, further cultivations beyond this minimum amount did more harm than good.

Other applications of the work are to soil surveying. Usually a soil surveyor has to work rapidly over a large area and unless he relies entirely upon personal judgment in classifying the soils he must have rapid methods of characterising them. Various easily-measured properties have from time to time been suggested as sufficient for soil characterisation ; a number of these were applied by J. R. Coutts to an extensive range of soils, and the data have been statistically examined by E. W. Russell so as to find out which methods give the most useful information.

Considerable attention is being paid to the meaning of soil tilth and the factors concerned in crumb structure. One of the important properties of the soil crumbs is their stability towards water, crumbs that will persist when moist are much more conducive to productiveness than crumbs which readily break down. Stability depends on the composition of the clay ; it is greater for a calcium clay than for others, and it is enhanced by micro-organic action, apparently through the formation of a film on the surface.

Crumb formation in soils and its related phenomena are due to interaction between the clay particles and the water present, and methods are being developed to elucidate the details of this interaction. By comparing the properties of clays dispersed in water and in organic liquids it is possible to pick out those particular properties of the water and organic liquid molecules responsible for any given property of the dispersion. Thus crumbs can be formed from clay dispersed in the alcohols, aniline, and nitrobenzene, but not from clays dispersed in a hydrocarbon, indicating that their formation depends on the presence of an appreciable dipole moment in the molecules of the dispersion medium.

The methods for studying the plasticity of clay can be used equally well for studying the properties of dough, and this is being done by G. W. Scott Blair and R. K. Schofield. The way in which viscosity and relaxation time vary with stress and strain has been discovered, and efforts are now being made to test the constancy of the rigidity modulus under varying stress and the influence of the "stress-history" of the dough on the modulus. Certain aspects likely to lead to results of milling interest are being studied in conjunction with the Research Association of British Flour Millers.

THE SOIL: ITS CHEMICAL COMPOSITION AND PROPERTIES

The Chemical Department is concerned with the study of the composition of soils and of crops; it also does a great amount of analysis for other departments, particularly in connection with the field experiments.

The study of the soil has been greatly advanced in recent years with the development of ideas on the constitution of the clay fraction of the soil. The clay is now regarded as analogous to a salt, being made up of a basic and an acidic portion; it can interact with salts forming new clays differing from the original as a salt of one metal differs from the salt of another metal. The forces of attraction between the acidic part of the clay and the basic part, and the attraction between the whole complex clay and other substances, are now being studied by modern physico-chemical methods and relations hitherto unsuspected are being found between the chemical and physical properties of soil.

With this new knowledge it has been found possible to reopen many old problems, among them the question of soil analysis, which many soil chemists had given up in despair. Work on the exchangeable bases and the buffer capacities of soils has suggested means of overcoming the more serious defects of the older empirical methods of soil analysis and so giving analytical data which are constant for the soil concerned and do not depend, like the old figures, on the particular analytical procedure adopted. This work is facilitated by the steadily-increasing supply of soil samples from plots on which good field experiments have been carried out so that the response to fertilisers is known.

THE CHANGES IN THE SOIL ORGANIC MATTER

Hitherto the method adopted at Rothamsted for studying the changes in the soil organic matter has been to compare the quantities of carbon and of nitrogen present in soils at the beginning and at the end of a long period of field experiments.

A. Walkley has recently completed a survey of the Woburn soils showing the magnitude of the losses of carbon and of nitrogen. Some of his results are given in Table X.

TABLE X.—Changes in Carbon and Nitrogen content of Woburn soils during 50 years, 1876-1926.

	Unmanured.			*Complete Artificials* (Plot 6).		*Farmyard Manure* (Plot 11b).	
	1876.	1926.	Change in 50 years.	1926.	Change in 50 years.	1926.	Change in 50 years.
Barley Plots—							
Nitrogen per cent.	0.156	0.094	−0.062	0.109	−0.047	0.151	−0.005
Nitrogen, tons per acre	2.14	1.29	−0.85	1.50	−0.64	2.07	−0.07
Carbon per cent.	1.49	0.90	−0.59	1.07	−0.42	1.50	+0.01
Tons per acre . .	20.4	12.3	−8.1	14.6	−5.8	20.5	+0.1
Wheat Plots—							
Nitrogen per cent.	0.156	0.109	−0.047	0.104	−0.052	0.145	−0.011
Tons per acre . .	2.14	1.49	−0.65	1.43	−0.71	1.99	−0.15
Carbon per cent.	1.49	1.23	−0.26	1.07	−0.42	1.52	+0.03
Tons per acre . .	20.4	16.8	−3.6	14.6	−5.8	20.8	+0.4

A second method is now, however, being used by means of which the changes in oxidisable carbon and nitrogen during a single season can be followed. The effects of fallowing and of growing clover or rye grass are being studied and the method is being applied to find whether organic manures such as poultry manure have any special action in the soil. The method will also be used for studying green manuring.

THE BIOLOGICAL DECOMPOSITION OF ORGANIC MATTER

The decomposition of organic matter plays an important part in soil fertility and in the making and storing of farmyard manure; it is the process responsible for the purification of effluents from sugar beet factories, milk factories and others : considerable attention is therefore devoted to it in the Microbiological and Fermentation Departments. The earlier work has shown that in natural conditions the rate of decomposition of organic matter, as for example the rotting of plant residues, is limited by the amount of food available for the micro-organisms that bring it about. Usually there is insufficient nitrogen present, frequently also insufficient phosphate, and the decomposition proceeds more rapidly when more is added.

Rotting of straw. The first application of this general rule was to the rotting of plant residues, straw and similar substances to form an artificial farmyard manure. The process was so successful that it was handed over to the Adco Syndicate who have developed it on the large scale and applied it for use in many parts of the world; many thousands of tons of artificial farmyard manure are now made annually.

Investigations of the process, however, still proceed and much new information has now been obtained.

Of the various forms in which nitrogen was supplied for the rotting of straw, ammonium salts seemed to be the best in the early stages of the decomposition, although in the end they were no better than nitrate. When nitrate was used, however, any excess of nitrogen beyond what the organisms needed to effect the decomposition of the cellulose tended to be lost ; this did not happen with the ammonium salts.

Some of the products of the decomposition of straw and similar materials by the mixture of micro-organisms usually occurring on straw are very sticky when wet and possess considerable cementing power when dry ; these are formed during the making of good farmyard manure. Alkalinity is a necessary condition ; maximum stickiness is attained when the pH rises to 9.5 or 10, as happens when nitrate of soda is used as the source of nitrogen. The stickiness of a rotted manure may be increased by adjusting the pH to this value, and for this purpose sodium or potassium ions are more effective than calcium or magnesium.

The mixture of organisms contains both fungi and bacteria, but the fungi, while they can themselves decompose cellulose, produce no sticky substances ; the active agents appear to be bacteria which operate after the fungus attack and make the sticky substance from the fungus mycelium. The process is being further studied.

Purification of effluents. These investigations are made under the aegis of the Department of Scientific and Industrial Research. A purification process based on our knowledge of biological oxidation was worked out in the Rothamsted laboratories and developed to the semi-commercial scale at the Colwick factory. It is proving quite satisfactory in practice and has definitely shown that the discharge of unpurified effluents into rivers need not occur.

The purification of effluents from milk factories is being attempted on the same general lines as for the sugar beet effluents but modifications are necessitated by the fat which is always present, and which leads to clogging of the filters. Various methods are being tried to overcome this difficulty.

PLANT PATHOLOGY

The department of Mycology suffered a severe loss in 1932 when Dr. W. B. Brierley, who had had charge since its inception in 1918 and had developed it to a high state of efficiency, left it to take up the Professorship of Agricultural Botany at Reading University. Further loss occurred a few months later when Dr. R. H. Stoughton, who had been in charge of investigations on bacterial diseases of plants, was appointed Professor of Horticulture in the same University.

The Lawes Trust Committee decided to reorganise the department and reconstitute it as a Department of Plant Pathology with Dr. Henderson Smith as Head.

During his fourteen years service at Rothamsted Dr. Brierley devoted much attention to the genetical analysis of the fungus

Botrytis and isolated large number of races. He found that new strains might arise but they could not be produced at will by varying the conditions ; a strain could be temporarily altered by changed conditions but it returned to its old characteristics on reversion to the old conditions. Apparently pure natural infections often consist of a mixed population of various races, but artificial infections give rise only to the original infecting race. All this work is now being written up for publication.

Before leaving Dr. Stoughton completed his study of the important parasite *Bacterium malvacearum* which causes Black Arm disease in cotton. Contrary to the general belief about bacteria it has apparently a sexual stage characterised by the fusion of two cells and the formation of a fusion body or zygospore. Further, it exists in many different strains, and these may remain constant for a long time then suddenly they may " dissociate " into new strains which either persist or reproduce the parent type. This dissociation cannot be controlled. The disease study was financed by the Empire Marketing Board and done in conjunction with the workers in the Sudan where Black Arm is troublesome : very useful help has been given to them and it is shown that this type of collaboration is not only practicable but economical and very effective.

VIRUS DISEASES

The general purpose of these investigations made by a team of workers under Dr. J. Henderson Smith is to obtain information about the nature of the pathogenic agent, its mode of propagation and dissemination within the infected plant, its spread from plant to plant, the effects it produces and the mechanism by which it produces them ; and as a consequence of the knowledge obtained to arrive if possible at some method of effective control. Direct attack on the nature of the agent is hindered by the failure hitherto to grow any virus in the absence of living cells. Several attempts have been made to achieve this, as yet without success, but new methods are tried from time to time.

While many viruses are able to pass fine porcelain filters which hold back all bacteria, others cannot pass even coarse filters through which bacteria pass readily ; but owing to the highly absorptive properties of porcelain it is unsafe to draw conclusions as to the size of the particles passing. By using collodion membranes of known and graduated porosity, however, it has been possible to estimate the limits of size of particles producing the various diseases. Some of the estimates are :

Tobacco or yellow mosaic ..	15μμ
Aucuba mosaic	40-50μμ
Hyoscyamus virus	150μμ

Whether the particle is itself the virus or only the carrier is not yet known. It has been possible in some cases to analyse the virus and separate it into two components each producing different symptoms in the plant.

A dilution method of counting the number of virus particles in a given quantity of the juice of diseased plants is being worked out : the method is based on the fact that one particle can apparently produce one disease spot.

These new discoveries have greatly facilitated the study of the group of virus diseases. It is shown that the virus moves freely in the plant from cell to cell along the protoplasmic strands ; also that it multiplies ; the rate of multiplication is much more rapid in some plants than in others. It is further shown that one of their effects is to inhibit the development of the plastid primordia so that chloroplasts do not form.

Some of the virus diseases are carried by aphids but the virus seems to undergo some change in the aphid's body. This is being investigated by Dr. Hamilton : the work is complicated and retarded by the difficulty of rearing aphids on artificial foods and by their small size which makes it difficult to follow the movements of the virus particles round their bodies and into their saliva. Polonium (Radium D) is now introduced with the food solution of the aphids so as to follow better the course through the body ; in this work useful assistance has been rendered by Dr. Chadwick of the Cavendish Laboratory.

The study of intracellular inclusions has been further advanced. Soon after infection minute particles of protein appear in the cytoplasm, are carried about the cell by its streaming, and coalesce when brought together. By successive fusions a large spherical body is gradually built up. This mode of origin lends support to the view that these " inclusions " are essentially products of interactions between the host cell and the virus. Hitherto these bodies have been found only in plants infected with certain virus diseases. If, however, normal plants are supplied with chemicals known to be protoplasm coagulants, symptoms develop within the cells which are similar to the first stages of a virus attack. The effect produced varies in degree with different reagents, but with molybdic acid or its salts it is possible to parallel all the intracellular phenomena which characterize aucuba mosaic disease. This work is to be continued.

Wart disease of potatoes. Some years ago Miss M. D. Glynne devised a rapid test for susceptibility to wart disease by means of which she can ascertain in a few weeks whether a variety is susceptible or immune. This method has now been used for some years for testing the potatoes sent in to Ormskirk for trial and it continues to give satisfactory results.

INSECT PESTS

The chief line of work in the Entomological Department is the study of the factors determining the size of insect populations. Insect pests are always with us, but so long as their numbers are small they are comparatively harmless. Sometimes, however, one species begins to multiply, and its power to increase is so enormous that the harmless few speedily become a serious pest causing great loss of crops. Hitherto the factors responsible for this rapid multiplication have been but little known and consequently it has not been possible to take preventive steps beforehand or even to warn farmers of the probability of attack. This subject is now under full investigation at Rothamsted. Soon after Dr. C. B. Williams entered on his duties as Head of the Department on July 1st, 1932, he began an investigation into the relation of insect numbers to weather conditions. The great difficulty has hitherto been to find some numerical expression of the abundance of insects ; Dr. Williams is trying to overcome this by taking daily samples of all flying insects under definite standard conditions, and identifying and counting them. He does this by means of a light trap, operating from sunset to sunrise and fitted with a mechanism for dividing its period of operation into eight sub-periods, so as to show the actual hours during which each catch of insects is obtained. The trap is near to the meteorological enclosure so that the precise meteorological conditions during each sub-period are known. All the working conditions, including the intensity of the light, are standardised so that the catches of each season may be comparable with those of any other. It is hoped in time to obtain data from which relations between weather conditions and rate of multiplication of insect populations may be worked out.

It does not necessarily follow that a large catch of insects means a large multiplication of the local population. Insect migrations are known to occur and steps are now being taken to follow them. A migration of small cabbage white butterflies (*Pieris rapae* with a few *P. brassicae*) was observed at Rothamsted in mid-August, 1932 : the horde was traced to the Norfolk coast where it had arrived presumably from the Continent ; it had travelled westwards passing over Rothamsted and the resulting larvae did a good deal of damage to cabbages in September.

Another factor affecting the size of the insect population is the degree of parasitism : this is being studied by Dr. Barnes using certain of the midges as the test insect. Some of his results are embodied in the following table :

Insect.	1928.	1929.	1930.	1931.	1932.
Dasyneura alopecuri Reuter—					
Relative Abundance	1498	4748	1366	965	1216
Percentage parasitism	38.0	2.3	19.0	26.5	3.0
Rhabdophaga heterobia H.Lw.—					
Relative Abundance	1573	1235	341	840	1480
Percentage parasitism	51	64	62	61	53

Similar studies have been made with *D. pyri* Bouché ; *D. arabis* Barnes ; *Sitodiplosis mosellana* Géhin, and *Contarinia tritici* Kirby.

An interesting observation was made on two of the grass plots by Dr. Sharga in studying one of the Thrips (*Aptinothrips rufus*) infesting the grasses. Where the grassland had been treated with lime about 12 to 20 per cent. of the thrips were parasitised by a nematode *Tylenchus aptini*, Sharga : where, however, the grassland had received no lime, the thrips were free from parasites. This is now being further investigated by Miss Lysaght. Another subject of investigation in the Department is to find how the insects are attracted to the host plant. Apparently they have some sense of smell, but among different varieties of the same plant some are attractive and others are not. The property is transmissible to the offspring and Dr. Barnes has tested willows supplied from Long Ashton. Thus some willows are resistant to the attack of a willow midge that ordinarily does much damage ; these are being studied by

Dr. Barnes. Mr. Newton is endeavouring to find what difference in the willow accounts for the difference in attractiveness to the midge.

Dr. Margot Metcalfe completed her studies on the red clover, cocksfoot and ryegrass gall midges, and worked out the biology of three gall midges found on Park Grass plots, two being new to science. She now has a Commonwealth Research Fellowship tenable at the Carnegie Institute and Johns Hopkins University.

BEE RESEARCH

Further work has been done on the recording of the daily life of the hive. The observations with marked bees have continued, and the results agree closely with those set out in last year's reports. Two more continuous weighing devices have been installed to record the mass movements of the bees by recording the changes in weight of the hive, and some interesting relations have been found between hours of sunshine and hours of nectar gathering. Search is being made for some method of recording the entrances and exits of bees to and from the hive.

A vigorous effort is being made to find the funds for a bacteriologist to study the Foul Brood diseases which are now causing great losses to beekeepers.

INSECTICIDES

Dr. Tattersfield and his staff continue their studies of plant products poisonous to insects : these have the advantage that they are safer in use than mineral poisons, being relatively harmless to human beings and domesticated animals.

Pyrethrum is one of the most interesting in that it can be grown in this country and its manurial requirements seem to be very low : it will indeed grow on poor sandy soils, but whether it would be economically advantageous as a crop is not yet known.

Culture experiments have been made by Dr. Martin to find the effects of temperature, dormancy and degree of illumination on the growth of the plant. By varying these conditions it was possible to obtain a short harvesting period, such as is usual in this country, or a long harvesting period, such as is usual on the Kenya uplands, or a complete absence of flowering, as is characteristic of tropical lowlands Trinidad, Uganda and elsewhere.

Further work has been done on the loss of virulence of pyrethrum dusts on exposure to air and light. This has already been traced by Dr. Tattersfield to oxidation and he has shown that it can be retarded in pyrethrum-talc dusts by an admixture of antioxidants. He finds, however, that the effect of pyrethrum extracts upon the insect is not materially increased by the addition of an antioxidant. The effect of light upon pyrethrum dusts is being studied ; it is found that as the activity declines, the yellow colour of the dusts fades and the question arises whether the pigment protects the poison.

The fish poison plants from the tropics have been further investigated. The rotenone content is still the best measure of toxicity but further tests with insects are being made. The problem is very important because some samples of these plants are almost devoid of insecticidal power, e.g., one sample of *Derris elliptica* contained no rotenone and was harmless to insects ; some cultivated samples of *Lonchocarpus* were much poorer than certain wild samples.

The biological tests require large supplies of insects raised under standard conditions, and last year H. C. F. Newton after various trials worked out the technique for producing cultures of *Myzus persicae* Sulg. in the necessary quantity, both the insect and its host plant, the dock (*Rumex obtusifolius*) being easy to grow.

INSECT PESTS AT ROTHAMSTED AND WOBURN, 1931-32

H. C. F. NEWTON

GENERAL. In the winter unusually severe damage to cereals was caused by slugs, chiefly the Grey Field Slug *Agrolimax agrestis* L. The wheat experiment on Fosters suffered badly, doubtless due to the encouragement of the slugs by the surrounding ley. Partial failure of wheat after ley appears to have been general especially in Norfolk though damage appears to be more severe after ley mixtures containing rye grass. It is therefore possible that frit fly attack is responsible for some of the loss (cf. last year's report) yet on one field examined at midnight scarcely a plant was without its attendant slug.

BROADBALK. *Wheat.* It is interesting to note that these observations indicate no increase in insect damage on this field, as compared with rotation wheat fields, in spite of the continuous cropping with the same plant. In fact, during the last two years the greatest loss of wheat plant has been on the rotation series. Similarly the permanent mangold field, Barnfield, suffered no loss from *Atomaria linearis* the Pigmy mangold beetle this year, though the severity of attack by this insect is supposed to be greatly increased by a sequence of mangold crops. It would seem therefore that the other factors controlling insect increase completely swamp any effect due to continuous cropping.

Frit Fly (*Oscinella frit* L.). No winter attack by this insect occurred this year.

The Wheat Bulb Fly (*Hylemyia coarctata* Fall.) attack was slight, as was also that of the Wheat Leaf-Miner. The latter insect was bred from material collected last year and identified by Mr. J. E. Collin as *Agromyza* (*Domomyza*) *ambigua* Fall. In addition, the following parasites have been bred out : the two Braconids *Dacnusa leptogaster* Hal., *Opius maculipes* Wesm. and a Chalcid *Lamprotatus gibbus* Walk.

Wheat Midge (*Contarinia tritici* Kirby, *Sitodiplosis mosellana* Géhin), attack though still high was slightly less than last year ; the parasitism was still high. The figures for the last six years are :

Year	1927	1928	1929	1930	1931	1932
Percentage of damage to grain	3.2	6.5	7.7	17.6	21.4	15.4

GREAT HOOS FIELD. *Barley.* The Grey Field Slug (*Agrolimax agrestis* L.) caused some damage during the winter months. Wireworm, *Agriotes* spp. was again present causing some gaps but less damage was done than last year. Gout fly *Chlorops taeniopus* Meig. was again less prevalent than in 1929-30.

LONG HOOS. SIX COURSE ROTATION. *Sugar Beet.* An attack of wireworm beginning when the plants were in the cotyledon stage and continuing up to July reduced the whole plant and replanting was necessary. *Bourletiella hortensis* Fitch added to the damage and *Atomaria linearis* Steph. was present. Their attack was intensified by their concentration on the plants left by wireworm on the eastern side. A few cases of the leaf miner *Pegomyia hyoscyami* Panz. were noted, both the cotyledons and true leaf being attacked.

Clover. Clover Seed Midge (*Dasyneura leguminicola* Lint.) was present in the flower heads (see Paper No. LIX., p. 87).

Forage Mixtures. Most of the beans were taken off during the winter by an agent not identified, but voles or mice are suspected. The stalks were bitten or broken through just above ground level the broken tops lying untouched by the side.

General. Losses in the wheat plant during the winter were caused by slugs and soil insects, e.g., leather jackets and wireworms. Similar attacks occurred sporadically on other cereals but otherwise there was no notable insect attack in the series.

FOSTERS. *Wheat*. An attack by slugs (*Agrolimax agrestis* L.) during the winter caused considerable loss of plant in local areas. No relation of attack to manurial treatment was noted. Slugs were collected from the field and the damage reproduced in the laboratory. Fraying of the leaves, only the veins being left, is a typical symptom. The barley experiment in this field suffered loss from birds.

GREAT KNOTT. Sugar beet suffered no attacks by wireworm, *Bourletiella* or *Atomaria*, and a good plant was obtained. The forage crop and potatoes were also free from insect attack, but occasional loss in cereals on the rest of the field occurred during the first months of the year from soil insects, e.g. leather jacket.

LITTLE HOOS. *Oats*. Frit fly was generally distributed throughout the field but the damage was not great.

GREAT HARPENDEN. The early sowings of Kale came through in wet weather (middle—end of May) and though flea-beetle was present, little loss occurred. Later sowings were untouched. The earlier sowings were regularly attacked by a flock of pigeons. The plants were well established but in many cases the whole leaf tissue was stripped leaving only the veins.

BARNFIELD. The mangolds germinated well and the full plant did not suffer from insect attack. A strip adjoining the poultry experiment was again attacked, the cotyledons being eaten off. Birds are suspected.

WOBURN

STACKYARD FIELD. Sporadic damage by wireworm and other soil insects in January was spread over the autumn sown cereals. No areas of serious attack were observed. Most of the beans of the forage mixture were eaten off at ground level as at Rothamsted. Only occasional wheat leaf-miner on wheat after mustard. No damage by frit fly was seen. The rotation sugar-beet remained free from attack except for occasional examples of leaf miner (*P. hyoscyami* Panz.). *Plectroscelis concinna* Marsh, often reported as attacking beet, was present but remained on the *Polygonum convolvulus* which was much eaten.

Clover. The clover in the pot cultures of soil taken from Stackyard series D was examined in June. Four varieties, Dutch White, Alsike, Broad Red and Crimson, were sown in Spring 1931 ; in June, 1932, all but the Crimson showed signs of considerable ill health and a microscopic examination showed an eelworm to be present. The identity of the eelworm was confirmed by Dr. Goodey to be *Anguillulina* (*Tylenchus*) *dipsaci* Kühn.

LANSOME FIELD. No insect damage was noted on the precision wheat experiment ; the Brussel Sprouts were badly eaten by hares ; Diamond Back Moth was common on the mustard during June ; no flea beetles were seen.

BUTT CLOSE. The sugar-beet, apart from occasional leaf miner (*P. hyoscyami*) was unattacked. Later, in July, quite large plants were broken off through the tap root at ground level and left. The agent was not certainly identified but pheasants were suspected. Kale was attacked slightly in the cotyledon stage during the end of June. No loss of plant occurred ; at that period of the year the attack is ceasing naturally.

WARREN FIELD. The beans suffered severely, as at Rothamsted, during the winter months, a strip along the road being very noticeably affected. Rodents (mice or rats) were probably responsible. *Sitona lineata* was also present but did no damage ; the larvae were plentiful on the roots at the end of June.

FUNGUS DISEASES AT ROTHAMSTED AND WOBURN, 1931-32

MARY D. GLYNNE

WHEAT

Mildew (*Erysiphe graminis* DC.) was plentiful on the Top Dressing Experiment, Fosters field ; elsewhere only slight. At Woburn it was also slight and on the Six Course Rotation Experiment on Stackyard much less than last year.

Whiteheads (Take-All) (*Ophiobolus graminis* Sacc.) was, as before, infrequent except on wheat grown continuously or in alternate years on the same land. It was slight on Broadbalk, Rothamsted, and on the Alternate Wheat and Green Manure Experiment on Lansome field Woburn, but was very abundant on certain plots of the Continuous Wheat on Stackyard field Woburn, the variations from plot to plot, as recorded by the detailed survey, being much the same as last year. High soil acidity, (pH below 5) almost eliminated it.

Loose Smut (*Ustilago Tritici* (Pers.) Jens.) Brown Rust, (*Puccinia triticina* Erikss.), and Foot Rot, (*Fusarium sp.*) were occasionally found in slight amount, and Leaf Spot (*Septoria tritici* Desm.) was found on most of the wheat crops, but its incidence was slight.

Yellow Rust (*Puccinia glumarum* (Schm.) Erikss. and Henn.) was in general slight though plentiful on some plots on Broadbalk, on the Top Dressing Experiment on Fosters field, on Long Hoos Wheat after Temporary ley, and the Precision experiment, where, as last year it was more abundant on Square Heads Master than on Yeoman II. It was much less plentiful at Woburn than at Rothamsted.

OATS

Mildew (*Erysiphe graminis* DC.) was on the whole slight except in patches under trees in particular on Butt Furlong at Woburn.

Loose Smut (*Ustilago Avenae* (Pers.) Jens.) was only occasional on the variety Unique. Rather more was found on the variety Marvellous.

Crown Rust (*Puccinia Lolii* Niels.) was uncommon, but was found on the Forage oats on Great Knott at Rothamsted.

Leaf Spot (*Helminthosporium Avenae* (Bri. and Caw.) Eid.) was moderate on Little Hoos, Commercial oats in January and February. This crop was then ploughed in and re-sown with Spring Oats, which later showed only slight attack. It was slight to moderate on other oats, becoming rather plentiful on Broadbalk Spring self-sown oats in July.

BARLEY

Mildew (*Erysiphe graminis* DC.) was in general slight except on certain plots in the Top Dressing Experiment on Fosters field where it was plentiful.

Whiteheads (Take-All) (*Ophiobolus graminis* Sacc.) is less common on barley than on wheat, being found only on the Continuous barley on Stackyard field Woburn. The detailed survey showed that the percentage of barley plants affected was considerably less than of wheat, but the critical pH below which little or no disease appeared was, as for wheat, about 5.

Net Blotch (*Pyrenophora teres* (Died.) Drechsl.) was present in all the barley crops, varying from slight to plentiful. On Hoos field Continuous barley, the attack was consistently less severe on Spratt-Archer than on Plumage-Archer and when as often happened every plant was infected the affected areas were fewer and smaller on Spratt-Archer than on Plumage-Archer.

Brown Rust (*Puccinia anomala* Rostr.) was fairly common, varying from slight to plentiful on different plots.

Leaf Stripe (*Helminthosporium gramineum* Rabenh.) was absent on some, slight on other crops including the Continuous barley at, Woburn, but was common on the Continuous barley on Hoos field, Rothamsted, where in most plots Plumage-Archer was more badly affected than Spratt-Archer.

Leaf Blotch (*Rhynchosporium Secalis* (Oud.) Davis) was more than slight only in the Six Course Rotation on Stackyard field Woburn, where it was moderate. It was very infrequent or absent on some of the crops, including Fosters, on the Commercial barley in Long Hoos and Great Knott at Rothamsted and on Butt Close at Woburn.

RYE

Stripe Smut (*Urocystis occulta* (Wallr.) Rabenh.) was occasional on Long Hoos Six Course Rotation.

Brown Rust (*Puccinia secalina* Grove) was slight to moderate on Long Hoos Six Course Rotation.

Leaf Blotch (*Rhynchosporium Secalis* (Oud.) Davis) was moderate on the Rye mixed with vetches and beans on the Six Course Rotation at Rothamsted and on Stackyard field, Woburn.

GRASSES

Ergot (*Claviceps purpurea* (Fr.) Tul.) was common on a number of grasses which were not cut, but allowed to ripen at the edge of the grass plots and between Fosters and Great Knott. It was found on Dactylis glomerata, on Ryegrass, and several other varieties.

GRASS PLOTS

Choke (*Epichloe typhina* (Fr.)Tul.) was found chiefly on Agrostis, but also to a less extent on Dactylis glomerata. Eye estimations showed as before that liming decreased and ammonium sulphate increased the disease. Plots 11—1 and 11—2 (treble ammonium salts), however, contain Agrostis only at the edge, and this was attacked by the disease. A comparison of plots 5—1 with 5—2, 7 with 8 and 9 with 10 showed rather more Epichloe apparent in plots 5—2 and 7 which receive potash than 5—1 and 8 which receive similar treatments without potash, on the other hand, in plot 9, which receives potash there appeared to be rather less disease than in 10 which does not. The evidence appears rather inconclusive as to whether potash deficiency is a predisposing cause for this disease. A more accurate method for assessing the amount of disease present is desirable. How far the manurial effect on the disease depends on the distribution of Agrostis is doubtful.

CLOVER

Downy Mildew (*Perenospora Trifoliorum* de Bary) was plentiful in May and June on the Alsike Clover on Stackyard field Woburn. It appeared to have decreased somewhat by July.

Rot (*Sclerotinia Trifoliorum* Erikss.) was observed in January on the Six Course Rotation Experiment on Long Hoos Field making bare patches and growing as a white mycelium over soil and over plants. The disease was checked by cold weather in February but bare patches remained. It was also found in Fosters Forage and Temporary ley experiments.

Leaf Spot (*Pseudopeziza Trifolii* (Biv.-Bern.) Fuck.) was commonly found though its incidence was slight in January and February on the old leaves, but the new leaves formed in the spring remained free from this disease until harvest.

BROAD BEANS

Chocolate Spot (*Bacillus Lathyri* Manns and Taubenh.) was slight in March but plentiful in July. It was more common on Warren field Woburn than on Pastures field Rothamsted, throughout the season. In July the attack in Warren Field was very severe, practically every leaf of every plant being affected, while on Pastures field, it was patchy varying from moderate to plentiful, though most plants were affected.

Grey Mould (*Botrytis sp.*) was slight to moderate on Warren field Woburn, as early as January. In mid-July it was very plentiful, most plants being infected and about 50 per cent. badly affected. It was consistently less in Pastures field Rothamsted, though by July it was plentiful.

POTATOES

Leaf Roll (*Virus*) was found occasionally.

Blackleg (*Bacillus phytophthorus* Appel) was slight in Hoos, Long

Hoos and Great Harpenden and moderate in Great Knott. It was not found on Stackyard field, Woburn.

Blight (*Phytophthora infestans* (Mont.) de Bary) appeared in late July, mostly on Great Knott where it was moderate in quantity.

Stem Canker (*Corticium Solani* Bourd. and Galz.) was slight at Rothamsted and moderate on Stackyard field, Woburn.

TURNIPS

Finger and Toe (*Plasmodiophora Brassicae* Woron.). There was a very bad attack in Agdell field on the variety Bruce (regarded as resistant).

FARM DIRECTOR'S REPORT, 1932.

Weather

Like the previous season, the year October, 1931, to September, 1932, was distinctly favourable for farm crops and grass. The rainfall was well distributed, while the summer was marked by hot sunny spells. Severe frost during the winter was practically absent, although there were several periods with light frost. The only appreciable amount of snow fell in the last week of December, but quickly disappeared.

October with only 0.66 inches of rain was 2.43 inches below the 79 year average ; mangold carting from Barn Field was completed under unusually favourable conditions ; there was no mud and thus the field escaped the usual cutting up with ruts. Despite this dry spell, it was more difficult to obtain good autumn seed-beds on account of the previous moist summer and wet harvest.

Root-lifting was finished before the weather broke in November. The rainfall of the next three months was all below the 79-year average, February being practically dry, with only 0.21 inches. This facilitated spring work after which numerous showers encouraged a good germination. May was unusually wet with 4.27 inches, compared with the average of 2.15 inches, which encouraged the grass, but also led to the leaching of some of our nitrogenous top-dressings. June had only 0.85 inches and there was a heat-wave at the end of the month and early in July, but well distributed showers kept the grass from becoming burnt up. For both hay-making and harvest the weather was highly favourable and conditions remained reasonably dry up to the end of the farm year. The rainfall for the 12 months was only 23.55 inches, 5.22 inches below the 79 years' average, yet there was never any fear of drought.

The sunshine for the year, 1,406 hours, was 173 hours below the average. This deficit occurred chiefly in April, May, July and September. The only month with an excess of over 12 hours was March with 144 hours (an excess of 28).

The mean temperature for the season practically coincided with the 54 years' average of 48°F. The winter months and August were warmer than usual, while all months from February to May were consistently below their averages. March was cold, with easterly winds, and this withered up the pastures and everything at all green.

For other weather features, see the graph of deviations from average values (p. 66).

Cropping, 1931-32 (For dates, yields and other information, see pp. 108-114).

This year it was the turn of Great Harpenden to receive dung and grow a crop of kale. Since Black Bent is now less conspicuous on this field, part of it was undersown with seeds in the spring of 1931 (under winter and spring oats), to save sowing rye over the whole field in the autumn. After harvest 4 acres were dunged and sown with rye. The seeds adjoining provided excellent material for flushing * the ewes and later for wintering them, after which the area received a good dressing of dung, while the rye was a useful bite for the ewes and lambs in April. Some of this rye, grazed and then left to harvest yielded about 78 per cent. grain, and less than 50 per cent. straw, as compared with the ungrazed area. After grazing and ploughing, the whole field was sown with kale. This year we escaped any trouble with the turnip flea-beetle and had an excellent yield. On the four acres after the rye, however, the kale was much poorer, as has been noticed in previous years. The explanation, now the subject of experiment, is not yet clear but may be only a time-of-sowing effect.

The experiments on kale are described on p. 160-162.

In Pastures field, beans, sown 14th October after potatoes and spring corn, suffered badly round the headlands from pheasants, so that two acres of the field had eventually to be fallowed. The rest of the field yielded well, thereby strengthening the place of beans in our commercial cropping. Immediately after harvest pigs are turned on to our bean stubbles so that we have no trouble with beans coming up in the following crop.

Spring oats were sown in Little Hoos on 26th February, drilling them in two directions. Frost shortly before sowing brought the land into a fine tilth for sowing and the crop looked thick and even. At the foot of Broadbalk another acre of Marvellous oats, self-sown from the previous year, also did well, but suffered badly in the stook from sparrows.

Fosters was this year devoted to experiments, the one year's ley being left untouched round about them and so filling up the odd ground profitably and neatly. The experiments were barley (varietal response to manures and time of sowing), wheat (top-dressing), temporary leys as a preparation for wheat, and forage mixtures (out-of-season sowing).

Great Knott also contained several experiments—potatoes (manurial), forage (time of cutting), forage mixtures, and sugar beet (manuring and cultivation). Wheat occupied the rest of the area. Victor wheat is preferred whenever possible. Although results have shown Wilhelmina and Swedish Iron III to be about equally productive, the strong straw of Victor is an advantage where there is a plentiful supply of nitrogen. The Victor wheat in the wheat experiment in Long Hoos V yielded so heavily that parts of it were laid and serious lodging occurred with one acre of winter oats in Long Hoos VI.

In our experience, spring oats are more successful than winter. The former yield better, and although their straw may be of rather less value, they stand up much better. Provided they are sown early we have had no trouble with frit-fly although occasionally wireworm proves troublesome.

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* By "flushing" is meant the better feeding of the ewes two or three weeks prior to tupping in order to bring them into a thriving condition for breeding.

The kale in Long Hoos I was folded off by sheep during the winter and the last of it was ploughed on 22nd February. Sections II and III after linseed were ploughed earlier and a few nights' frost on narrow furrows, well set up, enabled the whole field to be broken down to a good seed bed for barley. The crop after the linseed received 1 cwt. sulphate of ammonia, and gave a heavy yield, but, despite the folding of the kale, Section I could have stood a similar dressing. All three sections were undersown with a cheap seeds mixture for the sheep during autumn and winter.

The rape kale in Long Hoos VII looked well up to the end of December, 1931, but, after that, suffered badly from pigeons. It recovered later and provided green food at a time when grass was abundant. Even had it been unpalatable to pigeons its yielding capacity would have been low. From our experience, it does not seem worth growing. After the rape kale had been eaten off, mustard was sown and eaten off by our lambs, in preparation for beans.

Classical and Other Experiments

Broadbalk was sown on 13th October, it being the turn of Section II for fallow. In the spring the effect of the previous year's fallow on Section I stood out very clearly, particularly on plots 3 and 5. At harvest most of the plots on this section were very badly laid, with consequent loss of yield. Squareheads Master is a poor variety for measuring the effects of fallow.

One of the most striking results of the fallowing on weed control has been the ease with which Black Bent (*Alopecurus agrestis*) has been suppressed and the extraordinary rapidity with which it has increased after the fallow. Perennial weeds and poppies and most other weeds have now ceased to be troublesome on Broadbalk but Black Bent becomes a very serious weed by the time the next fallow in any particular section is due. Hand-hoeing, even if practicable, would harm the wheat since the Black Bent is so often closely mixed up with the rows of wheat. More intensive harrowing of the wheat, however, is being tried, whenever the ground is sufficiently dry during the winter, and a final harrowing is deferred as long as possible up to the end of April.

In view of the striking results of fallowing on Broadbalk, it was decided to split up each of the two alternate wheat and fallow strips in Great Hoos, into 4 sections, giving each one in turn an extra two years' fallow. This will supplement the information obtained on this question in Broadbalk by giving results on different soil and in different seasons for 3-year as well as 1-year fallows and their residual effects.

Hoos barley was sown this year for the fourth time with two different varieties of barley, in widely spaced rows. It has now been decided to fallow it until it is clean so that we can revert to the old method of narrow spacing, without further break in continuity. The total yields of grain (in lb.) were as follows :

1914-28	(narrow spacing) (average)	33,007
1929	(wide spacing)	18,672
1930		34,794
1931		32,323
1932		38,360

It is still doubtful whether the field, once clean, can be kept clean, even with modern implements. But we have had fair success with Little Hoos which is as clean to-day as it was five years ago, although the intervening crops have been clover hay, wheat, forage and corn, spring oats, and beans. In a small test on commercial barley it was found that the crop from 18 inch rows amounted to 66 per cent. of that from the closely spaced crop.

All crops in Agdell now show signs of suffering from acidity. The swedes are generally badly affected with finger-and-toe disease. This year we tried to overcome this difficulty by using the Bruce turnip, well known for its resistance to the disease, and much used for that purpose in the North of Scotland. A reliable strain of the variety was used but the attempt was a failure. Over 50 per cent. of the roots were diseased, many very badly.

Barnfield produced the best yield of mangolds for many years. The total crop over the whole field averaged over 20 tons per acre. As the production of a good spring tilth is difficult on those plots deficient in organic matter, in recent years we have ploughed the whole field in the early winter. Subsequent frost and weathering have then been effective in producing a fine seed-bed. In many places the top soil is very shallow, sometimes only 4 inches, but we are gradually increasing our ploughing depth. Germination of the mangolds is frequently slow, despite a good tilth, on those plots receiving no dung.

The experimental programme now contains three new rotation experiments, 3-course, 4-course and 6-course. These are worked on sites by themselves, for with their varying length of rotation and the numerous different crops, it is impossible to provide large non-experimental areas of these crops. This difficulty does not arise with the one-year experiments, which could be laid out in the appropriate commercial crops but, for convenience in working, supervision and demonstration have been concentrated within a few fields.

The general method of fitting in the experimental and the non-experimental cropping can be summarised as follows:

Dung is applied to each field once in five years.

Potash and phosphate are no longer applied to non-experimental crops, to minimise the risk of hiding responses to these fertilisers in subsequent experiments.

A period of not less than two years must elapse before a new experiment is laid down on an old experimental site.

About 12 acres of root crops are grown on the non-classical fields annually, chiefly in the form of kale.

About 12 acres of beans are grown on the non-classical fields annually.

Two sites for new long-period experiments are to be constantly held in reserve. At present they are Long Hoos V and VII.

In addition to the results of the kale experiments already mentioned, the forage experiments on Great Knott were particularly noteworthy from a husbandry point of view. In the one case the effect of time of cutting a mixture of oats, vetches and beans, was studied, in the other the effect of different proportions of oats and vetches on total green yield, yield of dry matter, and yield of nitrogen. For further particulars see pp. 148-149 ; 152.

The potato experiment in Great Knott failed to give information on the effect of a winter cover of rye, and on the comparison between autumn and spring dunging. The former question is now being studied in Rotation III and for the second an experiment of improved design is now under consideration.

Grassland

This was another highly favourable season for pastures. As usual there was a tendency towards a shortage early in July but it did not materialise. Wild white clover was again abundant in August. There has been little change recently in the composition of the grassland that has been sown down since 1927, but Great Field is still altering, the amount of clover and of good grasses continuing to increase. No cultivation treatments were found necessary, the animals spreading the droppings on their hooves. In view of the feeding of out-wintered stock it has so far been considered unnecessary to supplement this with nitrogenous top-dressings.

This year we tried the effect of topping the pastures earlier, starting on 14th June. But we found that this was less effective than later. The topped plants at once threw up new flowering stems ; thistles also quickly recovered.

In the autumn we took over two portions of Rothamsted Park each of about 20 acres.

Livestock

Sheep : The work begun last year with sheep has continued. By the end of the year we had over 40 home-bred Half-breds (Border Leicester-Cheviot, F_2) ready for putting to the ram.

The Dorset Horn-Cheviot gimmers obtained from the Earl of Elgin proved earlier than the *average* of our flock in taking the ram, but a number of our ordinary Half-breds were as early. Since gimmers are generally somewhat later in coming in season than ewes, this result appears reasonably satisfactory, although we had hoped to see a more striking difference. A Dorset-Horn ram ran with these gimmers all summer. Now we also have a number of Dorset-Horn x Half-bred lambs and will follow up their time of breeding in the same way.

In August we obtained seven Cheviot ewes, and three half-bred lambs from them, from Carlisle, which all had four very well developed teats. We have also collected a number of half-bred ewes with the same characteristic ; and two rams from America. One is a pure descendant from the flock, now dispersed, of the late Dr. Graham Bell ; the other is a first cross between the Bell stock and the commercial stock of the University of New Hampshire, Durham. Prof. Ritzman of that University kindly presented these animals to us. The point of importance is of course to discover whether ewes with this characteristic are any better mothers than those with two teats.

Those ewes not required for other experimental purposes were divided into two flocks. One was flushed in the ordinary way with good grass, the other received concentrates in addition. There was no significant difference in the number of lambs produced under the two treatments ; the recorded difference at Woburn for the old ewes, though large, is not significant. The following table summarises the results, and the body of the table gives the average number of lambs produced per ewe in each of the different classes of ewes. The figure in brackets gives the number of ewes in each class. The young ewes at Woburn were really gimmers, but some lambed the previous year.

	Old Ewes.			
	Total number of lambs produced per ewe in previous two years.			
	1 or 2	3	4 or 5	Mean.
Rothamsted—				
Grass only	1.62 (8)	2.00 (23)	1.80 (10)	1.81
Grass+Concentrated food	1.54 (13)	1.73 (22)	1.78 (9)	1.68
Woburn—				
Grass only	1.60 (5)	1.71 (14)	1.70 (10)	1.67
Grass+Concentrated food	1.80 (5)	2.00 (7)	2.20 (10)	2.00

	Young Ewes.			
	Total number of lambs produced per ewe in previous year.			
	0	1	2 or 3	Mean.
Rothamsted				
Grass only	1.43(7)		1.80 (15)	1.61
Grass+Concentrated food	1.42(12)		1.87 (8)	1.65
Woburn				
Grass only	1.80 (5)	2.00 (9)	2.00 (2)	1.93
Grass+Concentrated food	1.60 (10)	2.00 (8)	1.50 (4)	1.70

Standard errors of differences between means:

	Old.	*Young.*
Rothamsted	0.137	0.165
Woburn	0.183	0.191

In the autumn of 1931, 228 ewes (51 being gimmers) were put to the ram. The 215 that lambed during February and March, had 322 live lambs at the end of April, among which were 1 quadruplet, and 14 triplets.

An experiment is now under way on the improvement of the technique of grazing experiments. In this 60 tethered sheep are being used in an attempt to discover the difference in feeding value of a five-year-old pasture in Sawyers I, all under the same seeds mixtures, but parts made up of indigenous strains of grasses and other parts of commercial strains.

Cattle. In October, 1931, the stock consisted of 6 cows and 58 cross-bred Angus stores and calves. During the year the policy was continued of buying black polled calves. But unfortunately it has not yet proved possible to start any experimental work on this section. Six recorded pedigree Dairy Shorthorn heifer calves were purchased from the Anderson herd, to replace eventually our present cows. When it is impossible to obtain good quality black calves, at a reasonable price, for they are much sought after, specially in the spring, we are finding it preferable to go in for good quality Shorthorns.

Pigs. The chief development with pigs has been the commencement of an experiment on the technique of animal experiments. The aim is to discover means of increasing the efficiency and accuracy of these experiments. Seventy-two pigs are in the experiment and each is fed individually. Comparisons are also being made between wet and dry feeding, green food and no green food, and different degrees of crowding. For this purpose a number of new pens have been constructed, which can be divided into different sizes at random. Several reserve pigs are kept under similar conditions, to replace any casualties.

ANIMAL DISEASES

During the four years in which livestock have been a feature of the farm a wide variety of ailments has been noted. Even for small animals, whenever an unknown or unusual case has occurred, Mr. George Elmes, our veterinary surgeon, has been called in and shown keen interest in investigating the trouble. Some report of the various instances is now due. The list is probably no more varied than on an ordinary farm, but there a farmer generally avoids incurring expense on a dead or small animal and many interesting cases thus never come to light.

In most instances individual animals only have been affected, but in a few cases several have been involved.

Sheep Diseases.—Our most serious trouble has been Lockjaw (tetanus), affecting the lambs a few days after cutting. In our first experience of it in 1929 we lost half a dozen lambs in rapid succession. In subsequent years we seared the tails of the lambs and inoculated all male lambs with anti-tetanic serum. In both 1931 and 1932 we lost only one lamb, in each case a ewe. Instead of inoculation we have also tried, with success, bloodless castration.

In 1930 we lost a good ewe quite suddenly with volvulus of the bowel.

We have had the usual troubles with bad udders, but up to the end of 1932 had lost very few ewes from this trouble, although some lost either one or both quarters.

A curious trouble has been that occasional ewes, with splendid udders, which have reared lambs in previous years, have completely failed to milk. No treatment has been successful in obtaining milk from these udders ; they have just swollen, grown hard and then gradually diminished in size.

We had kept remarkably free from joint-ill in lambs up to the end of 1932 but we regularly dress the navel with iodine. Lamb dysentery is fortunately still unknown. Several lambs have died from wool-ball and also that curious complaint of " doing too well."

At least two ewes have been affected with gid, one only with scrapie, and one with encephalitis.

As a precaution we periodically dose our lambs for stomach worms with copper sulphate or other vermifuge.

Cattle Diseases.—Our most serious trouble in this case occurred in autumn, 1932. A number of young cattle in Sawyers II, wintered inside previously, suddenly began to scour and lose condition rapidly.

Although brought inside at once they did not improve. One had to be post-mortemed and then the trouble was tracked down to verminous gastritis, a severe infestation in the intestine of *Strongylus axii*. Some responded to treatment, although they received a severe check, but four did not.

In the autumn of 1928, we threw out some sliced sugar beets, left over after sampling for chemical analysis, and two cattle were affected with sugar beet poisoning, one fatally. They appeared to have gorged themselves on the slices. The slices were uncontaminated with chemicals.

Our only other trouble among store or fattening cattle was the loss of one of our best young beasts in 1931 through haemorrhagic gastro-enteritis. It had the appearance of haemorrhagic septicaemia, the occurrence of which in this country is disputed.

In our calf rearing we have been fortunate in escaping any infectious troubles, particularly white scour. We have, however, had cases of pneumonia, particularly in calves which have undergone a long journey, and have had some trouble from scour in putting fresh calves on to cows well on in their lactation.

Horse Diseases. Our horses have kept remarkably healthy and on only one occasion have they required the attention of the veterinary surgeon. In this case one horse was affected with facial paralysis. It gradually yielded to treatment with embrocation externally and strychnine internally.

Pig Diseases. In 1929 we had a slight outbreak of swine fever, brought in by a large white boar from a well-known herd. Luckily no sows or fattening pigs succumbed—as a precaution they were all inoculated—but we lost a number of young pigs.

In 1930 we lost a sow with lock-jaw, the result of putting a numbered disc in her ear.

Apart from the loss of 2 sows with milk fever, one from internal haemorrhage (from the omentum) and one or two deaths (chiefly sudden) from no clear cause, our troubles have been confined to small pigs. The most serious was an outbreak of contagious pneumonia in spring, 1931, which was overcome by turning sows with their litters into outside huts. On several occasions we have sent small pigs to the Cambridge Institute of Animal Pathology. At one time several of the best pigs in several litters were dying suddenly. The cause of death was reported to be septicaemia produced by an organism belonging to the *Salmonella* group of bacteria, infection having occurred through the navel. The Cambridge Institute has also isolated other bacteria from young pigs we have sent. The origin of these troubles was obscure and there have been no further cases for over a year.

On one occasion a sow, which had reared good litters, produced a litter of blind pigs. Although apart from that they appeared healthy, they all died more or less suddenly between four weeks and weaning.

We have been fortunately free from the trouble of scour in young pigs. If it develops it only lasts for a day or two. We attribute this to the attention of our pig man, rather than to any special treatment.

In 1931 we had one isolated case of swine erysipelas.

A.I.V. SILAGE

This autumn we tested this new process, in co-operation with Dr. S. J. Watson, of I.C.I., Ltd., using three crops—green maize, sugar beet tops and kale. Small wooden silos were used for the first two.

Both the maize and beet tops gave well-made silage, but the maize unfortunately was unpalatable. This seemed to be due to the use of too much acid in making it, 14 gallons per ton of diluted A.I.V. stock solution (chiefly commercial hydrochloric acid diluted with four times its bulk of water). The silage had a markedly bitter taste.

With the beet tops only 8 gallons of dilute acid were used for each ton of fresh material, and the product was very palatable, being eaten readily by young cattle.

The kale silage was a total failure, except for a layer of small kale near the top of the stack. Twenty-three tons of marrow stem kale were built into a stack, using the hay elevator, but it was a heavy crop with thick stems and did not settle into a sufficiently compact heap. As a result the bulk of the material continued to ferment and resulted in a rotten evil-smelling heap. The small kale on top, however, had settled down compactly so that fermentation was prevented and this product proved palatable. Its analysis was 20 per cent. dry matter and 1.45 per cent N.

The following table gives the results of ensiling the maize and the beet tops :

		Maize.		*Beet Tops.*	
		Fresh material	Silage	Fresh material	Silage
Total weight, tons		9.19	4.39	10.16	5.90
Dry matter content, % ..		10.28	—	14.45	—
Nitrogen	% in dry matter	2.02	1.80	2.13	2.18
Fibre	% in dry matter	29.92	40.16	9.77	11.90
Total Ash	% in dry matter	12.39	11.67	20.70	32.91

On the assumption that no loss of fibre occurred in the process, there was a loss of dry matter of 25 per cent. of the maize and of 18 per cent. of the beet tops, and in nitrogen of 30 per cent. for maize and 16 per cent. for beet tops. These losses are of the same order of magnitude as have been obtained for silage prepared in silos in the ordinary way.

A preliminary observational test was carried out on the value of the beet silage to young cattle, being outwintered in store condition. Fourteen cattle, receiving 40 lb. silage and 4 lb. concentrates put on 0.92 lb. per day live weight increase while 13, receiving 10 lb. hay and 3 lb. of the same concentrates put on 0.96 lb.

The electrical developments and the possible use of rubber on the farm are described on pp. 19-20.

BUILDINGS

There have been no further developments since the opening of the new buildings by Sir John Gilmour. The equipment and facilities for experimental work are now better than they have hitherto been. A scheme is under consideration for providing facilities for weighing cattle and giving accommodation for the making of dung and Adco under uniform conditions.

STAFF, ETC.

Mr. J. R. Moffatt has now joined the staff as a paid assistant. Mr. E. V. Knight was here for a short time in the autumn as voluntary assistant to help with the livestock experimental work and left to take up a post in connection with pig farming.

At the local annual ploughing match our men had their usual success. Both F. Stokes and A. Lewis appeared among the prize-winners, the former winning the Championship Cup for the second time in four years.

METEOROLOGICAL OBSERVATIONS

Meteorological observations have been systematically made at Rothamsted for many years; these records are being used in the Statistical Department in interpreting crop records. The Station has co-operated in the Agricultural Meteorological Scheme since its inauguration by the Ministry of Agriculture in 1926, and possesses all the equipment required of a Crop-Weather Station. The observations taken under this scheme include:

OBSERVATIONS TAKEN ONCE DAILY: 9 a.m. G.M.T.

Temperatures—maximum and minimum (screen), solar maximum, grass minimum.

Rain (inches) and *Sunshine* (hours and minutes by Campbell-Stokes recorder) during the previous 24 hours.

OBSERVATIONS TAKEN THRICE DAILY: 9 a.m., 3 p.m., and 9 p.m. G.M.T.

Temperatures—wet and dry bulb (screen), 4 inches and 8 inches under bare soil.

Wind—direction and force (continuously recording anemobiagraph).

Weather—(Beaufort letters).

Visibility.

These, together with notes and observations of crop growth are used in drawing up the weekly statement for the purpose of the Crop Weather Report of the Ministry of Agriculture.

Additional data are collected under the following heads:

RADIATION.—A Callendar Radiation Recorder (on loan from the Imperial College of Science) gives a continuous record of the radiant energy falling on a receiver situated on the roof of the laboratory. The records are compared with those for South Kensington, and are also used in plant physiological studies in the Station.

RAINFALL AND DRAINAGE.—The rain falling on one thousandth of an acre is collected in the big gauge erected by Lawes in 1871. Samples of the water are analysed in order to ascertain its nutrient value.

Evaporation.—The amount of water that evaporates in 24 hours from a porous porcelain candle dipping into a bottle of water is measured daily by the loss in weight. This measurement has been found to give a good general indication of the " drying power " of the atmosphere during rainless periods which, being controlled by wind, radiation, and humidity, is difficult to compute from standard data.

Soil Temperature.—Soil temperature records are taken under grass as well as bare soil. These are a continuation of experiments which have been carried out for some years past and which have for their object the determination of the best times for making single temperature measurement for use in calculating averages.

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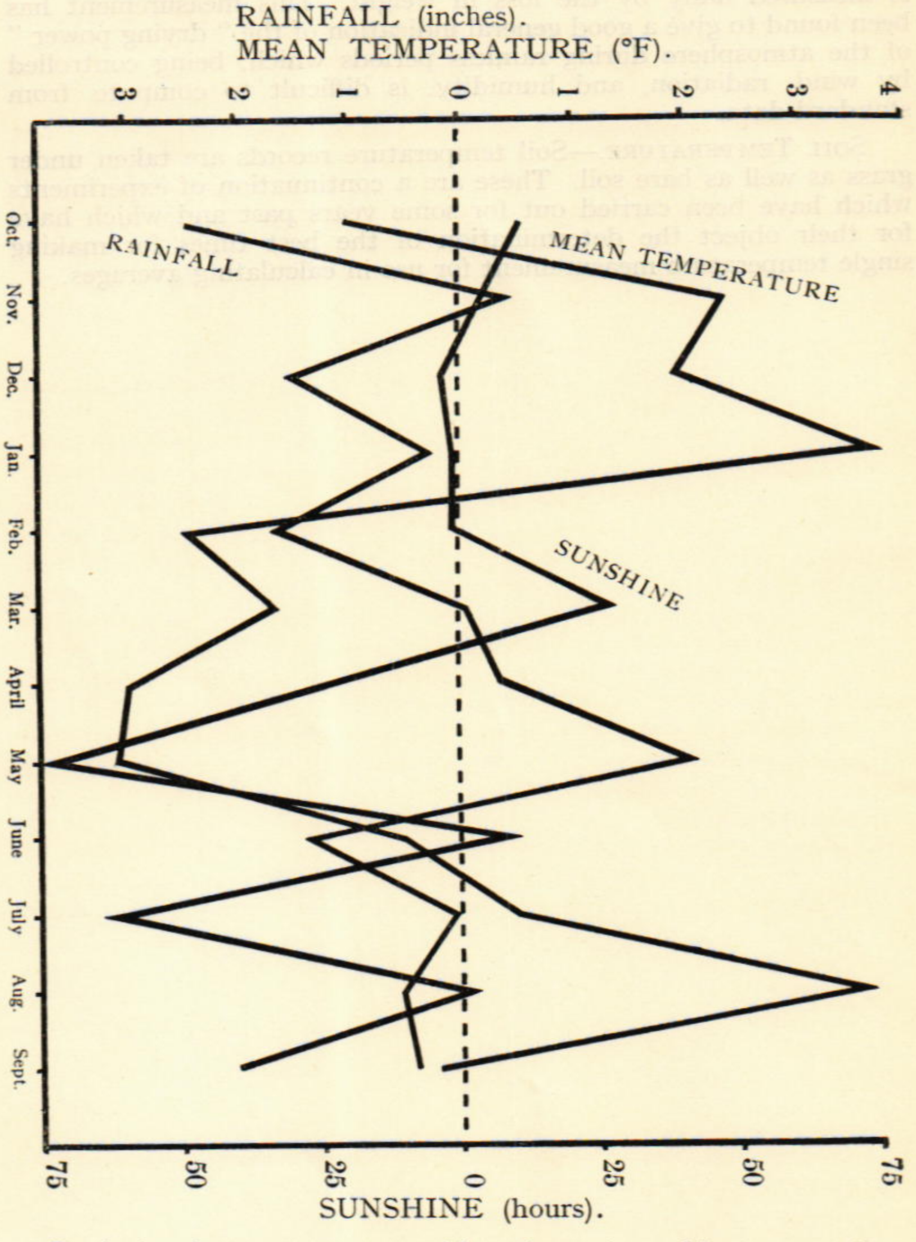

Deviation from average monthly values of sunshine, mean air temperature, and rainfall—Season, 1931-32.

SCIENTIFIC PAPERS

Published 1932, and in the Press

PLANT GROWTH, PLANT PRODUCTS AND ACTION OF MANURES

(Departments of Botany, Chemistry, Fermentation, Physics and Statistics ; and the Imperial College Staff)

(*a*) PLANT GROWTH.

I. F. J. RICHARDS. "*Physiological Studies in Plant Nutrition. III. Further Studies of the Effect of Potash Deficiency on the Rate of Respiration in Leaves of Barley.*" Annals of Botany, 1932, Vol. XLVI, pp. 367-388.

The part played by water content in determining the differences in the usual characteristics between leaves from barley grown under various types of mineral salt deficiency is discussed ; the conclusion is reached that differences in the ratio of dry weight to leaf area between treatments are almost wholly accounted for by differences in water content, whereas the variation of this ratio from leaf to leaf on the same plant is due primarily to variation in anatomical structure.

Results of experiments on the respiration rate of the successive leaves from plants grown at four external potash concentrations are presented. They show clearly that, in general, as the level of potash concentration is lowered, respiration rate increases, but that there is an optimum concentration below which the rate again decreases.

The positive correlation between respiration rate and amount of potash supplied, at very low concentrations, is apparently entirely due to the fact that carbohydrate concentration within the leaf is in the minimum. When abundant carbohydrate is present, the evidence is that over the complete range of manuring used there is a negative correlation between respiration rate and amount of potash supplied. A theory based on the amino-acid content of the leaf is put forward in explanation of this.

As the external concentration of potash decreases, so does the internal, but the relationship is not linear. There is strong evidence that where the amount of potash within the leaves is high, much of it may be washed out by rain, but under conditions of starvation what potash is present cannot be removed in a like manner.

II. W. E. BRENCHLEY AND S. G. HEINTZE. "*Colonisation by Epilobium angustifolium.*" Journal of Ecology, 1933, Vol. XXI, pp. 101-102.

Epilobium angustifolium (Rose-bay) established itself on certain acid areas of Park Grass plots on which the herbage had been devastated by the severe frosts of 1928-9, which was followed by exceptional drought. Examination of the pH value of the soil indicated that the varying distribution of Epilobium was a question of competition rather than soil reaction.

Where most Epilobium appeared, the return of the normal vegetation on the devastated patches was less complete than on the other plots, and the young Epilobium seedlings had therefore a better chance of establishing themselves. This fits in with the known facts of the habits of the species, which tends to spring up freely where areas have been cleared by fire, blizzard or similar drastic agencies, to disappear again as other vegetation reasserts itself, as has since happened in this case with the steady improvement in the grass herbage.

III. W. E. BRENCHLEY AND K. WARINGTON. "*The Weed Seed Population of Arable Soil. II. Influence of Crop and Methods of Cultivation upon the Relative Abundance of Viable Seeds.*" Journal of Ecology, 1933, Vol. XXI, pp. 103-127.

The weed seed population of the soil is greatly influenced by the type of crop grown. Soil conditions being similar, the composition of the flora under continuous wheat and barley is very much the same, but the relative abundance of the constituent species varies greatly, some being favoured by the wheat crop and others by the barley.

When fallowing operations are carried out, most species of weeds are reduced in number, but the degree of reduction ranges over a wide percentage, while a few species may even be increased. These variations seem to depend upon the correlation between the times of the fallowing operations and the periods of maximum germination of the different species, coupled with the length of their natural dormancy. If the intervals between cultivations are too prolonged, some species are able to reach maturity and replenish the soil with so many seeds that the beneficial effect of the fallowing is entirely lost.

When land is cropped, the processes of cultivation affect the weed flora more variably than is the case with fallowing. On the same area some species may be drastically reduced, while others may be doubled or trebled in quantity. This again depends on the correlation between the date of sowing the crop, the method of cultivation, and the habits of the weed species as regards maximum period of germination and length of natural dormancy.

Some weed species respond to cropping and fallowing in the same general direction, being reduced by both methods of cultivation. Other species may be generally reduced by fallowing, but behave variably under crop, being increased or decreased in different seasons.

From the agricultural point of view it is apparent that unless fallowing operations can be carried out with a much greater degree of thoroughness than is usual, reduction of many weeds can be effected almost as well and more economically by intensified cultivation while the land is under crop. Other species, however, which tend to increase in some seasons under crop conditions, may be more effectively dealt with by fallowing if their predominance justifies the expense, which implies loss of crop as well as the cost of numerous cultivations.

IV. R. J. KALAMKAR. "*A Statistical Examination of the Yield of Mangolds from Barnfield at Rothamsted.*" Journal of Agricultural Science, 1933, Vol. XXIII, pp. 161-175.

Series of yields (root weight) of twenty-five plots of Barnfield mangold field are analysed into components representing (*a*) deterioration, (*b*) slow changes other than steady deterioration, (*c*) annual fluctuations. The first two of these components are exhibited graphically from 1876 to 1930.

Yields are well maintained on the dunged strip, except for the last few years. This falling off does not appear in the other strips, and may be due to a falling off in the quality of the farmyard manure in the last five years.

On the strip receiving farmyard manure, and on that receiving superphosphate, the plots receiving nitrate of soda yielded more highly than any others ; on the strips receiving complete minerals, and on that receiving superphosphate and potash, the two plots receiving rape cake in one case, and sulphate of ammonia and rape cake in the other, gave higher yields than nitrate of soda ; on the strip receiving no minerals the result is intermediate, there being little to choose between these three plots. On all strips sulphate of ammonia is the least satisfactory of the four nitrogenous dressings tested.

In 1876 the land had been already for many years under experiment, and the deterioration from this date is not very striking. The complete minerals and the superphosphate plots Series O (without nitrogenous manure) show significant deterioration, as does the strip without minerals on Series AC (rape cake and ammonium sulphate). On the strip without minerals the unmanured plot also, and that receiving rape cake, both show a strongly suggestive deterioration.

Slow changes other than deterioration are unimportant relatively to annual variation except on the dunged plots. Change in the type of cultivation, prevalence of weeds and change in the quality of the manure, are suggested as the probable causes of the slow changes occurring on these plots.

Plots receiving organic manures or potash have shown relatively smaller annual variance. Plots receiving nitrogenous fertilisers have a large annual variation.

(*b*) PLANT PRODUCTS

V. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship Between Viscosity, Elasticity and Plastic Strength of Soft Materials as Illustrated by Some Mechanical Properties of Flour Doughs. I.*" Proceedings of the Royal Society of London, A, 1932, Vol. CXXXVIII, pp. 707-718.

An extended significance is given to Maxwell's "time of relaxation," and this has been used in quantitatively describing the viscous and elastic behaviour of flour dough. The length of the time of application of a stress in relation to the corresponding time of relaxation determines what proportion of the deformation is elastic (recoverable) and what proportion plastic (non-recoverable). This fact is illustrated by a comparison of the behaviour of dough in the "pachimeter" and on the "rack," the behaviour in the "pachimeter" (rapid stressing) being paralleled by that exhibited in a ballistic experiment. The decay of internal stress in pieces of dough which had been stretched out and held stretched has been followed, and the times of relaxation and the corresponding viscosities have been evaluated for a series of stresses. Dough shows a phenomenon similar to the hardening of metals under working as a result of which the time of relaxation and the viscosity for a given stress depend on the total deformation.

The internal structure of the dough thus revealed is briefly considered.

VI. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship between Viscosity, Elasticity and Plastic Strength of a Soft Material as Illustrated by some Mechanical Properties of Flour Dough. II.*" Proceedings of the Royal Society of London, A, 1933, Vol. CXXXIX, pp. 557-566.

The dependence of the viscosity of a flour dough on the shear which has taken place as well as on the shearing stress is brought out by a series of observations on the rate of shear in cylinders of unyeasted dough hung vertically and allowed to elongate under the action of gravity.

The deformations were recorded by marking a millimetre scale in enamel on the surface of the dough cylinders, and, after elongation had proceeded for a measured time, printing the deformed scale off on to a strip of duplicator paper. The print has been called a rheogram.

The conditions of test correspond closely with those ruling inside a dough distending under the action of yeast, but whether the method is capable of distinguishing the small differences which are of importance in baking has still to be determined.

VII. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship between Viscosity, Elasticity and Plastic Strength of a Soft Material as Illustrated by some Mechanical Properties of Flour Dough. III.*" Proceedings of the Royal Society of London, A, 1933, Vol. CXXXIX, pp.

A further study of the mechanical properties of flour dough has revealed the presence of two properties in addition to hardening, both of which are well known in the study of metals: namely, elastic after-effect and elastic hysteresis.

The first necessitates the addition of a term $d\alpha/dt$ to the Maxwell equation, which then becomes:

$$\frac{de}{dt}=\left(\frac{l}{n}\frac{dS}{dt}-\frac{d\alpha}{dt}\right)+\frac{1}{\eta}\cdot S$$

This term is only important when abrupt changes of stress have recently occurred.

The second property causes n to decrease steadily whenever dS/dt preserves the same sign for some time, and to increase abruptly when the sign of dS/dt is changed.

In Paper II it was shown that the viscosity, as determined from the rate of flow, agreed roughly but not exactly with that calculated as the product of the rigidity modulus and the relaxation time. It is now clear that the value adopted for n was a mean value, and differed somewhat from that appropriate to the conditions during stress relaxation. Due appreciation of this point renders the agreement quantitative.

VIII. F. E. DAY. "*Laboratory Trial Brews with New Varieties of Hops.*" Journal of the Institute of Brewing, 1932, Vol. XXXVIII, pp. 16-18.

Samples of several of the new varieties grown at E. Malling in 1930 were compared with E. Kent Goldings, Saaz, and Oregon hops by means of small-scale brewings. Oregon x English and German x English crosses had flavours intermediate between their parents. Manitoba seedlings gave very bitter flavour. Small-scale brewings are definitely of value in comparing hops. Bitterness of beer is not proportional to α-resin addition.

IX. F. E. DAY (in part). "*A Method for the Quantitative Comparison of the Relative Stabilities of Hopped Worts before and after Fermentation.*" Journal of the Institute of Brewing, 1932, Vol. XXXVIII, pp. 308-310.

Small-scale brewing tests gave evidence of the dependence of beer stability on hop resin content, other things being equal. Support is therefore given to the value of analyses of hops for determining their preservative strength.

(*c*) ACTION OF MANURES

X. W. E. BRENCHLEY. "*The Action on the Growth of Crops of Small Percentages of Certain Metallic Compounds when Applied with Ordinary Artificial Fertilisers.*" The Journal of Agricultural Science, 1932, Vol. XXII, pp. 704-735.

Copper. No beneficial effect on the growth of barley or mustard on two types of soil was obtained by the addition of quantities of copper sulphate ranging up to 4 per cent. of the total artificial fertilisers applied.

Vanadium. Increased fineness of grinding of basic slag in some cases brings about a certain reduction of crop, which may be due to the presence of vanadium in such slags.

Lithium. Barley is less sensitive to the toxic action of lithium than of copper, and a suggestion of stimulation was obtained with very dilute solutions in the presence of nutrient salts. Buckwheat is more sensitive to the action and exhibits stimulation with any concentration.

Titanium. The growth of mustard on two different soils was not improved by small proportions of titanium compounds added to the usual artificial fertilisers.

Aluminium. Barley proved to be very sensitive to the toxic action of aluminium sulphate, the harmful effect becoming more evident when the nutrient solutions were renewed, so that fresh supplies of poison were brought into contact with the roots. Peas were much less affected, remaining quite healthy in concentrations which killed barley. No evidence of stimulation was obtained with barley, peas, or maize, with any strength of aluminium sulphate, however dilute.

XI. E. M. CROWTHER. *"The Present Position of the Use of Fertilisers."* Journal of the Royal Agricultural Society of England, 1931, Vol. XCII, pp. 16-18.

A survey of the statistics for the world's production of fertilisers from the beginning of the industry to 1930 showed that for long periods before the war the annual percentage increase in output was remarkably steady. By the time of the "nitrogen crisis" of 1931, the total world output had reached the level that would have been attained if the relative rate of increase had continued at its pre-war rate. Comparisons of the results of large numbers of fertiliser trials brought out the uniformity of the average responses to unit N, P_2O_5, and K_2O in their effects on crops, but the wide differences in the ratios of the amounts of the fertiliser consumed in different countries.

XII. E. M. CROWTHER. *"The Loss of Lime from Light Soils (an Examination of the Woburn Barley and Wheat Soils)."* Journal of the Royal Agricultural Society of England, 1932, Vol. XCIII, pp. 199-214.

The exchangeable calcium contents of soil samples taken from the Woburn Experimental Station in 1927 after 50 years of continuous cultivation for wheat and barley and again in 1932 after two years of fallow and three years of cropping without manure are discussed in relation to the recovery of the lime added and the effects of farmyard manure, nitrate of soda, ammonium sulphate, and mineral manures. The conclusions are used in order to interpret past and present practices in light land farming and to show the type of field experiment now urgently required at a number of representative centres.

XIII. E. M. CROWTHER AND R. G. WARREN. *"Report on Field, Pot and Laboratory Work. Appendix to Tenth Interim Report of Permanent Committee on Basic Slag, Ministry of Agriculture,"* 1932, Vol. X, pp. 4-21.

This report gives (*a*) the yields and chemical composition of hay in a series of field trials on four phosphatic fertilisers, mostly in the second year of experimentation; (*b*) the results of a similar trial on pasture grazed by cattle and sheep except for a short period in the season when the produce was mown, weighed and analysed. A series of such separate experiments with interrupted grazing and one with repeated mowing without grazing has shown high effects from the more soluble fertilisers. Over 16 per cent. of the phosphoric acid added in superphosphate was recovered in the first year; (*c*) the results of a repeated mowing experiment for three years in Devon; (*d*) the results of pot experiments for three years on barley.

XIV. H. L. RICHARDSON. *"The Behaviour of Nitrogenous Fertilisers in Grassland Soils."* Agricultural Progress, 1933, Vol. X, p. 160-163.

Systematic determinations of ammonia and nitrate nitrogen in grassland soils showed that the ammonia level was generally higher than the nitrate level. There was a very rapid disappearance of added nitrate and a rather less rapid removal of added ammonia. The rate of removal of the latter, however, was such as to suggest that some of the ammonia might be taken up directly without nitrification. This was made practically certain by a study of the rate of nitrification, which was very low in certain soils from which ammonia was rapidly removed.

The equilibrium between ammonia and nitrate production in these soils is discussed.

XV. J. G. SHRIKHANDE. "*The Degree of Humification in Manures Measured by the use of Hydrogen Peroxide.*" Soil Science, 1933, Vol. XXXV, pp. 221-228.

It is known that humified organic matter can be distinguished from non-humified by the action of hydrogen peroxide. The action of three per cent. hydrogen peroxide has been used for measuring the degree of humification which appears to be a useful measure of the decomposition undergone by any one kind of plant material under different treatments. The loss after extraction with peroxide is not an infallible guide to the value of organic manures in general. A comparison has also been made between the extractive properties of water and peroxide.

STATISTICAL METHODS AND RESULTS

(Department of Statistics)

(*a*) MATHEMATICAL THEORY

XVI. R. A. FISHER. "*Inverse Probability and the Use of Likelihood.*" Proceedings of the Cambridge Philosophical Society, 1932, Vol. XXVIII, pp. 257-261.

An explanation of the distinction between these two methods of reasoning from experience, with a correction of some allusions to likelihood in which they are confused.

XVII. R. A. FISHER. "*The Concepts of Inverse Probability and Fiducial Probability Referring to Unknown Parameters.*" Proceedings of the Royal Society, A, 1933, Vol. CXXXIX p.p. 343-348.

The argument of Jeffreys in favour of a particular frequency distribution *a priori* for the precision constant of a normally distributed variate rests on the fallacy that the probability of the last of three observations, lying between the previous two, should be one-third, *irrespective of the distance apart of the two previous observations.*

The apparent simplicity of the results of assuming this particular distribution *a priori* rests on the fact that the *inverse* and the *fiducial* probability statements about the unknown parameter are thereby made to coincide, though logically they are entirely distinct. This particular distribution *a priori* is, however, not only hypothetical but unacceptable as such, since it implies that all ranges of values of the parameter covering finite ratios, however great, are infinitely improbable.

F

XVIII. F. YATES. "*The Principles of Orthogonality and Confounding in Replicated Experiments.*" Journal of Agricultural Science, 1933, Vol. XXIII, pp. 108-145.

The procedure of confounding certain treatment effects, either direct effects or high order interactions, with fertility differences, has been utilised in certain agricultural field trials of the complex type at Rothamsted and elsewhere for some years. The present paper describes the principles underlying this procedure, and the appropriate methods of analysis, and draws attention to certain dangers which must be guarded against when designing or analysing experiments of this type.

The discussion of confounding necessarily involves the consideration of the independence, or *orthogonality*, of the various sets of degrees of freedom appearing in the analysis of variance. The concept of orthogonality is therefore discussed, and the modifications which are necessary in the ordinary procedure of the analysis of variance when dealing with non-orthogonal data are illustrated by application to an example where there is a double classification (in this case classification by sex and treatments in a poultry feeding trial) and where the numbers in the various sub-classes are unequal, treatments not being equalised for sex, or sex for treatments. This type of data is of frequent occurrence where observation rather than planned experiment is the source of information. In addition to the accepted method of fitting constants by the method of least squares, various shorter methods of analysis are described, and their validity and applicability discussed.

XIX. F. R. IMMER. "*The Efficiency of the Correlation Coefficient for Estimating Linkage Intensities.*" American Naturalist, 1931, Vol. LXV, pp. 567-572.

Takezaki and Owen had independently derived a method of estimating linkage by means of the correlation coeffcient.

Takezaki derived a formula for the standard error of his estimate of p from the assumption that the standard error of r, obtained from the fourfold table, could be equated to the standard error of a correlation coefficient derived from a normal frequency surface having the same number of observations. This mistaken assumption has led to the precision of this method of estimating linkages being greatly over-estimated.

It is found that the curve for the actual efficiency of the correlation method calculated from the correct formula, does not exceed 100 per cent. for any possible values of p, from 0 to 1, in accordance with the general theory. The correlation method is fairly efficient in the coupling phase, and for loose linkage in repulsion. For close linkage in repulsion it is not efficient. Since there are other formulæ such as the maximum likelihood method, and the product ratio method, which are efficient for all values of p, it would seem preferable to use these formulae in most cases.

XX. R. S. KOSHAL. "*Application of the Method of Maximum Likelihood to the Improvement of Curves Fitted by the Method of Moments.*" Journal of the Royal Statistical Society, 1933, Vol. XCVI, pp. 303-313.

A method is given for the improvement of inefficient statistics obtained by the method of moments. It consists in the evaluation of a number of L's directly from the equation $L=S$ ($n_s$log p). For the estimation of S parameters it requires the calculation of $\frac{1}{2}(S+1)$ $(S+2)$ values of L. These values of L provide simultaneous equations from which the corrections to be added to the moment estimates of the parameters can be calculated. The method is illustrated by its application to a coarsely-grouped skew distribution to which Pearson's Type I was fitted by the method of moments. It is shown that the calculation of additional fourteen values of L is not laborious, as most of the material for this calculation is provided by the moment solution.

XXI. T. Eden and F. Yates. "*On the Validity of Fisher's z Test when Applied to an Actual Example of Non-normal Data.*" Journal of Agricultural Science, 1933, Vol. XXIII, pp. 6-17.

The validity of Fisher's z test depends theoretically on the assumption of normally distributed data. Since certain types of agricultural and other data to which the test may be usefully applied are decidedly non-normal in distribution practical tests with data of this nature are of importance in order to establish that the departures from normality ordinarily met with do not, in fact, invalidate the test. In this paper a test is described on data from the observation of height measurements on wheat. The data were arranged as an 8 block uniformity trial of 4 plots per block, and the distribution of the values of z obtained for a thousand random arrangements of the treatments. This distribution was found to agree satisfactorily with the theoretical distribution for normal data.

(*b*) TECHNIQUE OF FIELD EXPERIMENTS

XXII. S. H. Justesen. "*Influence of Size and Shape of Plots on the Precision of Field Experiments with Potatoes.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 366-372.

A uniformity trial with potatoes was used for investigating the effect of size and shape of plots on the precision of field experiments. Up to a certain limit the standard deviation in per cent. of the mean decreases when the size of plots is increased ; further increase of plot size increases the errors as a lesser part of the soil variation can be removed.

Two-row plots show less variation than either 1 or 3-row plots. This may be explained by row competition.

When the area to be used is fixed, smaller plots are more efficient than larger, owing to the greater number of replications in the former case. One exception occurs in the case where border rows are not harvested ; here 4-row plots are more efficient than 3-row plots, owing to the fact that a larger part of the area is included in the calculation when 4-row plots are used.

Long and narrow plots are more efficient than shorter and wider of the same size. The only exception is again explained by row competition.

In field experiments with potatoes, fairly large plots should be used ; at least two rows wide and preferably long and narrow strips.

XXIII. R. J. KALAMKAR. "*Experimental Error and the Field Plot Technique with Potatoes.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 373-385.

The present investigation consists of the statistical analysis of a uniformity trial with potatoes, conducted by Dr. Kirk. In this study the standard error in per cent. of the mean decreased slightly with the increase in the widths up to plots five rows wide, but any further increase in the width of the plot resulted in the higher standard error. The fertility contour map of the field is given to show graphically the effect of soil heterogeneity on the yield. The increased size of the plot resulted in decreased efficiency in the use of the land when the entire plot was harvested ; in other words, given a piece of land of certain size, it is advantageous to have a greater replication ot smaller plots than a smaller number of larger plots. Four-row plots proved to be the most efficient when the border rows are discarded. The superiority of long and narrow plots over shorter and wider ones is demonstrated.

XXIV. R. J. KALAMKAR. "*A Study in Sampling Technique with Wheat.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 783-792.

The edge rows give significantly higher yields than the inside rows, indicating thereby the inadvisability of using edge rows in yield trials.

The variation between rows is very much greater than within rows. Different parts of the same drill row should therefore not be regarded as subject to independent error. The present investigation emphatically confirms Clapham's conclusions on this point.

A slight advantage may be gained by the subdivision of the area to be sampled, without additional labour.

In order to study the effect of the structure of a sampling unit of given size, five types of unit have been examined. Of these, method (1), in which the " sampling unit " consists of four parallel half-metre lengths on adjacent rows, appears to be the most precise, and may be recommended on the basis of this trial. The half-metres within such sampling units appear to be negatively rather than positively correlated, and a significantly lower sampling error is obtained in consequence.

Effect of competition between the rows is suggested as the probable explanation for the smaller variation between the sampling units than within them in method (1). Similar analysis on the ear number for the same method, moreover, showed that variation within sampling units was significantly less than the variation between sampling units. This is regarded as additional evidence that there is a competition effect in samples obtained by method (1).

Eighteen such complex units amounting to 36 metres of drill from one-fortieth acre plots would give about 5 per cent. sampling error.

A significant correlation of 0.73 between yield and ear number is obtained. This fact can be used to obtain increased precision for the prediction of yield when the number of ears is known.

XXV. F. R. IMMER. "*A Study of Sampling Technic with Sugar Beets.*" Journal of Agricultural Research, 1932, Vol. XLIV, pp. 633-647.

Sampling technique was studied in relation to the determination of sugar percentage in sugar beets.

Regression of sugar percentage on weight of roots was not entirely linear. Ninety-two per cent. of the quadratic regression could be explained in terms of the linear function.

Soil heterogeneity between plots was found to affect sugar percentages significantly, even when the effect of weight was held constant by means of the regression relationship.

Tables are given showing the number of beets per plot needed to reduce the standard error of the mean to 0.3, 0.2, and 0.1 per cent. sugar for various sizes of plots and numbers of replications.

Variability in sugar percentage between plots and within plots must be considered in estimating the size of sample required and the number of replications needed to reduce the standard error to a given level.

The standard error of the mean of total sugar per beet was somewhat lower than the standard error for weight and much higher than that for sugar percentage.

Variability in sugar percentage between plots was essentially the same whether calculated from the mean of 10 beets analyzed individually or from a composite sample of the same number.

XXVI. F. R. IMMER. "*Size and Shape of Plot in Relation to Field Experiments with Sugar Beets.*" Journal of Agricultural Research, 1932, Vol. XLIV, pp. 649-668.

Studies of size and shape of plot in relation to field experiments with sugar beet have been made, and the relationship determined between weight, sugar percentage, and apparent purity.

Standard errors, expressed in percentage of the mean, decreased in general with increased size of plot. An explanation is offered to account for a greater standard error from 6-row plots than from 3 or 4-row plots, when the entire plot is harvested.

Efficiency in use of land decreased with increased size of plot when the entire plot was harvested. When the border rows of the plots were removed, 4-row plots were most efficient.

Weight of beets was significantly correlated (negatively) with sugar percentage, but not with apparent purity. Sugar percentage was highly correlated (positively) with apparent purity. Intra-plot regression and correlation coefficients were given.

Contour maps for weight of roots, sugar percentage, and apparent purity were drawn from data on one hundred 6-row plots 2 rods long.

Sugar percentage varied significantly from plot to plot apart from its relation to weight. Fifty-four per cent. of the variability in apparent purity between plots was due to factors that affected sugar percentage as well.

The sampling error was calculated for sugar percentage and apparent purity determination for 4-row plots 2 rods long. The manner in which the standard error between plots may be reduced by replication and size of sample has been demonstrated.

(*c*) GENETICS

XXVII. R. A. FISHER. " *The Social Selection of Human Fertility.*" (The Herbert Spencer Lecture, delivered at Oxford, June 8th, 1932.) Oxford : The Clarendon Press, 1932, 32 pp.

Lecture delivered at Oxford in commemoration of Herbert Spencer. It is argued that the existence of natural law and the reliability of scientific prediction has the same basis in the physical, the biological and the social sciences.

XXVIII. R. A. FISHER. " *The Bearing of Genetics on Theories of Evolution.*" Science Progress, 1932, Vol. XXVII, pp. 273-287.

Lecture delivered before the Royal Society of Dublin. The biological phenomena of the recessiveness of mutations, of loss of vigour through inbreeding, and of adaptation to ensure cross-fertilisation, are interpreted as evidence that evolution is opposed rather than promoted by the mutations which occur.

XXIX. R. A. FISHER. " *On the Evidence Against the Chemical Induction of Melanism in Lepidoptera.*" Proceedings of the Royal Society, B, 1933, Vol. CXII, pp. 407-416.

A method is given of assessing by calculation the value of evidence of the non-occurrence of recessive mutations under experimental conditions. It appears that the evidence against the induction of melanic mutations in moths by feeding with lead, is insufficient to disprove the existence of mutation rates up to 5 per cent. or 8 per cent., according to the stage at which mutation is postulated.

Mutation rates of this magnitude would be far greater than those which can be certainly induced by any other agency.

The use of back-crosses instead of inbreeding would increase the value of experimental data of this kind by approximately thirty-fold.

THE SOIL

(Departments of Chemistry, Physics and Statistics.)

(*a*) SOIL CLASSIFICATION

XXX. L. L. LEE. " *The Possibilities of an International System for the Classification of Soils. Being a Consideration of the Influence of Geology and Climate on Soil Types. A Comparative Study of South-East England and Central New Jersey, U.S.A.*" Journal of the South-Eastern Agricultural College, 1931, No. 28, pp. 65-114.

An examination of the soils of South-East England, using the American methods of classification as modified for the New Jersey area of the United States. In both areas the soils occur in belts corresponding to the geological formations. Since geology has been the dominant factor in the soil formation of these areas, geological factors therefore receive first consideration in classifying the soils. Climatic factors have altered soil reaction more in Central New Jersey than in South-Eastern England, and, in general, podsolization is further advanced in the soils of Central New Jersey. A similar regional profile is developed in both districts, and consists typically of A horizons which are lighter in texture than the B horizons overlying C horizons, which are heavy or light in texture, depending on the nature of the geological parent material. The textural relation between the A and B horizons is much more marked in Central New Jersey.

XXXI. E. M. CROWTHER. "*Climate, Clay Composition and Soil Type.*" Proceedings of the Second International Congress (1930) of Soil Science, Commission 5, 1932, pp. 15-23.

The results of an earlier (*see* Report 1931, XXXI) statistical analysis of the composition and distribution of American soils in relation to climate are reviewed and similar methods are used to compare the distributions of soils in U.S.A. and U.S.S.R.

(*b*) MECHANICAL ANALYSIS

XXXII. E. M. CROWTHER AND K. TROELL. "*Oxidation of Organic Matter in the Pretreatment of Soils for Mechanical Analysis.*" Proceedings of the Second (1930) International Congress of Soil Science, Commission 1, 1932, pp. 48-51, pp. 253-255.

A critical comparison of the hydrogen peroxide, sodium chloride and sodium hypobromite methods (*cf.* Report 1931, XXVIII).

(*c*) SOIL CULTIVATION

XXXIII. B. A. KEEN AND G. H. CASHEN. "*Studies in Soil Cultivation. VI. The Physical Effect of Sheep Folding on the Soil.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 126-134.

The folding of sheep on light land is commonly believed to improve its tilth by the consolidating effect of the sheep hooves. This belief has been criticised on the grounds that the subsequent ploughing will destroy the consolidation.The matter was investigated in two stages. An instrument, based on the principle of the pile-driver, was used to measure the actual consolidation ; the effect extended to a depth of 10 cm., the maximum compression occurring at 3-4 cm. The effect of subsequent ploughing was measured by passing the soil through a series of sieves of different mesh sizes, and it was found that the consolidation produced by sheep treading was not totally destroyed by ploughing, and further, it was still apparent five weeks later when the seed was drilled.

XXXIV. H. JANERT. "*Die Anforderungen des Maulwurfdränverfahrens an den Boden.*" (Soil Conditions necessary for Mole Drainage). Transactions of the Sixth Commission of the International Society of Soil Science, 1932, Vol. A, pp. 163-176.

The object of mole-drainage is to remove rain-water as rapidly as possible from the surface of the soil, and for this to be achieved the drains must be stable. The drains can only be stable if :

(*a*) The soil is heavy enough. This can conveniently be measured by the heat of wetting of the soil, which should exceed 4 cals./gram.;

(*b*) The soil structure is stable. This stability is measured by the ratio of the percentage of particles of diameter less than 0.02 mm.

(as determined in the Kopecky elutriator) and the heat of wetting. If this value is below 8, the fine particles are sufficiently flocculated not to be re-peptised by water.

(*d*) PHYSICAL PROPERTIES

XXXV. B. A. KEEN. "*Soil Physics in Relation to Meteorology.*" Quarterly Journal of the Royal Meteorological Society, 1932, Vol. LVIII, pp. 229-250.

This paper was the Symons Memorial Lecture for 1932, delivered to the Royal Meteorological Society. It consists of an account of those physical properties of soil of interest to meteorologists, and its scope is sufficiently indicated by the following subject headings : soil classification in relation to climatic zones ; soil temperatures ; the soil atmosphere ; soil moisture ; soil cultivation.

XXXVI. G. H. CASHEN. "*Measurements of the Electrical Capacity and Conductivity of Soil Blocks.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 145-164.

An improved method has been devised for measuring the electrical capacity and conductivity of soil blocks at different moisture contents. While the phenomena are complicated, and depend on the nature of the electrodes as well as on the soil texture, there is evidence that the soil moisture passes through characteristic points. Two of these are identified with Atterberg's constants—the lower plastic limit ; and the moisture content at which air enters the pores. The two lower moisture contents have not yet been completely identified, but one of them seems to be related to the shrinkage and cohesion behaviour of soil and the rate of evaporation of water.

XXXVII. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*Rapid Methods of Examining Soils. I. Measurements of Rolling Weights.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 135-144.

A small cylinder of moist clay is rolled backwards and forwards between two plates by giving a reciprocating motion to the upper one. Weights are gradually added to the top plate until the cylinder just elongates. This weight is a measure of the weight required to deform the soil and is thus related to the agricultural property known as heaviness. The apparatus is suitable for other plastic materials besides soil, and accounts of it have therefore been published in other appropriate journals.

XXXVIII. J. R. H. COUTTS. "*'Single Value' Soil Constants: A Study of the Significance of Certain Soil Constants. VI. On the Changes Produced in a Soil by Exposure to High Temperatures.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 200-202.

Measurements on the loss of ignition of four soils of different physical type are not affected by changes in the temperature of furnace, provided that the temperature is above 600°. Errors in the determination of the loss on ignition are of the order of 1 per cent. of the true value.

The loss in weight of the soils can be ascribed in the main to loss of free and interstitial water up to about 100° ; to destruction of organic colloids between 100° and 250° ; and to destruction of inorganic colloids at higher temperatures.

XXXIX. J. R. H. COUTTS. "'*Single Value' Soil Properties: A Study of the Significance of Certain Soil Constants. VII. The Moisture Equivalent and Some Related Quantities.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 203-211.

The moisture equivalent has been measured (by a technique requiring only small quantities of soil) for a number of samples comprising Natal and Sind soils. It is concluded that while with the latter (alkaline and saline) soils the moisture equivalent gives valuable information, it adds little to the data obtained by other methods for the Natal soils. The xylene equivalent of the Natal soils has also been measured ; from the moisture equivalent and the xylene equivalent, the imbibitional water can be calculated if the specific gravity of the soil is known.

Equations expressing the moisture equivalent and the xylene equivalent of the Natal soils in terms of their loss on ignition and mechanical composition are obtained, and the significance of the relative values of the numerical coefficients in these equations is discussed.

XL. G. W. SCOTT BLAIR AND F. YATES. "*The Effect of Climatic Variations on the Plasticity of Soil.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 639-646.

The plasticity of a soil as measured by the flow plasticity (Soil Science, 1931, Vol. XXXI, p. 291) depends on the climatic history of the soil from which the paste is prepared. In general, soil has a higher plasticity in cold and dry weather than in warm and wet weather, thus affording independent evidence of seasonal fluctuations in the quantity of highly dispersed particles. Mechanical treatment of the soil, *e.g.* flattening and digging, did not produce any regular effect in comparison with the untreated soil, but the design of the experiment was not such as to enable the differences that were observed to be distinguished from the seasonal fluctuations.

(*e*) PHYSICAL CHEMISTRY

XLI. E. W. RUSSELL. "*The Present Position of the Theory of the Coagulation of Dilute Clay Suspensions.*" Journal of Agricultural Science, 1932, Vol. XXII, p. 165-199.

A critical review : the influence of Brownian motion and mass motion of one particle group relative to another in causing collisions between suspended particles ; the electro-kinetic potential and the absence of exact experimental methods of measuring it ; the influence of electrolytes and non-electrolytes on the electrokinetic-potential and the stability of suspensions ; the influence of the type and amount of exchangeable ions on the stability of clay suspensions and their rapid flocculation in electrolyte media with special reference to the effect of secondary chemical reactions.

(*f*) ORGANIC CHEMISTRY

XLII. H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. V. The Origin of the Humic Matter of the Soil.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 291-296.

The results so far recorded in this series of papers support the hypothesis that the humic matter of the soil is derived from lignin, and emphasise the importance of studying the part played by nitrogen in the formation of soil humic matter.

XLIII. R. H. HOBSON AND H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VI. The Extraction of the Organic Nitrogen of the Soil with Alkali.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 297-299.

The alkali-extraction of the nitrogen from soils of certain plots of the classical permanent experiments on Barnfield and Broadbalk, follows a closely similar course to the alkali-extraction of carbon from the same soils.

XLIV. R. P. HOBSON AND H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VII. The Nature of the Organic Nitrogen Compounds of the Soil; 'Humic' Nitrogen.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 497-515.

The nitrogen contained in purified preparations of humic acid obtained from Rothamsted soils cannot be eliminated by methods which would be expected to remove simple nitrogenous impurities. The distribution of nitrogen in the hydrolysates of these preparations of humic acid by hydrochloric acid resembles that in the hydrolysates of proteins. A mixture of egg albumen and artificial humic acid from lignin resembles soil humic acid in the behaviour of its nitrogen on treatment with chemical reagents or enzymes. In soil humic acid the combination of non-nitrogenous humic acid and protein is more intimate than that involved in the formation of a colloidal "salt" by the precipitation of two oppositely charged colloids.

XLV. R. P. HOBSON AND H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VIII. The Nature of the Organic Nitrogen Compounds of the Soil: 'Non-Humic' Nitrogen.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 516-526.

The nitrogen extracted from Rothamsted soils by alkaline solutions but not precipitated by subsequent addition of acid, is made up of 30-40 per cent. as peptides, 5 per cent. as free amino compounds, 12 per cent. as ammonia with the remainder as other, non-basic forms.

MICROBIOLOGY

(Departments of Bacteriology, Fermentation and General Microbiology)

(*a*) BACTERIA

XLVI. E. McCOY. "*Infection by* Bact. Radicicla *in relation to the Microchemistry of the Host's Cell Walls.*" Proceedings of the Royal Society, B, 1932. Vol. CX, pp. 514-533.

It is statistically proved that infection of the root hairs is not a mere invasion of mechanically injured or broken root hairs. The presence of the bacteria, even of strains belonging to foreign inoculation-groups, causes a significant increase in the number of curled and bent hairs. The bacteria produce a secretion capable of modifying the wall, as evidenced by the abnormal curling of the root-hair tips. This secretion is separable from the cells by filtration, and is not specific for the plants of the cross-inoculation group to which the bacteria belong.

The bacteria in culture were unable to attack cellulose, pectin or calcium pectate. Curled tips of root hairs, whether infected or not, contain the same constituents as normal hairs. These constituents are cellulose, calcium pectate, and probably pectose, and a very resistant hemicellulose.

The cell walls of the nodule contain cellulose, a hemicellulose, calcium pectate in the mature parts, and pectose at least in the meristematic tip. Walls of the tip also give a protein reaction. There are numerous pits perforating the secondary layers of the walls, but the middle lamellae appear to be continuous. These pits are of sufficient size to admit infection threads, and it is suggested that the bacterial zoogloea crosses a cell wall by way of the pits. The infection thread is surrounded by a definite sheath consisting of cellulose and hemicellulose ; calcium pectate is absent and the presence of other pectic materials has not been confirmed. The sheath is probably a deposit of the individual plant-cell.

XLVII. JADWIGA ZIEMIECKA. "*The* Azotobacter *Test of Soil Fertility applied to the Classical Fields at Rothamsted.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 797-810.

The kneaded plate (*plaque moulée*) method of detecting deficiency in lime and available phosphate was applied to 79 soil samples taken from the classical Rothamsted arable plots.

The test correctly indicated whether phosphate had been applied in soils receiving little or no nitrogen manures. In soils receiving 86 lb. or more mineral nitrogen per acre, the test usually showed little or no *Azotobacter* growth, even in the presence of phosphate and calcium carbonate. Silica jelly counts showed that *Azotobacter* cells were very much reduced in number in such soils. In some cases the test was modified by inoculating the sample with a culture of *Azotobacter* and it then gave correct indications as to phosphate content.

In general, *Azotobacter*, when present, was found to develop on kneaded plates, if the soil contained at least 10 mg. of water-soluble P_2O_5 per kilogram of soil, but below this limit little growth occurred.

(*b*) PROTOZOA

XLVIII. D. WARD CUTLER, L. M. CRUMP AND A. DIXON. "*Some Factors Influencing the Distribution of Certain Protozoa in Biological Filters.*" Journal of Animal Ecology, 1932, Vol. I, pp. 143-151.

The purity of a medium, as measured by the amount of reducing material present in the solution, and the food supply, are two of the principal factors influencing the distribution of protozoa in sewage filters. The protozoa considered occur throughout a wide range of pH values, but the optima for different species are different.

Where chemical compounds added to the solution affect the protozoan population adversely, it may be due either to the formation of deleterious oxidation products, or to the development of a bacterial flora which is inimical to the protozoa.

(*c*) BIOLOGICAL ACTIVITIES

XLIX. (a) A. G. NORMAN. "*The Biological Decomposition of Plant Materials. VII. The nature of the residual hemicelluloses of rotted straw.*" Biochemical Journal, 1932, Vol. XXVI, pp. 573-577.

The nature of the residual hemicelluloses of well-rotted straw has been investigated. Only very small quantities were obtained, and there was no indication of variation in availability or the accumulation of less available groupings. The results indicate that the distribution and arrangement of the hemicelluloses in the cell-wall are such that microbial attack is not hindered by the presence of any resistant barrier. A water-soluble polysaccharide, probably of microbial origin, was also prepared. It contained 33 per cent uronic acid anhydride, and 66 per cent hexosan, and gave evidence of the presence of glucose units.

XLIX. (b) A. G. NORMAN. "*The Biological Decomposition of Plant Materials. VIII. The Availability of the Nitrogen of Fungal Tissues.*" Annals of Applied Biology, 1933. Vol. XX, pp. 146-164.

Fungal tissue was found to be as suitable a source of nitrogen as ammonium salts or nitrates for the decomposition of straw both by mixed soil flora and by pure cultures of certain fungi. Nitrification in soils of a number of samples of fungus tissue was compared with that of artificial mixtures of equal C/N ratio built up from glucose, cellulose and straw, each with added inorganic nitrogen. A clear correlation was found between the C/N ratio of the fungal material and the nitrogen nitrified. In all cases fungus tissue was at least as readily nitrified as the artificial mixtures. No evidence was found for the existence of a very resistant and unnitrifiable residue from fungus tissue.

L. S. H. JENKINS. "*The Biological Oxidation of Carbohydrate Solutions. II. The Oxidation of Sucrose in the Presence of Different Inorganic Nitrogen Compounds.*" Biochemical Journal, 1933, Vol. XXVII, pp. 245-257.

The effect of different sources of nitrogen on the biological oxidation of sucrose through a percolating filter was studied. Under the conditions of filtration in these experiments there was a considerable disappearance of nitrogen from solutions having C/N ratios of 8.4/1 and 4.2/1, irrespective of the form in which the nitrogen was supplied. Greatest disappearance of nitrogen occurred with nitrite and less with ammonia. The apparent losses when nitrogen was supplied as nitrite and nitrate were most marked in that part of the filter in which carbohydrate oxidation was most active. These apparent losses include the nitrogen immobilised by the microorganisms of the film, and it was impossible to state how much of this was due to losses of elementary nitrogen.

LI. S. H. JENKINS. "*The Biological Oxidation of Carbohydrate Solutions. III. Nitrogen, Phosphorus and Potassium Balances in Percolating Filters.*" Biochemical Journal, 1933, Vol. XXVII, pp. 258-273.

By studying the decomposition of sucrose in percolating filters filled with glass, and so allowing the recovery of the synthesised film, it was possible to draw up balance sheets for the nitrogen, phosphorus and potassium salts added. The recovery of the last two elements was not quantitative, possibly owing to inadequate methods of analysis. In experiments containing sugar and ammonium salts, giving a C/N ratio of 8.4/1, the balance sheets for nitrogen showed that about 14 per cent. of that supplied was lost. With a ratio of 8.4/1 a slight gain was recorded. When filters were supplied with an ammonium salt as the source of nitrogen neither nitrite nor nitrate was detected in the effluents. When the source of nitrogen supplied to the filters was organic neither ammonia nor oxidised compounds of nitrogen were found. The observed losses, therefore, could not have taken place through formation of ammonia or the production of nitrite or nitrate and subsequent denitrification. Liberation of elementary nitrogen is probably carried out entirely within the cells of the organisms.

LII. S. H. JENKINS. "*The Design of Experimental Percolating Filters.*" Biochemical Journal, 1933, Vol. XXVII, pp. 240-244.

Percolating filters of a new design have been constructed composed of sections which fit together so that no air spaces occur between individual sections. These have been made in wood built from six octagonal units, the top and bottom edges of each being bevelled at an angle of 60°. The medium was supported in each section by means of a rustless steel tray. Similar filters have been made with cylindrical glass units joined together by means of wide bands of rubber. The medium was held in each section on a perforated aluminium plate cemented to the bottom of each cylinder. Such filters may be operated as a whole or the changes taking place at any given depth investigated by sampling.

LIII. J. MEIKLEJOHN. "*The Effect of* Colpidium *on Ammonia Production by Soil Bacteria.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 584-608.

In two series of experiments using different media (peptone dissolved in soil extract in the first series, and a synthetic medium containing alanine in the second), cultures containing the ciliate protozoon *Colpidium* with two species of soil bacteria were compared against control cultures containing only the two species of bacteria.

On both media an appreciable reduction in bacterial numbers, as compared with the numbers in the control cultures, was observed in the *Colpidium* cultures, but in spite of this reduction, the *Colpidium* cultures produced more ammonia from peptone than the controls, and nearly the same amount of ammonia and carbon dioxide from alanine as the controls.

In both series of experiments an inverse linear relation was found to exist between total bacterial numbers and the amount of ammonia or carbon dioxide produced per 1,000 million bacteria (efficiency).

In the second series of experiments, the regression coefficients of efficiency on average bacterial numbers are significantly different in the *Colpidium* and the control cultures.

It follows that the presence of *Colpidium* has a stimulating effect on ammonia production, which is not due solely to the reduction of bacterial numbers to an optimum value, and it is suggested that in the cultures in which *Colpidia* are present, the bacteria are kept in a state of physiological youth for a longer period than the normal.

LIV. D. WARD CUTLER AND L. M. CRUMP. "*Some Aspects of the Physiology of Certain Nitrite-Forming Bacteria.*" Annals of Applied Biology, 1933, Vol. XX, pp. 291-296.

One hundred and four species of bacteria which produce small quantities of nitrite from ammonium sulphate have been isolated from filters receiving waste water from a beet sugar factory and these bacteria do not differ in their behaviour on carbohydrates from non-nitrifying bacteria obtained from the same source.

Ammonium lactate is more readily oxidised than is ammonium carbonate, phosphate, sulphate or acetate, and in the majority of cases nitrite itself can also be utilised by these bacteria in the course of growth.

There is positive correlation between increase in bacteria numbers and the percentage nitrite in a culture during the initial growth period and there is evidence that nitrite may disappear slowly from acid solutions without the intervention of bacteria, though this is not invariably the case.

LV. N. W. BARRITT. "*The Nitrification Process in Soils and Biological Filters.*" Annals of Applied Biology, 1933, Vol. XX, pp. 165-184.

Nitrifying cultures in mineral salt solutions were obtained from laboratory percolating filters and resembled similar cultures obtained from soils in their ability to grow on silica gel plates and in showing a low thermal death point. The addition of organic matter depressed the rate of nitrification in comparison with the rate of nitrification in the presence of mineral carbonates. The addition of a solution of carbonic acid also depressed nitrification, and it is inferred that the supposed toxic effect of organic matter is not a direct one, but due to the liberation of excessive amounts of CO_2.

The optimum pH for nitrification is between 6.7 and 8.0. It ceases at pH 9.2 and 5.5, at which point the free acid is spontaneously oxidised to nitric acid without the aid of a specific organism.

An increase in nitrifying power of soil after passage through earthworms is recorded and accounted for by the digestion of organic matter and addition of $CaCO_3$ from the subsoil.

It is suggested that the evidence of many workers points to a possible autotrophic phase in the life cycle of heterotrophic organisms.

THE PLANT IN DISEASE: CONTROL OF DISEASE

(Departments of Entomology, Insecticides and Fungicides, and Plant Pathology)

(*a*) INSECTS AND THEIR CONTROL

LVI. H. F. BARNES. "*Studies of Fluctuations in Insect Populations. I. The Infestation of Broadbalk Wheat by the Wheat Blossom Midges* (*Cecidomyidae*)." Journal of Animal Ecology, 1932, Vol. I, pp. 12-31.

Fluctuations of insect populations are being studied in three directions: (1) the intensity of attack by the larvae; (2) the degree of parasitism; and (3) the dates of emergence and number of broods. Study of the two wheat blossom midges reveals considerable fluctuations in intensity of attack and the extent to which they are parasitised by other insects. Extensive new information regarding the bionomics of these two midges, *C. tritici* and *S. mosellana*, is given.

LVII. H. F. BARNES. "*A Study of the Segmentation of the Antennae in Gall Midges*." Proceedings of the Zoological Society of London, 1932, pp. 323-334.

From a study of over 14,300 individuals of fourteen species of economic importance, it is shown that, in some species and genera, food affects the size of the adult midges only; in others it affects the size of adult midges and, in addition, the number of antennal segments. A formula is given for the frequency and range in the number of antennal segments.

LVIII. H. F. BARNES. "*On the Gall Midges Injurious to the Cultivation of Willows. I. The Bat Willow Gall Midge* (Rhabdophaga terminalis *H.Lw.*)." Annals of Applied Biology, 1932, Vol. XIX, pp. 243-252.

The bionomics of the bat willow gall midge, which does serious damage to certain willows grown for basket-making and the cricket bat willow grown for sets, are described. The midge exhibits a distinct host-plant preference, choosing the bat willow (*S. coerulea*) when possible. But it also breeds readily on a golden willow (*S. alba* var. *vitellina*). It will not attack Black Maul (*S. triandra*), Long Skin (*S. viminalis*) and Dicky Meadow (*S. purpurea*).

LIX. MARGOT E. METCALFE. "Dasyneura leguminicola (*Lint.*), *the Clover Seed Midge*." Annals of Applied Biology, 1933, Vol. XX, pp. 185-204.

An attempt was made, after studying the biology of this midge, to find resistant or immune varieties of red clover. It is suggested that clovers grown for seed production should be in the green-head either before or after the time of maximum emergence of the midges. The dates for cutting the first crop as a means of ensuring a clean second crop are discussed.

LX. MARGOT E. METCALFE. "*Some Cecidomyidae Attacking the Seed of* Dactylis glomerata L. *and* Lolium perenne L." Annals of Applied Biology, 1933, Vol. XX, pp. 327-341.

Three species, two of which were new to science, have been found on these grasses in the Park Grass plots. Unsuccessful efforts were made to compel the midges to attack other grasses. Their biologies are described.

LXI. MARGOT E. METCALFE. "*The Morphology and Anatomy of the Larva of* Dasyneura leguminicola *Lint.* (*Diptera*)." Proceedings of the Zoological Society of London, 1933, pp. 119-130.

The title of this paper is self-explanatory.

LXII. MARGOT E. METCALFE. "*Notes on the Structure and Development of the Female Genital System in* Dasyneura leguminicola *Lint.* (*Cecidomyidae, Diptera*)." Quarterly Journal of Microscopical Science, 1933, Vol. LXXVI, pp. 89-105.

Genitalia of an appendicular nature are absent, the tubular abdominal segments being modified to form a tubular retractile ovipositor. Apart from the ovaries and a portion of the paired oviducts, the efferent system is unpaired and ectodermal in structure. The gonopore is posterior to the ninth sternite and is derived from the primitive spermathecal invagination as in the Coleoptera.

LXIII. H. C. F. NEWTON. "*On* Atomaria linearis *Stephens* (*Coleoptera, Cryptophagidae*) *and its Larval Stages.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 87-97.

A brief survey is made of the habits and life history of *Atomaria linearis* Steph., the Pigmy Mangold Beetle, a pest of sugar beet and mangolds. The egg and larval stages are described for the first time.

LXIV. F. TATTERSFIELD AND C. T. GIMINGHAM. "*The Insecticidal Properties of* Tephrosia macropoda *Harv. and other Tropical Plants.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 253-262.

Preliminary data are reported on the insecticidal properties of three tropical fish poison plants (*Tephrosia macropoda* Harv., *Mundulea suberosa* Benth. and *Neorautanenia* (*Rhynchosia*) *fisifolia* C. A. Sm.).

A list is given of other plants (most of them known to be fish poisons) from many different countries, which have been tested but appear to have little or no toxicity to *Aphis rumicis* L.

Extracts of the stems of black Haiari (*Lonchocarpus* sp.) are shown to be toxic as contact insecticides to young larvae of two species of moths. Older larvae are much more resistant.

All the plants so far tested which are toxic to both fish and to insects are members of the natural order Leguminosae.

LXV. F. TATTERSFIELD. "*The Loss of Toxicity of Pyrethrum Dusts on Exposure to Air and Light.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 396-417.

Pyrethrum powders and dusts, prepared by grinding or by the incorporation of extracts of pyrethrum flowers upon absorbent earths, such as talc and kieselguhr, lose their insecticidal activity on exposure to light and air. The loss is more rapid in the case of artificially-prepared dusts than with ground flower-heads.

Both light and air play an important part in the process of inactivation, as samples of kieselguhr-pyrethrum and talc-pyrethrum dusts stored in closed vessels in the dark or exposed to air in the dark are relatively stable; also samples exposed to light in an atmosphere of carbon dioxide, nitrogen or *in vacuo* lose little of their toxicity under the same conditions of illumination; samples exposed in oxygen, however, rapidly lose their activity.

Both wet and dry oxygen were effective in destroying the activity of the dusts, but apparently at different rates, and the type of reaction may be different in the two cases.

The incorporation of anti-oxidants with talc-pyrethrum and kieselguhr-pyrethrum dusts retards loss of activity due to exposure to light and air.

Such compounds as pyrocatechol, resorcinol, hydroquinone, pyrogallol confer a large measure of protection against loss of toxicity. Phenol and phloroglucinol were not effective.

Tannic acid exerted a considerable measure of protection.

The protection was greater in the case of artificially-prepared dusts than with ground pyrethrum flowers.

There is no conclusive evidence that anti-oxidants, naturally occurring in pyrethrum, play any great part in stabilising the pyrethrins against inactivation. The greater part of the protection would appear to be due to particle size or to cellular inclusion.

(*b*) BACTERIAL DISEASES

LXVI. R. H. STOUGHTON. "*The Morphology and Cytology of* Bacterium malvacearum, *E.F.S., Part II. Reproduction and Cell-Fusion.*" Proceedings of the Royal Society B, 1932, Vol. CXI, pp. 46-52.

New morphological forms have been observed in *Bacterium malvacearum*. The production of coccoid bodies, their liberation and subsequent development to form apparently normal rods are described, as well as the formation of densely spherical bodies, which apparently arise from the fusion of two cells and are liberated by the degeneration of the parent cells.

LXVII. R. H. STOUGHTON. "*The Influence of Environmental Conditions on the Development of the Angular Leaf Spot Disease of Cotton. IV. The Influence of Atmospheric Humidity on Infection.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 370-378.

It was found in control chambers that high humidities favour the development of the disease. Maximum infection occurred at 85 per cent., and diminished rapidly at humidities below this figure. The relation of these results to the experiments on the influence of air temperature is discussed; and it is concluded that the importance of humidity is mainly physical in nature, by affecting the time of persistence of the infection droplets.

(*c*) VIRUS DISEASES

LXVIII. J. CALDWELL. "*The Physiology of Virus Diseases in Plants. III. Aucuba or Yellow Mosaic of Tomato in* Nicotiana glutinosa *and other hosts.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 144-152.

The symptoms induced by aucuba or yellow mosaic of tomato in certain other members of the Solanaceae (notably *N. glutinosa* and *D. stramonium*) differ markedly from those in tomato. Neither formation of intracellular inclusions nor systemic infection occurs in those plants. In *N. glutinosa* the symptoms appear only on the rubbed leaves or portions of a leaf and little multiplication of the virus takes place. In *D. stramonium*, although no mosaic symptoms appear on the host, the virus travels through the tissues and can infect susceptible grafts. The use of *N. glutinosa* as a ready means of demonstrating the presence of a virus agent in a juice has been confirmed and simplified.

It is possible to inject the intracellular spaces of the leaf of *N. glutinosa* with virus juice without rupturing the cells, in which case no symptoms of the disease develop. The virus apparently is unable to enter unbroken cells.

LXIX. D. MACCLEMENT AND J. HENDERSON SMITH. "*Filtration of Plant Viruses.*" Nature, 1932, Vol. 130, p. 129.

By the use of graded collodion membranes it was shown that plant viruses vary in size, as judged by their ability to pass membranes of known porosity. Tobacco mosaic and yellow mosaic have a size of 15 $\mu\mu$, aucuba mosaic of tomato 40-50 $\mu\mu$, a virus of Hyoscyamus 150 $\mu\mu$. With these membranes it is possible to separate two viruses which occur together in nature.

LXX. MARION A. HAMILTON. "*On Three New Virus Diseases of* Hyoscyamus niger." Annals of Applied Biology, 1932, Vol. XIX, pp. 550-567.

The source and general characters of three virus diseases occurring naturally in *Hyoscyamus* are described under the names of Hy. II, III and IV. They have a host range of various solanaceous plants, so far excluding potato. Hy. II and III are not filterable through a Pasteur-Chamberland filter of L3 grade, and are transmitted to and from all hosts except tomato by the peach aphid *Myzus persicae*. They survive for a relatively short period in clarified juice. They have many points in common with, and are probably related to the potato viruses X and Y. Hy. IV is filterable through an L3 candle and no insect vector has yet been found for it.

TECHNICAL AND OTHER PAPERS

GENERAL

LXXI. E. J. RUSSELL. "*The Rural School in the Modern World.*" (Paper presented to the meeting of Rural School Teachers at the Folkestone Conference of the National Union of Teachers, 1932.)

LXXII. E. J. RUSSELL. "*Since Gilbert White—Two Centuries of Change.*" The Gilbert White Fellowship, London, Pamphlet No. 7, 1932.

LXXIII. R. K. SCHOFIELD. "*Colloid Chemistry. Part III. Colloid Chemistry of Clays.*" Annual Reports of the Chemical Society for 1931 (issued 1932), Vol. XXVIII, pp. 351-366.

LXXIV. R. K. SCHOFIELD and E. K. RIDEAL. "*On Gibbs' Adsorption Equation for the Case of Binary Mixtures.*" Philosophical Magazine, 1932, Vol. XIII, pp. 806-809.

LXXV. W. E. BRENCHLEY. "*Openings for Women in Scientific Research.*" Women's Employment, 1933, Vol. XXXIII, pp. 75-76.

LXXVI. HUGH NICOL. "*Agricultural Sources of Mechanical Information.*" Transactions of the Newcomen Society, 1932. Vol. X, pp. 115-119.

LXXVII. HUGH NICOL. "*Railways and Agriculture.*" Railway Gazette, Oct. 14th, 1932, pp. 458-459.

LXXVIII. HUGH NICOL. "*Heat Absorption and Essential Oils.*" Perfumery and Essential Oil Record, 1932, Vol. XXIII, pp. 312-314.

CROPS, SOILS AND FERTILISERS

LXXIX. E. J. RUSSELL. "*Soils and Manures.*" The Farmer's Guide to Agricultural Research in 1931. Royal Agricultural Society of England, 1932, pp. 156-204.

LXXX. H. G. MILLER. "*The Relative Productivity of Scottish, English and Danish Agricultural Land.*" Scottish Journal of Agriculture, 1933, Vol. XVI, pp. 172-184.

LXXXI. H. G. MILLER. "*The Further Development of Agricultural Practice.*" Scottish Journal of Agriculture, 1932, Vol. XV, pp. 160-167.

LXXXII. H. V. GARNER. "*Straw and Crop Residues as Organic Manures.*" Journal of the Ministry of Agriculture, 1932. Vol. XXXIX, pp. 827-833.

LXXXIII. H. G. THORNTON AND HUGH NICOL. "*Suggestions to Prospective Growers of Lucerne.*" Journal of the Ministry of Agriculture, 1932, Vol. XXXIX, pp. 46-52.

LXXXIV. H. G. THORNTON. "*Lucerne in England and Wales.*" Journal of the Ministry of Agriculture, 1932, Vol. XXXIX, pp. 420-428.

LXXXV. W. E. BRENCHLEY AND K. WARINGTON. "*Fallowing for Weed Suppression.*" Journal of the Ministry of Agriculture, 1933, Vol. XL, pp. 32-41.

LXXXVI. E. M. CROWTHER. "*Soils and Fertilisers.*" Reports of the Progress of Applied Chemistry, 1931, Vol. XVI, pp. 479-515.

LXXXVII. H. L. RICHARDSON, "*Work on Soil Science at Rothamsted Experimental Station.*" (In English and Russian). Pedology, 1932, Vol. XXVII, pp. 103-111.

LXXXVIII. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Pachimeter, a Machine for Measuring the Shearing Strength of Plastic Bodies.*" Transactions of the Ceramic Society, 1932, Vol. XXXI, pp. 79-82.

LXXXIX. G. W. SCOTT BLAIR AND R. K. SCHOFIELD. "*The Pachimeter as an Instrument for Testing Materials, with Special Reference to Clays, Soils, and Flours.*" Journal of Rheology, 1932, Vol. III, pp. 318-325.

XC. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Rothamsted Pachimeter.*" Journal of the Society of Chemical Industry, 1932, Vol. LI, pp. 205-206.

XCI. G. W. SCOTT BLAIR. "*Consistency Constants of the Soil with Special Reference to Field Operations.*" Transactions of the Sixth Commission of the International Society of Soil Science, 1932, Vol. A, pp. 246-252.

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WOBURN EXPERIMENTAL FARM REPORT FOR 1931-32

By Dr. J. A. Voelcker, C.I.E., M.A.

A favourable period was experienced for the sowing of winter corn and the weather remained mild and open without much rain through the early part of the winter. Throughout February and March cold east winds with night frosts checked the winter crops and made the period of sowing spring crops unfavourable. Growth was slow in April, but improved in May.

An abundant yield of hay was obtained and the sowing conditions for root crops were good. Corn crops made fair progress during June and July, and were reaped early in August.

The rainfall for the harvest year was 25.51 inches, as against 29.08 inches in 1930-31.

METEOROLOGICAL RECORDS.

	Rainfall.			*Temperature (Mean).*			
	Total Fall.	No. of Rainy Days	Bright Sun-shine.	Max.	Min.	1 ft. in Ground.	Grass Min.
1931—	Ins.	No.	Hours.	°F.	°F.	°F.	°F.
Oct. ..	0.64	5	100.9	55.2	37.8	49.3	35.5
Nov. ..	2.61	17	59.8	50.5	40.0	45.1	35.5
Dec. ..	0.88	12	34.6	45.4	35.9	41.5	33.2
1932—							
Jan. ..	1.44	16	42.5	47.6	36.6	41.9	33.5
Feb. ..	0.23	9	49.5	41.4	30.1	38.1	26.6
Mar. ..	1.79	13	123.0	48.0	30.4	39.5	25.7
April ..	2.21	22	117.1	51.2	37.4	44.7	34.6
May ..	4.92	21	106.0	57.9	43.0	52.2	41.2
June ..	0.67	5	177.5	66.4	46.7	61.8	44.6
July ..	3.80	15	116.4	68.5	53.4	64.4	50.7
Aug. ..	4.31	11	171.9	72.3	53.9	65.6	51.3
Sept. ..	2.01	19	109.0	63.4	46.9	57.5	44.5
Oct. ..	3.43	22	98.4	54.2	40.7	48.8	37.4
Nov. ..	1.22	14	43.2	48.2	38.0	43.7	34.7
Dec. ..	0.48	9	49.6	45.5	35.4	40.5	31.6
Total or mean of 1932 ..	26.51	176	1204.1	55.4	41.0	49.9	38.0

CONTINUOUS GROWING OF WHEAT AND BARLEY.

Stackyard Field, 56th Year

(No manure since 1926)

Wheat.—" Red Standard " wheat, dressed with " Corvusine," was drilled on October 15th, 1931 and, watching being adequately provided, little damage was experienced from pheasants, though starlings were frequently troublesome. The wheat came up well, and showed a fair plant even on the very " acid " plots 2, 5 and 8 ; but the limed portions were better, though lime had in no case been put on since 1918. The best yield was given on plot 11b, which received farmyard manure up to 1926. Owing to the initial weediness and favourable conditions for weed growth, the crops on many plots were seriously affected. Mayweed was thick over all the plots, as also was a newcomer, *Holcus mollis*. Twitch and coltsfoot were abundant, as was vetchling on the nitrate of soda plots. Never before in the 56 years' experience have the plots been so weedy. The crop results are given in Table I.

Table I.—CONTINUOUS GROWING OF WHEAT, 1932.
Stackyard Field—Produce per acre.

Plot.	Manures Applied Annually to 1926 (before the two years Fallow 1926-28). For amounts see Report 1927-28. No Manures in 1929, 1930, 1931 or 1932.	Dressed Corn per acre. Bushels	Total Corn per acre. Cwt.	Weight per bushel. lb.	Straw, Chaff, etc.,per acre. Cwt.
1	Unmanured	5.4	2.79	56.0	10.98
2a	Sulphate of Ammonia	—	—	—	5.61
2aa	As 2a, with 5 cwt. Lime, Jan. 1905, repeated 1909, 1910, 1911	5.3	2.70	54.0	8.50
2b	As 2a, with 2 tons Lime, Dec., 1897	6.8	3.51	56.0	9.64
2bb	As 2b, with 2 tons Lime, repeated Jan., 1905	6.5	3.45	57.0	9.07
3a	Nitrate of Soda = 50 lb. Ammonia	4.9	2.56	57.0	9.21
3b	Nitrate of Soda = 25 lb. Ammonia	4.2	2.13	55.0	7.32
4	Mineral Manures (Superphosphate and Sulphate of Potash)	5.8	2.91	55.5	13.23
5a	Mineral Manures and Sulphate of Ammonia ..	7.6	3.98	57.0	16.04
5b	As 5a, with 1 ton Lime, Jan., 1905	8.1	4.34	59.0	12.16
6	Mineral Manures with Nitrate of Soda	7.7	3.90	56.2	13.64
7	Unmanured	3.8	1.88	54.5	9.66
8a	Mineral Manures and, in alternate years, Sulphate of Ammonia	—	—	—	2.43
8aa	As 8a, with 10 cwt. Lime, Jan., 1905, repeated Jan., 1918	4.4	2.24	56.0	9.32
8b	Mineral Manures and Sulphate of Ammonia (omitted in alternate years)	—	—	—	4.28
8bb	As 8b, with 10 cwt. Lime, Jan., 1905, repeated Jan., 1918	7.6	4.01	58.0	10.89
9a	Mineral Manures and, in alternate years, Nitrate of Soda	6.5	3.38	57.0	14.55
9b	Mineral Manures and Nitrate of Soda (omitted in alternate years)	7.3	3.72	56.0	16.46
10a	Superphosphate and Nitrate of Soda	9.0	4.58	56.5	11.28
10b	Rape Dust	6.5	3.38	57.0	9.04
11a	Sulphate of Potash and Nitrate of Soda ..	9.9	5.17	57.5	14.43
11b	Farmyard Manure	12.3	6.22	55.0	19.00

Noticeably better crops than last year were given on Plots 1 (unmanured), 4 (mineral manures), and 11b (farmyard manure). In contrast to last year no yield was obtained on the plots previously treated with sulphate of ammonia without lime, 2a, 8a, and 8b.

Barley.—Seed, treated with " Corvusine," was drilled on March 16th. As in 1931, two varieties, " Plumage " and " Archer," were drilled in alternate strips.

On 8, 9, 10a and 11a, manurial treatment was renewed, minerals and sulphate of ammonia on 8, minerals and nitrate of soda on 9, superphosphate and nitrate of soda on 10a, and sulphate of potash and nitrate of soda on 11a. The quantities supplied were as given in the Table on page 96 of the 1931 Report, except that on 10a and 11a the amount of ammonium sulphate was reduced to the equivalent of 25 lb. of ammonia per acre.

As the season went on, spurry showed thickly on most of the plots, and, later, other weeds became prominent as with the adjoining wheat ; mayweed, however, was not in such abundance. On the acid

Table II.—CONTINUOUS GROWING OF BARLEY, 1932.

Stackyard Field — Produce per acre.

Plot	Manures Applied Annually to 1926. (before the two years' Fallow 1926-28). For amounts see Report 1927-28. No manures in 1929, 1930 or 1931. For manures in 1932 see footnote.	Plumage.				Archer.			
		Dressed Corn per acre.	Total Corn per acre.	Weight per bushel.	Straw, Chaff, etc.,per acre.	Dressed Corn per acre.	Total Corn per acre.	Weight per bushel.	Straw, Chaff, etc., per acre.
		bushel.	cwt.	lb.	cwt.	bushel.	cwt.	lb.	cwt.
1	Unmanured	0.3*	0.20	—	2.25	0.2**	0.15	—	2.78
2a	Sulphate of Ammonia		No	yield.			No	yield.	
2aa	As 2a, with 5 cwt. Lime, Mar., 1905, repeated 1909, 1910, 1912 and 1923	0.7*	0.43	—	2.21	1.1**	0.78	—	3.50
2b	As 2a, with 2 tons Lime, Dec., 1897, repeated 1912	0.7*	0.50	—	2.07	0.7**	0.43	—	2.71
2bb	As 2a, with 2 tons Lime, Dec., 1897, repeated Mar., 1905.. ..	0.7*	0.57	—	2.43	0.9**	0.64	—	2.57
3a	Nitrate of Soda=50 lb. ammonia	2.2*	1.28	—	4.78	3.2**	1.71	—	6.78
3aa	As 3a, with 2 tons Lime, Jan., 1921	2.2*	1.21	—	4.42	2.7**	1.36	—	4.57
3b	Nitrate of Soda=25 lb. ammonia	1.5*	0.71	—	4.28	2.4**	1.36	—	5.57
3bb	As 3b, with 2 tons Lime, Jan., 1921	2.1*	1.07	—	5.07	2.5**	1.43	—	5.28
4a	Mineral Manures (Superphosphate and Sulphate of Potash) ..	0.5*	0.32	—	2.32	0.4**	0.25	—	2.46
4b	As 4a, with 1 ton Lime, 1915	0.2*	0.14	—	1.25	0.2**	0.18	—	2.25
5a	Mineral Manures and Sulphate of Ammonia		No	yield.			No	yield.	
5aa	As 5a, with 1 ton Lime, Mar., 1905, repeated 1916		No	yield.			No	yield.	
5b	As 5a, with 2 tons Lime, Dec., 1897, repeated 1912	2.8*	1.43	—	6.50		No	yield.	
6	Mineral Manures and Nitrate of Soda	4.2	1.73	39.0	6.75	4.9	2.21	42.0	7.71
7	Unmanured	1.0*	0.57	—	4.37	1.2**	0.64	—	5.04
8a	Mineral Manures and, in alternate years, Sulphate of Ammonia ..		No	yield.			No	yield.	
8aa	As 8a, with 2 tons Lime, Dec., 1897, repeated 1912	12.5	5.57	46.0	11.00	17.8	7.78	45.0	16.28
8b	Mineral Manures and Sulphate of Ammonia (omitted in alternate years)		No	yield.			No	yield.	
8bb	As 8b, with 2 tons Lime, Dec., 1897, repeated 1912	16.7	7.21	44.0	14.21	20.1	9.00	47.0	16.43
9a	Mineral Manures and, in alternate years, Nitrate of Soda ..	18.5	7.75	43.0	16 78	25.2	10.43	44.5	20.36
9b	Mineral Manures and Nitrate of Soda (omitted in alternate years)	21.8	8.98	43.2	20.46	27.6	11.61	44.7	21.57
10a	Superphosphate and Nitrate of Soda..	2.1*	0.92	—	8.17	2.9**	1.37	—	8.62
10b	Rape Dust		No	yield.			No	yield.	
11a	Sulphate of Potash and Nitrate of Soda	3.0*	1.65	—	12.58	5.3	2.44	41.0	13.69
11b	Farmyard Manure	8.5	3.99	41.0	12.94	9.9	4.74	45.0	13.76

*Estimated from average bushel weight (42.7). **Estimated from average bushel weight (44.2).

Manuring in 1932 :

Plots.	Quantity per acre.
1-7	Unmanured.
8a, 8b, 8aa, 8bb	3 cwt. Superphosphate, 1½ cwt. Sulphate of Potash, 1¾ cwt. Sulphate of Ammonia.
9a, 9b	3 cwt. Superphosphate, 1½ cwt. Sulphate of Potash, 2.28 cwt. Nitrate of Soda.
10a.	3 cwt. Superphosphate, 2.36 cwt. Nitrate of Soda.
10b.	Unmanured.
11a.	1½ cwt. Sulphate of Potash, 2.36 cwt. Nitrate of Soda.
11b.	Unmanured.

plots 2a and 5a, sorrel to a great extent had replaced spurry, though it was not to be seen on the limed plots.

The barley began to look yellow and unhealthy, with very short straw. There was little difference between " Plumage " and " Archer."

The crop was cut with the scythe—August 15th to 23rd—and threshed in the field September 6th to 13th.

The results are given in Table II.

The harvest results were the lowest recorded since the cessation (after 1926) of manurial applications. Since the barley grew well at first, the chief adverse factor was, no doubt, the prevalence of weeds, especially spurry, mayweed, chickweed and *Agrostis*. On the unmanured (1932) plots the produce was in no case above 4 bushels per acre, that of the continuously unmanured plot being only 0.7 bushels per acre ; farmyard manure (last applied 1926) gave considerably the highest return, *viz*. 9.3 bushels per acre (11b). The very acid plots, 2a, 5a, 8a and 8b, gave no yield whatever, but wherever lime had been previously given some produce was obtained. Lime, however, in addition to mineral manures alone, proved no benefit (4a, 4b) ; rape-dust also gave a very small yield. In the case of the plots which received manurial dressings in 1932, plots 8 and 9 showed by their yields, amounting to 15.2 bushels per acre on plot 8aa and 24.7 bushels per acre on plot 9b, that the land was capable of responding to a stimulus. The low yields of 10a and 11a have not been accounted for.

The yields from the plots which received nitrate of soda up to 1926 and nothing since were superior to those from plots receiving sulphate of ammonia up to 1926 and, likewise, nothing since that date.

" Archer " gave a greater yield than " Plumage," whether the plot was actually manured in 1932 or had received no manure since 1926.

ROTATION EXPERIMENTS

THE UNEXHAUSTED MANURIAL VALUE OF CAKE AND CORN (STACKYARD FIELD)

Series C. The Alsike presented a good appearance until towards the end of January, 1932, when it became very weedy. A month later there was very little clover visible on either half. About the middle of March, a striking recovery set in and when cut for seed in July, the alsike yielded a crop far better than at once time seemed possible. The growth was patchy, but there were less weeds on the corn-fed half. The weights of clover (Alsike) hay per acre were : Corn-fed Plot, 15.2 cwt. ; Cake-fed Plot, 10.2 cwt.

Series D. After ploughing up the red clover, alsike and tares of 1931, " Red Standard " wheat, at the rate of 12 pecks per acre, was drilled on October 16th. The wheat grew well throughout, giving an excellent crop for this light land. It was cut on August 16th. The results are given in Table III.

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Table III.—WHEAT AFTER CLOVER.
Produce per acre.

Plot.	Head Corn.		Tail Corn.	Straw, Chaff, etc.
	Bushels.	Weight per Bushel lb.	lb.	cwt.
1. Corn-fed . .	16.6	63.2	13	16.3
2. Cake-fed . .	18.5	63.2	22	20.5

The yield differences between the two plots were, as usual, small in comparison with the amounts of nitrogen supplied to the plots when the root crop was fed off in 1929 (corn plot, 24.6 lbs. per acre ; cake plot, 56.5 lbs. per acre of nitrogen).

GREEN CROP AND GREEN MANURING EXPERIMENTS

(a) *Stackyard Field—Series A*

Upper half. 1932. *Green Crops*. Tares were drilled on April 11th, mustard on May 10th—the usual mineral manures (superphosphate 3 cwt., and sulphate of potash 1 cwt. per acre) being given previously. Fair crops were obtained, and these were successively fed off with sheep receiving for each crop 1½ cwt. per acre mixed linseed and undecorticated cotton cake. Second crops of tares and mustard were sown which grew slowly and gave small yields. They were in turn fed off with cake as before. The two feedings of cake provided an additional 15.92 lbs. of nitrogen per acre. After this the land was ploughed and prepared for wheat. Samples of the green crops were analysed (Table IV).

TABLE IV.—GREEN MANURING EXPERIMENT, STACKYARD FIELD.
(Upper Half, 1932).

Plots	First Crop.				Second Crop.				Total.		
	Green Matter per acre. lb.	Dry Matter per acre. lb.	Nitrogen per cent.	Nitrogen per acre. lb.	Green Matter per acre. lb.	Dry Matter per acre. lb.	Nitrogen per cent.	Nitrogen per acre. lb.	Green Matter per acre. lb.	Dry Matter per acre. lb.	Total Nitrogen, peracre lb.
Mustard unlimed	3400	690	1.92	13.2	1440	249	3.71	9.3	4840	939	22.5
Mustard limed . .	2020	376	2.06	7.7	1140	235	2.75	6.5	3160	611	14.2
Tares unlimed	8250	1659	2.72	45.1	460	96	2.94	2.8	8710	1755	47.9
Tares limed . .	8560	1669	3.00	50.1	460	93	2.98	2.8	9020	1762	52.9

Lower half, 1932. *Wheat after Green crops fed off by sheep*.

"Red Standard" wheat, at the rate of 12 pecks per acre, was drilled on October 23rd. The wheat was drilled closely in 7-inch rows instead of the usual 9 inch, but this did not have the hoped-for effect of keeping the weeds in check. The principal weeds were twitch, veronica, shepherd's purse, mayweed, and chickweed ; they were more plentiful on the tares portion than on the mustard one. The plant of wheat was never strong and was always inferior to the adjoining permanent wheat. But in the warmer weather of May, there was not the sudden failure and withering up which had been noticed generally in earlier years. In appearance there was nothing to choose between the two portions. The crop was cut August 16th. The results are given in Table V.

Table V.—WHEAT AFTER GREEN CROPS, FED OFF BY SHEEP.
Produce per acre.

Plot.	*Head Corn.*		*Tail Corn.*	*Straw, Chaff, etc.*
	No. of Bushels.	Weight per Bushel lb.	lb.	cwt.
1. After Tares fed off (unlimed) . .	6.0	58.0	16	9.8
2. After Tares fed off (limed) . .	8.2	57.0	54	14.5
3. After Mustard fed off (unlimed) . .	9.0	59.0	10	11.1
4. After Mustard fed off (limed) . .	5.7	58.5	6	8.0

These results are even lower than those of 1931, the first year in which the falling away of the crops in May had not been experienced.

(*b*) *Lansome Piece. Green crops ploughed in.*

Green crops of mustard and tares were sown in 1932. Tares were drilled on April 8th and mustard three weeks later. The green crops were ploughed in and second crops drilled in July, these in turn being ploughed in. Table VI gives the weights of green and dry matter and nitrogen supplied in each crop.

Table VI.—GREEN MANURING EXPERIMENT, 1932.
Lansome Piece.

Plot.	*First Crop.*				*Second Crop.*				*Total.*		
	Green Matter per acre. lb.	Dry Matter per acre. lb.	Nitrogen per cent.	Nitrogen per acre. lb.	Green Matter per acre. lb.	Dry Matter per acre. lb.	Nitrogen per cent.	Nitrogen per acre. lb.	Green Matter per acre. lb.	Dry Matter per acre. lb.	Total Nitrogen, peracre lb.
1. Mustard old series	2240	352	2.20	7.7	2980	492	2.83	13.9	5220	844	21.6
2. Tares old series	2700	505	2.11	10.7	5380	933	2.98	27.8	8080	1438	38.5
3. Mustard new series	2440	386	2.41	9.3	2820	418	3.13	13.2	5260	804	22.5
4. Tares new series	2150	389	2.65	10.3	3000	630	3.05	19.2	5150	1019	39.5
5. Control new series	2500	410	2.29	9.4	560	105	2.86	3.0	3060	515	12.4

It will be observed that a considerable amount of nitrogen was supplied on the control plot by weeds. Wheat was sown, following the ploughing-in of the second green crops.

https://doi.org/10.23637/ERADOC-1-64

LUCERNE INOCULATION, LANSOME FIELD, 1932

Inoculated and uninoculated seed were sown in strips on April 21st, with a small proportion of mustard seed for the purpose of a cover crop. The lucerne grew well, and a first cutting was taken on August 16th. The average yield of hay was just over 13 cwt. per acre. No significant effect of inoculation was observed, in contrast to the results obtained in 1927-29, when a 23 per cent. increase was secured. The experiment is being continued.

MANURING OF GRASS LAND, BROAD MEAD, 1932

The five plots of this area were again closely grazed, and the herbage continued to improve. That on the farmyard manure plot has become much less rank. The limed plot—which remains distinguishable from the others by its profusion of daisies—is still the most closely grazed plot.

POT-CULTURE EXPERIMENTS

Green Manuring. To test whether quantities of green manure greater than those grown in the experiments in Lansome and Stackyard fields would give increased yields in the following cereal crop, a series of pot cultures was done. Earthenware drainpipes 20 inches in depth, open at the bottom to allow free drainage, were sunk into the ground and filled in March, 1929, with soil from the headland of Stackyard Field. The experiment was in quadruplicate, and three successive crops of mustard and of tares, were grown in 1929 and turned in. Wheat was grown in 1930, the green cropping was repeated in 1931, and wheat again grown in 1932.

The results follow :

Average Produce of Corn, 1930 and 1932, after Green-manuring (1929 and 1931)

	Corn Grammes	Straw Grammes
1. Without Green-manure	78.7	130.1
2. Mustard.	90.9	193.9
3. Tares	86.8	166.5

It appears that a more liberal green manuring than that used in the field condition has but little effect on the yield of grain, though the effect on the straw is greater. There is no marked difference between the effects of tares and mustard.

Pot experiments in which drainage is permitted or prevented, at different periods, are now in progress.

WOBURN FARM

REPORT BY H. G. MILLER, 1932

The weather, though favourable to the root crops and grassland was much less favourable to corn crops. The spring rains, coming shortly after the application of manures, caused serious leaching. The contrast between yields of barley, and in particular wheat, in the 6 course Rotation Experiment at Woburn and Rothamsted is most striking. The Woburn wheat was practically a failure, the mean yield being only 5.3 cwt. per acre while at Rothamsted it was 27.3 cwt. And the barley plots at Woburn gave only about half the Rothamsted yield, although in the former there was a much better response to nitrogen.

The details of the cropping are given on pp. 133, 135. Butt Furlong oats proved most disappointing. Despite folding with sheep in the winter, even dung on certain portions of the field, and a dressing of artificials, the spring oats showed all the symptoms of acute nitrogen starvation. They refused to develop, weeds got a hold and there was serious trouble with poppies. These were reported bad about 1925, but since 1928 had been practically absent.

The attempt at growing brussels sprouts was a failure due to the extensive damage done by hares ; while for those that did escape there was again no demand. There was a good crop of beans in Warren Field but more than an acre round the outsides was completely destroyed before germination by rats.

Grassland is the one crop which escapes damage by game and pests. That sown down recently has come on surprisingly well and is frequently remarked on by neighbours as being the best in the neighbourhood. In Warren Field the differences between the 5 seeds mixtures still persist clearly, but there is remarkably little difference between the indigenous and commercial plots of the same seeds mixture. This year it showed itself for only about a week in June, when the flowering heads on the commercial appeared slightly earlier and were slightly more numerous. From the appearance of this field in both 1931 and 1932 it was very difficult to justify the greater cost of the indigenous strains, or the cost of the dearer as compared with the cheaper mixtures. Mixture IV (see 1930 Report, p. 104) cost 38/6 ; V, 38/3 ; III, 35/6 ; I, 35/- and II (as I but with commercial strains), only 24/6. As at Rothamsted, the plots with meadow fescue appear to be the more palatable.

A nitrogenous top-dressing was again applied to the seven intensive grazing plots to encourage an early spring bite, but for the last two seasons the response to this has been remarkably small. This is similar to experience at Rothamsted and leads us to doubt its value as a general practice where stock receive winter trough feeding on good grassland.

The mixtures sown in 1931 in Road Piece and Great Hill have filled up well but the narrow strips where the lucerne in the mixtures was inoculated are not obviously superior to the rest of the area. The Eastern half of this area was cut for hay, then grazed, but the Western half was grazed throughout the year. Already this seems to have had a weakening effect on the lucerne in the mixtures.

Livestock

In autumn, 1931, 54 ewes were put to the ram. The 50 that lambed produced 84 lambs alive at the end of April. There were born, alive or dead, 14 triplets and 26 doubles. Unfortunately the extra good condition of the ewes, resulted in heavier losses than usual, both of triplets and ewes. " Steaming up " did not pay. But we ascribed the prolificacy of the ewes to attention at flushing time, with supplementary concentrates, and therefore tried an experiment on this point. As already described for Rothamsted, the Woburn results confirmed the negative results obtained there.

Fifty first-class half-bred ewe lambs were bought at Newtown St. Boswells in August, 1931, from the well-known Border farm of Blackhaugh. They were treated well all autumn and run with a Southdown ram. 28 lambed, producing 32 lambs and, although they lambed after the main flock, the lambs throve well and grew quickly. This was a quite satisfactory result, but, considering the condition of the ewe-lambs, we had hoped for a still bigger crop. The two ewes that reared doubles nursed their lambs well and seemed to have plenty of milk.

With pigs, evidence was obtained at both farms during the year which threw doubts on the value of green food for fattening pigs, even when only recently weaned. This is now one of the subjects of a carefully designed experiment at Rothamsted.

We were less successful at the local Bedfordshire Show than in previous years with pigs, winning only 2 third prizes and a "highly commended." But at the London Dairy Show, with three entries in the class for recorded bacon pigs, we won three second-class awards.

The bullock feeding boxes, which had stood empty so long, have now been adapted for pig feeding, without destroying them for their original purpose.

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, WOBURN, 1932

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
I. Arable, non-experimental, and Replicated Experiments— Warren Field	Beans		Sept. 14-26, tractor plough. Oct. 17-21, tractor cultivator, roll and harrow. April 21, horse hoe. May 6-10, horse hoe.		Oct. 26	Aug. 16	Sept. 1-3	18 cwt.
Butt Close (1)	Sugar Beet	Kuhn	March 31-April 2, plough and harrow. May 5 and 12, harrow. June 20-30, single. June 6, 7, 17, July 4, horse-hoe all plots.	see p. 163	May 5-12	Nov. 7-12	Nov. 7-12	see pp. 164-165
(2)	Kale	Thousand-head	May 17-18, plough. June 3, cross harrow and roll. June 17-20, July 4-15-29, horse hoe.	see p. 166	June 4	Dec. 19—Jan. 20	—	see p. 166
(3)	Brussels Sprouts		May 17-18, plough. May 25, double harrow and roll. July 20, 27, Aug. 8, 23, horse hoe.	2 cwt. S/Amm.	May 25	Fed to stock		—
Butt Furlong	Oats after Sugar Beet	Garton's Marvellous	Feb. 15-17, plough. Feb. 20, double harrow and roll. March 8, Cambridge roll. April 26, double harrow.	12 tons dung	Feb. 27 April 26 (undersown)	Aug. 11-18	Sept. 8-20	—
	Oats after ley fed off with sheep		Cultivations same as above.	1 S/Amm.	,,	,,	,,	—
Lansome Piece (1)	Brussels Sprouts		March 18-April 13, plough in dung. May 18-19, tractor spring hoe, harrow, and roll. June 31, July 10, July 19, 26, Aug. 6, Aug. 23, horse hoe.	15 tons dung 1 cwt. S/Amm.	May 19-25	Fed to stock	—	—
(2)	Kale Micro Plots	Marrow Stem	March 21, plough and harrow. March 26-28, hand digging. May 11-June 12, hand hoe. May 17, harrow.	see p. 167	Mar. 7	Oct. 4-5, 19, Nov. 1 & 18	—	see p. 168
(3)	Kale	Thousand-head	Sown to replace brussels sprouts taken by vermin. Cultivations as brussels sprouts.		June 20	Fed to stock		

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, WOBURN, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
II. Classical and Rotation Experiments								
Stackyard	Permanent Wheat	Red Standard	Oct. 9-14, 1931, plough. Oct. 15, 1931, harrow. Feb. 15-23, hand hoe and remove twitch. April 7 and May 20, harrow. May 11, hand hoe.	see p. 95	Oct. 15	Aug. 9	Aug. 30	see p. 95
	Permanent Barley	Plumage and Archer	Jan. 22-27, plough. Feb. 25, Mar. 15, May 20, harrow. June 8-15, July 5-10, hand hoe.	see p. 96	Mar. 16	Aug. 20-22	Sept. 5-10	see p. 96
Series A (*a*)	Wheat	Red Standard	Oct. 19-20, 1931, plough. Oct. 22, 1931, April 7, May 12, May 21, harrow.	After green crops in 1931, fed off (2 crops)	Oct. 23	Aug. 16	Sept. 1	see p. 99
Series A (*b*) (1)	Tares	—	Jan. 22-27 plough. Feb. 25, harrow. Mar. 1, cultivate. Mar. 16, April 6, cultivate and harrow. April 6, roll. May 21, harrow, feed off with 20 sheep also getting 1½ cwt. mixed cotton and linseed cake. Aug. 3-5, plough. Aug. 10, harrow. Oct. 14-24, feed off with 6 to 8 sheep with 1½ cwt. mixed cotton and linseed cake with 1 cwt. of hay.	3 super. 1 s/pot.	April 11 Aug. 11	— —	— —	— —
Series A (*b*) (2)	Mustard	—	Jan. 22-27, plough. Feb. 25, harrow. Mar. 1, cultivate. Mar. 16, April 6, cultivate and harrow. April 6, roll. Feed off with 20 sheep also getting 1½ cwt. mixed cotton and linseed cake. Aug. 3-5, plough. Aug. 10, harrow. Oct. 14-24, feed off second crop mustard with sheep (6 to 12) also getting 1½ cwt. mixed cotton and linseed cake with 1 cwt. hay.	3 super. 1 s/pot.	May 9 Aug. 25	—	—	—

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, WOBURN, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
6 Course Rotation	Clover	Alsike	May 7, 1931, roll.	see p. 131	May 7	June 27	July 20	see p. 135
	Sugar Beet	Kuhn	Feb. 24, plough in rye, and harrow. April 7, cultivate three times. May 10, harrow. June 3, hand hoe. June 29-30, horse hoe. July 7-8, hand hoe. Aug. 2, horse hoe.	see p. 131	May 10	—	Nov. 2-4	see p. 135
	Barley	Plumage-Archer	Jan. 12-13, plough in sugar beet tops. Mar. 16, cultivate, harrow twice, and roll. Mar 17, roll.	see p. 131	Mar. 17	Aug. 15	Sept. 2	see p. 135
	Wheat	Yeoman	Oct. 22, 1931, plough and harrow twice. May 10, hand hoe. June 5, cut out thistles.	see p. 131	Oct. 23	Aug. 11-12	Aug. 30	see p. 135
	Forage	Rye, Vetches Beans	Oct. 21-22, 1931, plough and double harrow.	see p. 131	Oct. 23	May 31-June 1	June 14	see p. 135
	Potatoes	Ally	Oct. 23, 1931, plough in wheat stubble. Spring 1932, plough in rye. May 12, harrow ridges. June 29, cut out thistles and horse hoe.	see p. 131	April 7	—	Sept. 27	see p. 135
Series C	Clover	Alsike	May 8, 1931, clover sown under barley; after removal of barley, crop allowed to grow.	—	May 8	Aug. 10-15	Sept. 10	see p. 97
Series D	Wheat	Red Standard	Oct. 3-6, 1931, plough. Oct. 16, 1931, drill and harrow. April 7-21, May 20, harrow.	see p. 97	Oct. 16	Aug. 16	Aug. 26-27	see p. 98
Lansome Piece	Green Crops		Oct. 11, 1931, plough. Oct. 23, 1931, Feb. 2-3, cultivate. Feb. 8, harrow. Feb. 18-19, plough. Feb. 25, cultivate and harrow. April 8, harrow in vetches. May 9, harrow in mustard. July 7-8, plough in green crops. Sept. 29-30, plough in second green crop.	3 super. 1 s/pot.	(First crop) Vetches, April 8, Mustard, May 9. (Second crop), Vetches, July 9, Mustard, Aug. 6	—	—	see p. 99

H

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, WOBURN, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
III. Grassland								
Warren Field			Chain harrow, Feb. 14-20.	—	—	June 7-8	June 16-17	25 cwt.
Broad Mead (1) (2) (3) (4)			Chain harrow, Feb. 14-20.	1 s/amm. on all plots at weekly intervals from Feb. 14	—	Grazed	—	—
Great Hill (6) Bottom (7)			Chain harrow, Feb. 14-20.					
Honey Pot (5)			Chain harrow, Feb. 14-20.	No manure	—	Grazed	—	—
Long Mead			Chain harrow, Feb. 14-20.	—	—	Grazed and cut over	—	—
Mill Dam Close			Chain harrow, Feb. 14-20	No manure	—	Grazed and cut over for hay	—	—
Great Hill			Chain harrow and patched March.	No manure	—	Grazed and cut over	—	—
Road Piece			Chain harrow and patched March. Rest of field grazed and cut over.	—	—	4 acres No. 2 mixture cut for hay. June 6, Aug. 6th	June 17 Sept. 6	25 cwt. 20 cwt.
Butt Furlong						Grazed.		

YIELDS OF
EXPERIMENTAL PLOTS
1932

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
I. Arable—non-experimental								
Pastures	Beans 3½ bus. p.a.	Winter	Sept. 23-Oct. 8, tractor plough potato land and mangold land. Rest of field, rotary cultivated (all stubble), mid Sept.	Oct. 14 and 15 1931 1½ cwt. Super. 3 cwt. 30% Potash Salts	Oct. 14 and 15	Aug. 17 and 18, 1932	Aug. 31 to Sept. 1	21 cwts.
Gt. Harpenden 9 acres	Kale Kale Both at 4 lbs. p. acre	Marrow stem Thousand-head	Mar. 6-23, tractor plough in dung. April 27-29, horse harrow. May 6, horse harrow.	Mar. 1-19, Farmyard Manure, 16 tons per acre. 2 cwt. S/Amm. (2 acres, N side also had 3 cwt. 30% Potash Salt).	May 6	Used, by folding and carting from Dec. to end of Feb.		See pp. 161-162 (Cultivation Expt. and Time of Cutting Expt.)
3 acres	Kale 4 lbs. per acre	Thousand-head	Sept. 22-23, 1931, plough in farmyard manure. Oct. 10, tractor disc harrow and harrow; also harrow after seed sowing. Rye fed off. Tractor plough, May 7-18. Plough twice more and work down.	Farmyard Manure, Sept. 3, 1931, for rye, 16tonsperacre. 2 cwt. S/Amm. on non-experimentalportion in May.	June 11	Used in Mar.		see p. 160 (Humate Expt.)
½ acre	Potatoes	Kerrs Pink	Ploughed and dunged as for Kale (9 acres). April 20, horse harrow and ridge for potatoes.	2 cwt. per acre S/Amm. April 23	April 23	—	Oct. 15-17	12 tons
Little Hoos	Spring Oats 2 bus. per acre drilled each way	Marvellous	Oct. 1, plough 4 acres next Gt. Harp. Fd. side (tractor). Oct. 9, tractor disc harrow, cultivate and harrow. Jan. 28-Feb. 3, Horse plough remaining area. Feb. 26, tractor cultivate, disc harrow and harrow.	1 cwt. S/Amm. Mar. 9	Feb. 26-27	Aug. 9-10	Aug. 19-20	24 cwts.
Pennell's Piece	Oats	Marvellous	Self-sown after rotary cultivation Mid-Sept.	—	Mid-Sept.	Aug. 5	Aug. 18	20 cwts.
Fosters	Seeds	Italian Rye-grass and a little Brd. Red Clover	This hay crop occupied the odds and ends around the various experiments.	2 cwt. S/Amm. Mar. 21	Second year	June 16-17	June 22	—

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Gt. Knott	Wheat (4 acs.). 3 bus. per acre	Victor, Yeoman, Wilhelmina, in this order from farm building side	Sept. 23-28, tractor plough. Oct. 15.	1½ cwt. S/A. Mar. 10	Oct. 16,1931	Aug. 11-15	Aug. 20	18 cwts.
	Forage	Barley, Oats and Vetches	Plough up wheat, Feb. 19. Same cult. as Forage Expt. except tractor disc harrow and harrow, March 10.	1½ cwt. S/A.	Mar. 12, 1932	July 9	July 20	see pp. 148-149
Long Hoos (1), (2) and (3)	Barley and Beans 2½ bus. and ¾ bus. resp. per acre	Plumage-Archer and Spring Beans.	Plough Sections (2) and (3) Jan. 28th-Feb. 1st (Horses) and Section (1), Feb. 5-23. Tractor Cultivate (1) and (2), Mar. 4, and (3), Mar. 5. Disc harrow, roll and harrow, 3 times, 7-8 Mar. Undersown, April 26, ryegrass and trefoil.	Apply 1 cwt. S/Amm., Mar. 19 to Sections 2 and 3 only	Mar. 7	Aug. 11-15	Aug. 26-28	30 cwts.
(Sections 4 and 5 Experimental) (6)	Wheat and Oats Varieties		16 and 17, Oct., 1931, Tractor plough, work down, disc harrow and harrow.		Oct. 23, 1931	Aug. 23 *Wheat* Aug. 4-5 *Oats*	Aug. 28 *Wheat* Aug. 19 *Oats*	—
(7)	Mustard after Rape-Kale		Kale ploughed up beginning of June. 16 and 27, Tractor work (disc harrow and cultivate) and harrow for seed bed.	—	June 27	—	—	—
Hoos (next Farm Buildings)	Maize (2 bs./ac.)	Giant White Horsetooth	Plough after kale, April. Cultivate during May. Harrow before and after drilling.	12 tons dung 1½ cwt. S/A.	June 11	During Sept. and Oct. for stock		30 tons (green)
II. Replicated Experiments— Fosters	Wheat	Victor	Oct. 14-16, 1931, plough. April 9, harrow wheat with small seed harrows.	see p. 147	Nov. 2	Aug. 16	Aug. 24	see p. 147

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Fosters (*cont.*)	Barley	Plumage Archer, Victory, July	Feb. 16-19, plough. March 2, tractor cultivate with discs and tooth harrow. March 10, roll.	see pp. 138-139	Mar. 4, 5, 8	Aug. 10-30	Aug. 10-30	see pp. 139-141
	Temporary Leys	—	April 19, plough, harrow after (no ley plots). June 4, cultivate twice over with small motor cultivator (intensive fallow plots). July 2-12, plough plots with 1 cut taken (light and intensive fallow). Aug. 11-13, motor hoe, 4-5 in. deep (intensive fallow plots).	see p. 136	April 23	June 21, Aug. 29	—	see p. 137
	Forage	Rye, Barley, Oats, Wheat, Italian Rye-grass	See 1931 Report, p. 111.	see p. 150	July 22-24	May 24	—	see pp. 150-151
Long Hoos (5)	Wheat	Victor	Oct. 8-13, 1931, plough. Oct. 31, 1931, harrow before and after drilling. April 13, harrow with small seed harrows.	see pp. 142-143	Oct. 31	Aug. 17-20	—	see pp. 143-146
Gt. Knott	Potatoes	Ally	Feb. 29-Mar. 4, plough with tractor and horses. April 4-6, cultivate with disc and tooth harrows. May 11-July 1, ridging and hand hoeing.	see pp. 153-154	April 7-8	—	Oct. 24	see pp. 154-156
	Sugar Beet	Kuhn	Mar. 3-4, plough with tractor and horses. April 4-14, cultivate with disc and tooth harrows. May 18 harrow with spring tined harrow. May 19, roll before, harrow and roll after drilling. June 20, horse hoe. July 7-15, horse and hand hoe. July 14-Aug. 2, motor hoe (intensive plots).	see p. 157	May 19	—	Nov. 3-4	see p. 158
	Forage (1)	Oats and Vetches	Feb. 19-23, plough in wheat. Mar. 10, cultivate with disc and tooth harrows. Mar. 11-12, harrow. May 9, undersown with grass seeds.	see p. 148	Mar. 11-12	July 11-12	July 11-12	see pp. 148-149

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Great Knott (*cont.*)	Forage (2)	Oats, Vetches and Beans	Feb. 19-23, plough in wheat. Mar. 10, cultivate with disc and tooth harrows. Mar. 11, harrow. May 9, undersown with grass seeds.	see p. 152	Mar. 11	June 11 July 1 July 22 Aug. 12		see p. 152
Great Harpenden	Kale (1)	Thousand-head	May 17-18, tractor plough in rye after sheep. June 1, tractor cultivate with tooth harrows. June 2-3, tractor plough. June 6-7, cultivate with discs, drag harrows and heavy roll. June 7-10, plough, drag harrows and heavy roll. June 10-11, roll. July 18-19, Aug. 6-8, horse hoe. Aug. 15, hand hoe.	see p. 160	June 10-11	Nov. 19	Nov. 19.	see p. 160
	Kale (2)	Marrow Stem	Mar. 22-24, tractor plough in dung. May 6, harrow before and after drilling. June 2-4, horse hoe. June 29-30, singling thinned plots. July 4-27, motor hoe intensive plots.	see p. 162	May 6	Nov. 14-18	Nov. 14-18	see p. 162
III. Classical and Rotation Experiments—								
Hoos	Barley	Plumage-Archer, Spratt-Archer	Jan. 5, plough. Mar. 8, tractor cultivate with disc and tooth harrow. May 19-July 25, horse and hand hoe. Rows again 18 in. apart.	see p. 126	Mar. 9-10	Aug. 23	Sept. 2	see p. 126
½ Acre Hoos	Wheat	Red Standard	Sept. 16, 1931, plough. Oct. 14, 1931, harrow. June 3, cultivate all fallowland, with tooth harrows and thistlebar.	see p. 119	Oct. 14	Aug. 10	Aug. 18	see p. 119
Barnfield	Mangolds	Prizewinner Yellow Globe	Oct. 29-Nov. 5, 1931, plough, 7 to 8 in. deep. April 21-25, tooth harrow across and down. Mar. 26-Aug. 8, horse and hand hoeing. June 8-22, singling.	see p. 120	April 25	Oct. 18-27	Oct. 20-Nov. 2	see p. 120

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Agdell	Turnips	Bruce	Sept. 18 and Oct. 31, 1931, shallow and deep plough. Oct. 12, 1931, tractor cultivate. May 14, tractor cultivate 3 times. June 2, tractor cultivate with chain harrows and thistle bar. June 3, harrow and roll. July 14-Aug. 6, horse and hand hoe. July 16-18, singling.	see p. 118	June 3	Oct. 27-Nov. 2	Nov. 5-7	see p. 118
Park	Hay	——	June 23-24; Sept. 12-13.	see p. 121	—	June 23 & 24 (first crop) Sept 12-14 (second crop)	June 28-July 4 Sept. 22-28	see p. 121
Broadbalk	Wheat	Haslers Red Standard	Aug. 29-Sept. 15, 1931 plough. Sept. 21 and 26, 1931, tractor cultivate with disc and tooth harrows. Oct. 10-12, 1931, cultivate with thistle bar attached. Oct. 15, 1931, harrow. Feb. 25, harrow.	see pp. 124-125	Oct. 13	Aug. 9-10	Aug. 16-18	see pp. 124-125
Gt. Hoos 4 Course Rotation	Wheat	Yeoman	July 14-15, 1931, plough. Aug. 31, 1931, drag. harrow. Sept. 21, 1931, tractor cultivate. Nov. 4, 1931, plough and harrow. Nov. 5, 1931, harrow before and after drilling. April 9, harrow wheat with seed harrows. July 8, hand weeding.	see pp. 127-128	Nov. 5	Aug. 15	Aug. 26	see p. 130
	Potatoes	Ally	Dec. 7-15, 1931, plough. April 8, harrow, July 1, hand hoe.	see pp. 127-128	April 12	—	Sept. 30	see p. 130
	Barley	Plumage-Archer	Dec. 7-15, 1931, plough. Mar. 11, tractor cultivate with disc and tooth harrows. May 30, hand weeding.	see pp. 127-128	Mar. 12	Aug. 15	Aug. 29	see p. 130

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 (*Continued*)

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Gt. Hoos 4 Course Rotation (*cont.*)	Seeds	Italian Rye-grass, Dutch White Clover and Alsike Clover	Mar. 25, 1931, roll.	see pp. 127-128	April 22	June 22	June 27	see p. 130
Long Hoos Six Course Rotation	Potatoes	Ally	Sept. 21, 1931, plough. Sept. 25, 1931, tractor cultivate with disc harrow. Feb. 24-25, plough. April 8, harrow. July 1, hand weeding.	see pp. 131-132	April 12	—	Sept. 30	see p. 134
	Barley	Plumage-Archer	Jan. 20, plough. Mar. 11, tractor cultivate with disc and tooth harrows. Mar. 12, roll. July 8, hand weeding.	see pp. 131-132	Mar. 12	Aug. 15-16	Aug. 26	see p. 134
	Clover	Broad Red	Mar. 26, roll.	see pp. 131-132	—	June 15	June 23	see p. 134
	Wheat	Yeoman	Aug. 25-26, 1931, plough. Sept. 22 and Oct. 16 tractor cultivate with disc and tooth harrows. July 8, hand weeding.	see pp. 131-132	Oct. 16	Aug. 15-16	Aug. 24	see p. 134
	Forage	Rye, Beans, Vetches, followed by Mustard	Oct. 16, 1931, plough and harrow.	see pp. 131-132	Oct. 16	June 4	June 10	see p. 134
	Sugar Beet	Kuhn	Aug. 15, 1931, plough. Aug. 31, 1931, drag harrow. Feb. 26, plough. May 18, cultivate with spring tined harrows. May 19, harrow and roll. July 5 and Aug. 5, horse hoe. July 15, singling.	see pp. 131-132	May 19	—	Nov. 4	see p. 134
IV. Grassland— Great Harpenden	Grazing	see Rpt. 1931	—	—	—	June 15 tractor topped (power mower)	—	—
Fosters Corner	Grazing	see Rpt. 1931	—	—	—	—	—	—

DATES OF SOWING AND HARVESTING, AND YIELD PER ACRE, ROTHAMSTED, 1932 *(Continued)*

Field.	Crop.	Variety.	Principal Cultivations and Dates.	Manuring, cwt. per acre.	Sowing Dates.	Cutting Dates.	Carting Dates.	Yield per acre.
Gt. Knott	Grazing	see Rpt. 1931	—	—	—	June 14 topped by tractor mower	—	—
Gt. Field 1	Hay, after Grazing	—	—	—	—	June 22	June 27	22 cwt.
2 and 3	Grazing	—	—	—	—	June 3 and 22 respect.	—	—
Little Knott 1, 2 and 3	Grazing	see Rpt. 1931	—	—	—	—	—	—
New Zealand	Grazing	see Rpt. 1931	—	—	—	June 15 topped by tractor mower	—	—
Stackyard	Grazing	see Rpt. 1931	—	—	—	Topped June 21	—	—
W. Barnfield 1	Hay after Grazing	see Rpt. 1931	—	—	—	June 13	June 17	20 cwt.
2	Grazing	see Rpt. 1931	—	—	—	Topped June 4	—	—
Sawyers 1	Hay after Grazing	see Rpt. 1931	—	—	—	June 9 and 10th	June 16 17th	22 cwt.
2 and 3	Grazing	see Rpt. 1931	—	—	—	June 20th 24 respect.	—	—

CROP YIELDS ON THE EXPERIMENTAL PLOTS

Notes.—In each case the year refers to the harvest, *e.g*., Wheat 1932 means wheat harvested in 1932. In the tables, total straw includes straw, cavings and chaff. These were weighed separately prior to 1928. Since 1928 the figure given as total straw in the replicated experiments has been arrived at as the difference : total sheaf weight—weight of grain.

CONVERSION TABLE.

1 acre	0.405 Hectare	0.963 Feddan.
1 bushel (Imperial)	0.364 Hectolitre (36.364 litres)	0.184 Ardeb.
1 lb. (pound avoirdupois)	0.453 Kilogramme	1.009 Rotls.
1 cwt. (hundredweight, 112 lb.)	50.8 Kilogrammes	113.0 Rotls. 1.366 Maunds.
1 ton (20 cwt. or 2,240 lb.)	1016 Kilogrammes.	
1 metric quintal or Doppel Zentner (Dz.)	100.0 Kilogrammes. 220.46 lb.	
1 metric ton (tonne)	1000 Kilogrammes.	
1 bushel per acre	0.9 Hectolitre per Hectare	0.191 Ardeb per Feddan
1 lb. per acre	1.12 Kilogramme per Hectare	1.049 Rotls. per Feddan
1 cwt. per acre	1.256 dz. per Hectare	117.4 Rotls. per Feddan
1 ton per acre	25.12 dz. per Hectare.	
1 dz. per Hectare	0.796 cwt. per acre.	
1 kg. per Hectare	0.892 lb. per acre.	

In America the Winchester bushel is used = 35.236 litres. 1 English bushel = 1.032 American bushels.

CONVERSION TABLE—CWT. TO BUSHELS.

Crop.	Cwt.									
	1	2	3	4	5	10	15	20	25	30
Wheat (60 lb.) bushels	1.87	3.73	5.60	7.47	9.33	18.67	28.00	37.33	46.67	56.00
Barley (52 lb.) ,,	2.15	4.31	6.46	8.62	10.77	21.54	32.31	43.08	53.85	64.62
Oats (42 lb.) ,,	2.67	5.33	8.00	10.67	13.33	26.67	40.00	53.33	66.67	80.00

The yields of grain in the 1925-26 Report were given for the replicated experiments in standard bushels of 60, 52 and 42 lb. respectively.

Average Wheat Yield of Various Countries.

Country.	Mean yield per acre, 1922-31. cwt.	Country.	Mean yield per acre, 1922-31. cwt.
Great Britain	17.4	Denmark	22.1
England and Wales	17.3	Argentine	6.7
Hertfordshire	16.3	Australia	6.3
France	11.1	Canada	9.2
Germany	15.1	United States	7.8
Belgium	20.2	U.S.S.R. (Europe and Asia)	5.8*

Note.—Figures for Great Britain, England and Hertfordshire are taken from the Ministry of Agriculture's "Agricultural Statistics," Vol. 66. Other figures from "International Year Book of Agricultural Statistics," 1927-31.

* 1924-28

METEOROLOGICAL RECORDS, 1932

	Rain.		Drainage through soil.				Temperature (Mean).				
	Total Fall 1/1000th Acre Gauge.	No. of Rainy Days (0.01 inch or more) 1/1000th Acre. Gauge.	20 ins. deep.	40 ins. deep.	60 ins. deep.	Bright Sun-shine.	Max.	Min.	1 ft. in ground	Solar Max.	Grass Min.
1932—	Inches.	No.	Inches.	Inches.	Inches.	Hours.	°F.	°F.	°F.	°F.	°F.
Jan. ..	2.200	13	2.040	2.252	2.178	50.5	47.0	35.7	41.2	68.7	31.5
Feb. ..	0.209	5	0.000	0.018	0.017	67.6	40.7	31.5	37.3	80.3	27.6
Mar. ..	2.002	11	0.852	0.809	0.840	144.2	47.0	31.9	38.1	98.8	25.4
April ..	2.336	19	0.697	0.757	0.745	131.3	50.1	37.5	43.7	108.7	34.2
May ..	4.274	21	2.425	2.493	2.460	128.4	57.2	43.6	50.6	85.3	40.4
June ..	0.850	4	0.006	0.046	0.034	215.5	65.2	48.0	57.6	105.7	43.2
July ..	2.619	17	0.642	0.576	0.574	136.3	68.2	53.7	61.5	98.0	50.2
Aug. ..	2.102	8	0.621	0.658	0.638	191.5	71.8	55.2	63.2	103.9	50.5
Sept. ..	1.985	18	0.270	0.208	0.175	113.2	62.3	48.7	57.1	84.7	44.0
Oct. ..	4.842	23	2.840	3.418	3.290	104.1	53.5	41.9	49.1	74.6	37.5
Nov. ..	1.783	16	1.069	1.154	1.114	47.4	47.4	38.7	43.9	71.9	35.3
Dec. ..	0.733	12	0.453	0.564	0.559	56.2	44.7	36.1	40.1	65.7	31.9
Total or Mean	25.935	167	11.915	12.953	12.624	1386.2	54.6	41.9	48.6	87.2	37.6

RAIN AND DRAINAGE.

MONTHLY MEAN FOR 62 HARVEST YEARS, 1870-1—1931-2.

	Rain-fall.	Drainage.			Drainage % of Rainfall.			Evaporation.		
		20-in. Gauge.	40-in. Gauge.	60-in. Gauge.	20-in. Gauge.	40-in. Gauge.	60-in. Gauge.	20-in. Gauge.	40-in. Gauge.	60-in. Gauge.
	Ins.	Ins.	Ins.	Ins.	%	%	%	Ins.	Ins.	Ins.
Sept. ..	2.377	0.819	0.796	0.735	34.4	33.5	30.9	1.558	1.581	1.642
Oct. ..	3.099	1.762	1.732	1.603	56.8	55.9	51.7	1.337	1.367	1.496
Nov. ..	2.886	2.207	2.263	2.134	76.5	78.4	73.9	0.679	0.623	0.752
Dec. ..	2.842	2.422	2.522	2.408	85.2	88.7	84.7	0.420	0.320	0.434
Jan. ..	2.406	1.976	2.171	2.071	82.1	90.2	86.1	0.430	0.235	0.335
Feb. ..	1.999	1.487	1.599	1.527	74.4	80.0	76.4	0.512	0.400	0.472
March ..	1.967	1.045	1.170	1.107	53.1	59.5	56.3	0.922	0.797	0.860
April ..	2.056	0.674	0.754	0.719	32.8	36.7	35.0	1.382	1.302	1.337
May ..	2.104	0.514	0.583	0.550	24.4	27.7	26.1	1.590	1.521	1.554
June ..	2.191	0.523	0.552	0.531	23.9	25.2	24.2	1.668	1.639	1.660
July ..	2.737	0.727	0.755	0.706	26.6	27.6	25.8	2.010	1.982	2.031
Aug. ..	2.654	0.715	0.730	0.687	26.9	27.5	25.9	1.939	1.924	1.967
Year ..	29.318	14.871	15.627	14.778	50.7	53.3	50.4	14.447	13.691	14.540

CHEMICAL ANALYSES OF MANURES USED IN REPLICATED EXPERIMENTS, 1932

Manures	% N		Manures	% P_2O_5 Total	% P_2O_5 Soluble in water	% P_2O_5 Soluble in Cit. Acid
Sulphate of Amm...	20.6		Superphosphate (9) ..	16.1	15.1	—
Nitrate of Soda (1)	15.3		Superphosphate (10) ..	16.2	15.5	—
Nitrate of Soda (2)	16.0		Superphosphate (11) ..	16.1	—	—
Cyanamide ..	20.0		Mineral Phosphate ..	25.9	—	—
Dicyanodiamide ..	66.6		(90% through 120 mesh)			
Humic Acid (3) ..	4.36		Basic Slag High Sol. ..	14.9	—	14.4
Humic Acid (4) ..	4.29		Basic Slag Low Sol. ..	15.1	—	3.5
	Total N.	Amm. N.				
Amm. Humate (5)	7.95	2.88	Sulphate of Potash : 49.6% K_2O			
Amm. Humate (6)	8.30	3.16	Potash Manure Salt (30%) : 30.6% K_2O			
Amm. Humate (7)	8.00	2.87	Dung : 0.392% N, 0.226% P_2O_5, 0.736% K_2O			
Amm. Humate (8)	8.16	3.02				

(1) Used in R.S. 1-64, W.S. 1-64.
(2) Used in R.S. 1-64, W.S. 1-64.
(3) Used in R.K. 1-25, W.K. 65-89.
(4) Used at Welshpool, Tonbridge, Burford, Godalming, Hull.
(5) Used in R.K. 1-25, W.K. 65-89.
(6) Used in V.B. 1-64, S.B. 1-64, Z.B. 1-64.
(7) Used in P.S. 26-57, Z.S. 1-25, Z.M. 1-25.
(8) Used at Welshpool, Tonbridge, Burford, Godalming, Hull.
(9) Used in R.B. 1-96.
(10) Used in R.P. 1-162, R.S. 1-64, W.S. 1-64.
(11) Used in G.H. 1-50, D.H. 1-50, Bakewell.

FOUR COURSE ROTATION, 1932

Manures	% Organic Matter	% N	% P_2O_5	% K_2O
Chaff	80.4	0.398	0.291	1.42
Dung	19.2	0.559	0.264	1.08
Adco	10.8	0.294	0.248	0.308
Superphosphate.. ..	—	—	16.4	—
Mineral Phosphate .. (90% through 120 mesh)	—	—	26.1	—
Muriate of Potash ..	—	—	—	50.6
Sulphate of Ammonia ..	—	20.6	—	—

SIX COURSE ROTATION, 1932

	% N	% P_2O_5			% K_2O	
Sulphate of Ammonia	20.6		—		—	
Muriate of Potash ..	—		—		50.6 (1)	51.8 (2)
Superphosphate ..	—	15.7 (3)	16.4 (4)	16.2 (5)	—	

(1) Used in B.C., B.W., B.F., C.W., C.F., C.C.
(2) Used in B.S., B.B., B.P., C.S., C.P., C.B.
(3) Used in B.W., B.F., C.W.
(4) Used in B.C., C.F., C.C.
(5) Used in B.P., B.B., B.S., C.S., C.P., C.B.

CROPS GROWN IN ROTATION, AGDELL FIELD

PRODUCE PER ACRE.

Year.	Crop.	O. Unmanured since 1848.		M. Mineral Manure.‡ No Nitrogen.		C. Complete Mineral and Nitrogenous Manure.	
		5. Fallow.	6. Clover or Beans.	3. Fallow.	4. Clover or Beans.	1. Fallow.	2. Clover or Beans.
	Average of first twenty-one courses, 1848-1931.						
	Roots (Swedes) .. cwt.*	32.0	16.1	174.0	206.5	352.0	310.0
	Barley—						
	Dressed Grain .. bush.	21.6	19.8	22.7	26.6	30.3	35.0
	Total Straw .. cwt.†	13.3	13.2	13.6	15.6	18.4	21.7
	Beans—						
	Dressed Grain .. bush.‡‡	—	13.1	—	18.2	—	22.3
	Total Straw .. cwt.‡‡	—	9.2	—	13.2	—	15.3
	Clover Hay cwt.§	—	25.6	—	52.1	—	52.0
	Wheat—						
	Dressed Grain .. bush.	23.1	21.6	26.9	29.4	27.5	29.0
	Total Straw .. cwt.†	22.9	21.2	28.2	29.8	29.4	29.3
	Present Course (22nd), 1932.						
1932	Roots (Turnips) .. cwt.	20.2	5.4	86.0	118.0	120.0	98.6

* Plots 1, 3 and 5 based upon 19 courses. Plots 2, 4 and 6 based upon 18 courses.

† Includes straw, cavings and chaff.

‡ Mineral Manure: 528 lb. Superphosphate (35%); 500 lb. Sulphate of Potash; 100 lb. Sulphate of Soda; 200 lb. Sulphate of Magnesia, all per acre. Nitrogenous Manure—206 lb. Sulphate of Ammonia and 2,000 lb. Rape Dust per acre. Manures applied once every four years, prior to sowing of Swedes.

‡‡ Based on 8 courses.

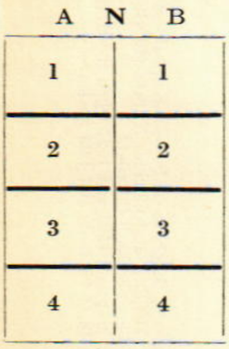
§ Based on 13 courses.

WHEAT AFTER FALLOW—HOOS FIELD

Without Manure, 1851 and since.

SCHEME FOR COMPARING A THREE YEAR FALLOW WITH A ONE YEAR FALLOW.

Each of the two strips on Hoos Wheat after Fallow is to be divided into four parts separated by headlands. In the year when a strip is in crop, one quarter is to continue to be fallowed, so that this quarter has a three year fallow. Different quarters are to be selected for fallow in successive years in the rotation given in the following table :—



Cropping of strips A and B.

C=Crop. F=Fallow.

Year.	A1.	A2.	A3.	A4.	B1.	B2.	B3.	B4.
1932	F	C	C	C	F	F	F	F
1933	F	F	F	F	C	C	F	C
1934	C	F	C	C	F	F	F	F
1935	F	F	F	F	C	C	C	F
1936	C	C	F	C	F	F	F	F
1937	F	F	F	F	F	C	C	C
1938	C	C	C	F	F	F	F	F
1939	F	F	F	F	C	F	C	C
1940	F	C	C	C	F	F	F	F

A comparison of the effect of a three year fallow with the effect of a one year fallow will be possible in every year.

Half the experiment will continue to be wheat after one year fallow, and continuity with previous results will thus be maintained.

PRODUCE PER ACRE.

	A2	A3	A4	Mean.	Average 76 years, 1856-1931.
Dressed Grain—bushels	16.4	18.6	15.6	16.9	14.2
Total grain—cwt.	11.0	12.0	9.3	10.8	8.0
Weight per bushel—lb.	63.8	63.3	63.3	63.5	58.7
Straw—lb.	2182	2118	2182	2161	—
Total straw—cwt.	25.4	24.4	22.3	24.1	12.5

MANGOLDS—BARNFIELD, 1932

Roots each year since 1856. **Mangolds each year since 1876.**

PRODUCE PER ACRE.

	Strip.	Normal spacing * Strip Manures. (Amounts stated are per acre.)	1932.					50 Year Average, 1876-1928. †				
			Cross Dressings.					Cross Dressings.				
			O	N	A	AC	C	O	N	A	AC	C
			None.	Nitrate of Soda (550 lb.)	Sulphate of Ammonia (412 lb.)	Sulphate of Ammonia (412 lb.) & Rape Cake.	Rape Cake (2,000 lb.)	None.	Nitrate of Soda (550 lb.)	Sulphate of Ammonia (412 lb.)	Sulphate of Ammonia (412 lb.) & Rape Cake.	Rape Cake (2,000 lb.)
			Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
ROOTS	1	Dung only (14 tons)	25.41	40.89	34.03	33.09	34.15	17.47	26.16	21.70	23.58	23.53
	2	Dung, Superphosphate (3½ cwt.), Sulphate of Potash (500 lbs.)	31.97	43.74	39.76	40.50	40.39	18.94	26.68	24.71	27.57	26.50
	4	Complete Minerals : Super. and Potash as 2, Salt (200 lb.) Sulphate of Magnesia (200 lb.)	8.01	(a)29.38 ** (b)33.90 **	25.79	37.67	32.52	4.60	(a)17.35 (b)17.81§	14.37	26.06	20.96
	5	Superphosphate only (3½ cwt.)	7.66	28.59	15.44	13.40	17.02	4.47	14.63	6.70	9.49	10.16
	6	Super. (3½ cwt.) Sulphate of Potash (500 lb.)	6.89	27.14	24.20	32.92	27.24	4.03	15.12	13.50	22.55	18.14
	7	Super. (3½ cwt.) Sulphate of Magnesia (200 lb.) and Sodium Chloride (200 lb.)	6.87	29.96	26.47	27.99	29.90	4.86	16.04	14.70	22.31	19.10
	8	No Mineral	5.02	21.19	12.80	11.79	15.78	3.34	9.61	5.32	8.52	8.89
	9	Sodium Chloride (200 lb.), Nit. Soda (550 lb.), Sulph. Potash (500 lb.) and Sulph. Mag. (200 lb.)	23.98	—	—	—	—	—	—	—	—	—
LEAVES	1	Dung only (14 tons)	3.48	4.52	4.83	5.54	4.77	3.04	4.65	4.93	5.25	4.54
	2	Dung, Superphosphate (3½ cwt.), Sulphate of Potash (500 lb.)	3.32	5.79	5.45	5.77	4.99	3.16	5.15	5.49	6.29	4.80
	4	Complete Minerals : Super. and Potash as 2, Salt (200 lb.) Sulph. of Magnesia (200 lb.)	1.27	(a)3.90 (b)4.58	3.01	4.68	3.95	1.04	(a)3.87 (b)4.09 §	2.88	5.33	3.37
	5	Superphosphate only (3½ cwt.)	1.36	3.21	2.31	2.18	2.88	1.05	3.19	2.61	3.29	2.84
	6	Super. (3½ cwt.) Sulphate of Potash (500 lb.)	1.19	3.23	2.90	4.59	3.34	0.93	3.04	2.81	5.20	2.87
	7	Super. (3½ cwt.) Sulphate of Magnesia (200 lb.) and Sodium Chloride (200 lb.)	1.16	4.35	3.90	4.05	4.10	1.10	3.31	3.01	5.23	3.31
	8	No Minerals	1.03	3.59	3.12	3.22	4.32	0.98	3.19	2.52	3.30	2.84
	9	Sodium Chloride (200 lb.), Nit. Soda (550 lb.), Sulph. Potash (500 lb.) and Sulph. Mag. (200 lb.)	3.15	—	—	—	—	—	—	—	—	—

* In 1932 the normal spacing of 26 ins. was resumed over the whole field.

** From 1904 onwards plot 4N has been divided, 4(a) receiving Superphosphate, Sulphate of Potash, Sulphate of Magnesia, Sodium Chloride and Nitrate of Soda, amounts as above ; (4b) receiving Superphosphate, Calcium Chloride, (190 lb.), Potassium Nitrate (570 lb.), and Calcium Nitrate (100 lb.) Nitrogenous manures are applied as to one third at time of sowing and two thirds as top dressing at a later date, except with Rape Cake which all goes on with the seed.

† Excluding 1885 when nitrogenous fertilisers were not applied, owing to poor crop and 1908 and 1927 when the crop was swedes.

§ 23 years only, 1904-1928. For this period the average yield of plot 4(a) was 18.11 for roots and 4.05 for leaves.

HAY—THE PARK GRASS PLOTS, 1932

Plot.	Manuring (amounts stated are per acre.)		Yield of Hay per acre.			Dry Matter per acre.		
			1st Crop.	2nd * Crop.	Total	1st Crop.	2nd Crop.	Total.
			cwt.	cwt.	cwt.	lb.	lb.	lb.
1	Single dressing (206 lb.) Sulphate of Ammonia (=43 lb. N.), (with Dung also 8 years ,1856-63)	not limed	21.8	8.6	30.4	2044	766	2810
		limed	27.1	10.4	37.5	2463	931	3394
2	Unmanured (after Dung 8 years, 1856-63)	not limed	19.0	11.5	30.5	1670	1030	2700
		limed	23.1	10.3	33.4	2032	919	2951
3	Unmanured	not limed	17.4	10.3	27.7	1497	921	2418
		limed	21.3	8.8	30.1	1794	788	2582
4–1	Superphosphate of lime (3½ cwt.)	not limed	26.6	12.0	38.6	2241	1073	3314
		limed	25.7	7.5	33.2	2201	675	2876
4–2	Superphosphate of lime (3½ cwt.), and double dressing (412 lb.) Sulphate of Ammonia (=86 lb. N.)	not limed	35.6	13.7	49.3	2918	1225	4143
		limed	42.2	14.1	56.3	3562	1266	4828
5–1	(N. half) Unmanured following double dressing Ammonia salts (=86 lb. N.) 1856-97	not limed	18.2	8.1	26.3	1562	729	2291
5–2	(S. half) Superphosphate (3½ cwt.) Sulphate of Potash (500 lb.) following double dressing Amm. salts (=86 lb. N.) 1856-97	not limed	31.8	12.2	44.0	2602	1097	3699
6	Complete Mineral Manure as Plot 7 ; following double dressing Amm. salts (=86 lb. N.) 1856-68	not limed	32.7	11.3	44.0	2817	1009	3826
7	Complete Mineral Manure : Super. (3½ cwt.) ; Sulphate of Potash (500 lb.) ; Sulphate of Soda (100 lb.) ; Sulphate Magnesia (100 lb.)	not limed	34.4	11.4	45.8	3040	1022	4062
		limed	29.3	11.7	41.0	2505	1052	3557
8	Mineral Manure without Potash	not limed	26.2	14.4	40.6	2148	1289	3437
		limed	21.4	14.6	36.0	1808	1305	3113
9	Complete Mineral Manure and double dressing (412 lb.) Sulphate of Ammonia (=86 lb. N.)	not limed	92.5	9.6	102.1	6251	858	7109
		limed	64.4	15.0	79.4	5502	1349	6851
10	Mineral Manure (without Potash) and double dressing Amm. salts (=86 lb. N.)	not limed	41.2	11.2	52.4	3725	1006	4731
		limed	43.0	14.8	57.8	4094	1326	5420
11–1	Complete Mineral Manure and treble dressing (618 lb.) Sulphate of Amm. (129 lb. N.)	not limed	86.1	31.2	117.3	5606	2794	8400
		limed	63.5	22.0	85.5	5374	1971	7345
11–2	As Plot 11-1 and Silicate of Soda	not limed	82.6	32.2	114.8	5770	2886	8656
		limed	72.2	27.6	99.8	6017	2477	8494
12	Unmanured	not limed	18.0	9.3	27.3	1612	830	2442
13	Dung (14 tons) in 1905, and every fourth year since (omitted 1917), Fish Guano (6 cwt.) in 1907 and every fourth year since	not limed	52.3	11.2	63.5	4794	1003	5797
		limed	41.9	7.8	49.7	3856	699	4555
14	Complete Mineral Manure and double dressing (550 lb.) Nitrate of Soda (=86 lb. N.)	not limed	60.0	17.4	77.4	4463	1562	6025
		limed Sun.	66.0	14.2	80.2	5529	1276	6805
		,, Shade	39.5	14.0	53.5	3233	1259	4492
15	Complete Mineral Manure as Plot 7 ; following double dressing Nitrate of Soda (=86 lb. N., 1858-75)	not limed	30.1	13.8	43.9	2710	1232	3942
		limed	30.1	9.8	39.9	2672	875	3547
16	Complete Mineral Manure and single dressing (275 lb.) Nitrate of Soda (=43 lb. N.)	not limed	41.2	16.0	57.2	3610	1429	5039
		limed	37.6	12.8	50.4	3328	1146	4474
17	Single dressing (275 lb.) Nitrate of Soda (43 lb. N.)	not limed	19.5	11.6	31.1	1643	1037	2680
		limed	28.3	9.6	37.9	2620	865	3485
18	Mineral Manure (without Super.), and double dressing Sulphate of Amm. (=86 lb. N.), 1905 and since ; following Minerals and Amm. salts supplying the constituents of 1 ton of hay, 1865-1904	not limed	37.6	12.0	49.6	3553	1078	4631
		limed (6788 lb.)	50.6	11.2	61.8	3827	1002	4829
		limed (3951 lb.)	39.3	8.6	47.9	3535	774	4309
19	Farmyard Dung (14 tons) in 1905 and every fourth year since (omitted in 1917), following Nitrate of Soda (=43 lb. N) and Minerals, 1872-1904	not limed	27.2	12.6	39.8	2436	1126	3562
		limed (3150 lb.)	25.0	9.5	34.5	2184	847	3031
		limed (570 lb.)	33.0	11.7	44.7	2834	1050	3884
20	Farmyard Dung (14 tons) in 1905 and every fourth year since (omitted in 1917) ; each intervening year Plot 20 receives Sulphate of Potash (100 lb.) ; Superphosphate (200 lb.) and 1½ cwt. Nitrate of Soda (=26 lb. N.) ; following Nitrate of Potash and Superphosphate, 1872-1904	not limed	45.7	13.5	59.2	4008	1206	5214
		limed 2772 lb.)	47.8	12.0	59.8	3928	1070	4998
		limed 570 lb.)	46.2	12.0	58.2	4025	1070	5095

Ground Lime was applied to the southern portion (limed) of the plots at the rate of 2,000 lb. to the acre in the Winters of 1903-4, 1907-8, 1915-16, 1923-24, 1927-28, 1931-32, and at the rate of 2,500 lb. to the acre in the Winter of 1920-21, except where otherwise stated.

Up to 1914 the limed and unlimed plot results were not separately given in the Annual Report, but the mean of the two was given. From 1915 onwards the separate figures are given.

*The second crop was carted green ; the figures given are estimated hay yields, calculated on the basis of hay containing 20 per cent. moisture.

PARK GRASS PLOTS

BOTANICAL COMPOSITION PER CENT.

1928 (1st Crop)

Plot	Manuring	Liming	Gramineae	Leguminosae	Other Orders	" Other Orders " consist largely of
3	Unmanured.	Limed	64.4	7.1	28.5	*Plantago lanceolata*
		Unlimed	54.3	6.0	39.7	*Plantago lanceolata*
7	Complete Mineral Manure.	Limed	57.4	34.1	8.5	*Heracleum sphondylium*
		Unlimed	20.0	20.7	59.3	*Achillea millefolium*
9	Complete Mineral Manure and double Amm. Salts.	Limed	98.5	—	1.5	—
		Unlimed	99.9	—	0.1	—
14	Complete Mineral Manure and double Nitrate of Soda.	Limed (sun)	92.7	3.9	3.4	*Taraxacum vulgare* *Anthriscus sylvestris* *Rumex acetosa*
		Limed (Shade)	96.0	3.5	0.5	*Anthriscus sylvestris*
		Unlimed	99.2	0.4	0.4	*Anthriscus sylvestris* *Rumex acetosa*
15	As plot 7 following double Nitrate of Soda, 1858-75.	Limed	not	analysed		—
		Unlimed				—
17	Single Nitrate of Soda.	Limed				—
		Unlimed				—
18	Mineral Manure (without Super) and double Sulphate Amm. 1905 and since.	L. 6,788 lb.	94.5	0.2	5.3	*Heracleum sphondylium*
		L. 3,951 lb.	96.7	—	3.3	*Rumex acetosa*
		Unlimed	96.3	—	3.7	*Rumex acetosa*
19	Farmyard Dung in 1905 and every fourth year since (omitted 1917).	L. 3,150 lb.	89.8	4.4	5.8	*Ranunculus spp.*
		L. 570 lb.	88.6	2.0	9.4	*Rumex acetosa* *Ranunculus spp.*
		Unlimed	89.8	1.9	8.3	*Rumex acetosa* *Ranunculus spp.*
20	Farmyard Dung in 1905 and every fourth year since (omitted in 1917) each intervening year Sulphate of potash, Super., and Nitrate of Soda.	L. 2,772 lb.	87.2	5.4	7.4	*Taraxacum vulgare* *Ranunculus spp.*
		L. 570 lb.	89.6	3.2	7.2	*Rumex acetosa* *Ranunculus spp.* *Taraxacum vulgare*
		Unlimed	93.0	2.8	4.2	*Rumex acetosa* *Ranunculus spp.* *Canopodium denudarum*

PARK GRASS PLOTS

BOTANICAL COMPOSITION PER CENT.
1929 (1st Crop)

Plot	Manuring	Liming	Gramineae	Leguminosae	Other Orders	" Other orders " consist largely of
3	Unmanured.	Limed	43.1	19.1	37.8	*Plantago lanceolata*
		Unlimed	33.8	7.3	58.9	*Plantago lanceolata*
7	Complete Mineral Manure.	Limed	33.0	57.0	10.0	*Heracleum sphondylium*
		Unlimed	40.3	34.8	24.9	*Achillea millefolium*
9	Complete Mineral Manure and double Amm. Salts.	Limed	99.5	—	0.5	—
		Unlimed *	—	—	—	—
14	Complete Mineral Manure and Double Nitrate of Soda.	Limed (sun)	91.4	4.8	3.8	*Taraxacum vulgare*
		Limed (shade)	97.1	2.2	0.7	—
		Unlimed	97.5	1.0	1.5	*Taraxacum vulgare*
15	As plot 7 following double Nitrate of Soda, 1858-75.	Limed	41.8	49.3	8.9	*Achillea millefolium*
		Unlimed	52.4	22.0	25.6	*Achillea millefolium* *Plantago lanceolata*
17	Single Nitrate of Soda.	Limed	70.8	1.7	27.5	*Plantago lanceolata*
		Unlimed	60.9	0.2	38.9	*Plantago lanceolata*
18	Mineral Manure (without Super.) and double Sulphate Amm. 1905 and since.	L. 6,788 lb.	96.6	0.1	3.3	—
		L. 3,951 lb.	96.3	—	3.7	*Achillea millefolium*
		Unlimed *	—	—	—	—
19	Farmyard Dung in 1905 and every fourth year since (omitted 1917).	L. 3,150 lb.	77.4	16.4	6.2	—
		L. 570 lb.	84.3	7.6	8.1	—
		Unlimed	83.9	9.3	6.8	—
20	Farmyard Dung in 1905 and every fourth year since (omitted in 1917) each intervening year Sulphate of Potash, Super., and Nitrate of Soda.	L. 2,772 lb.	72.2	18.4	9.4	—
		L. 570 lb.	83.3	8.9	7.8	—
		Unlimed	81.1	12.4	6.5	—

* No sample taken. Herbage killed by frost and drought.

WHEAT—BROADBALK FIELD, 1932

Plot.	Manurial Treatment (amounts stated are per acre).	Dressed Grain, bushels per acre (in some cases estimated from half or quarter-bushel).				Total Grain, cwt. per acre.				74-year Average 1852-1925 (prior to fallow). Total Grain, cwt.
		I	III	IV	V	I	III	IV	V	
2A	Farmyard Manure (14 tons)	10.7	18.0	15.1	10.1	8.3	11.9	9.9	7.6	16.3 **
2B	Farmyard Manure (14 tons)	14.0	23.3	10.0	9.3	10.4	14.3	7.4	7.2	19.4
3	Unmanured since 1839	17.6	8.5	10.8	9.4	11.5	5.7	6.1	6.2	6.7
5	Complete Mineral Manure §§	19.1	10.2	11.5	10.5	12.9	6.7	7.7	7.1	7.8
6	As 5, and 206 lb. Sulphate of Ammonia	16.1	15.6	11.0	9.3	11.0	10.0	7.4	6.3	12.5
7	As 5, and 412 lb. Sulphate of Ammonia	16.2	22.0	19.5	14.9	11.3	14.2	12.9	10.0	17.6
8	As 5, and 618 lb. Sulphate of Ammonia	18.4	23.0	18.9	18.0	13.4	15.6	13.7	12.4	20.1
9	As 5, and 275 lb. Nitrate of Soda	16.8	18.5	16.1	11.8	11.5	11.8	10.4	7.0	13.9 ††
10	412 lb. Sulphate of Ammonia	23.4	19.5	14.9	15.2	15.2	12.8	9.9	10.4	10.9
11	As 10, and Superphosphate (3½ cwt.)	18.4	20.6	16.4	16.5	12.2	13.1	10.8	11.3	12.3
12	As 10, and Super (3½ cwt.) and Sulph. Soda (366 lb.)	15.5	21.8	19.9	15.1	10.7	14.3	13.2	10.4	15.7
13	As 10 and Super (3½ cwt.) and Sulph. Potash (200 lb.)	16.8	19.7	16.2	11.0	11.5	12.8	11.0	8.1	17.0
14	As 10, and Super. (3½ cwt.) and Sulph. Magnesia (280 lb.)	16.0	20.4	19.2	15.7	10.4	13.3	12.6	10.6	15.5
15	As 5, and 412 lb. Sulphate Amm. all applied in Autumn	14.1	16.6	14.6	13.8	9.4	10.8	9.6	8.9	16.1
16	As 5, and 550 lb. Nitrate of Soda	21.6	25.8	21.8	17.3	14.8	16.3	14.1	11.4	17.8 ††
17	Minerals alone as 5 or 412 lb. Sulphate of Ammonia alone in alternate years	A20.2	21.8	21.5	15.2	13.6	14.0	13.4	10.2	A16.1 *
18		M16.3	3.6	6.5	8.9	10.9	2.8	4.6	6.2	M 8.1
19	Rape Cake (1,889 lb.)	18.2	16.8	16.3	11.9	11.9	11.2	10.9	8.1	12.6‡
20	As 7, without Super.	23.8	—	—	—	15.6	—	—	—	10.3 §

Fallowing Rotation. After the fallows of 1925-6 to 1928-9 a regular cycle of fallowing was started in the season 1930-31. This cycle and the preceding fallows are shown in the accompanying diagram (C=crop, F=fallow). The sections (I. to V.) are numbered in order from the upper or western end of the field. Preparatory to the first fallow the field was harvested in five separate sections (1924-5).

Season.	I.	II.	III.	IV.	V.	Season.	I.	II.	III.	IV.	V.
1925-26	F	F	F	C	C	1930-31	F	C	C	C	C
1926-27	F	F	F	C	C	1931-32	C	F	C	C	C
1927-28	C	C	F	F	F	1932-33	C	C	C	C	F
1928-29	C	C	F	F	F	1933-34	C	C	C	F	C
1929-30	C	C	C	C	C	1934-35	C	C	F	C	C

For notes, see next page.

WHEAT—BROADBALK FIELD, 1932

Plot.	Manurial Treatment (amounts stated are per acre).	Bushel Weight in lb. (in some cases estimated from half or quarter-bushel).				Total Straw†, cwt. per acre.				74-year Average 1852-1925 (prior to fallow.) Total Straw, cwt.
		I	III	IV	V	I	III	IV	V	
2A	Farmyard Manure (14 tons)	61.1	62.6	61.4	62.8	59.0	39.5	41.0	42.6	32.1 **
2B	Farmyard Manure (14 tons)	61.6	62.0	61.1	62.1	62.4	45.3	51.5	59.8	34.2
3	Unmanured since 1839	63.2	62.0	60.5	62.5	27.8	9.9	13.0	12.3	9.8
5	Complete Mineral Manure §§	62.9	61.9	63.4	63.6	34.2	12.0	14.4	14.2	11.5
6	As 5, and 206 lb. Sulphate of Ammonia	62.3	62.8	63.8	63.4	44.3	21.5	16.2	15.4	20.3
7	As 5, and 412 lb. Sulphate of Ammonia	61.8	62.9	63.4	63.5	58.8	39.8	42.4	42.2	32.1
8	As 5, and 618 lb.Sulphate of Ammonia	61.5	62.9	62.9	62.0	59.5	56.4	56.2	58.1	39.8
9	As 5, and 275 lb. Nitrate of Soda	61.9	62.7	62.9	63.4	52.7	27.0	27.4	25.9	24.6††
10	412 lb. Sulphate of Ammonia	62.5	63.2	62.1	63.2	43.1	30.2	29.4	31.2	17.8
11	As 10, and Superphosphate (3½ cwt.)	62.2	62.5	62.4	62.9	45.6	32.9	34.3	34.8	21.4
12	As 10, and Super (3½ cwt.) and Sulph. Soda (366 lb.)	61.8	62.9	62.9	62.9	54.4	36.5	31.1	36.2	26.8
13	As 10, and Super (3½ cwt.) and Sulph. Potash (200 lb.)	61.6	63.4	63.2	63.1	47.6	38.6	37.7	46.3	30.6
14	As 10, and Super. (3½ cwt.) and Sulph. Magnesia (280 lb.)	60.6	63.6	63.2	62.9	52.5	37.5	39.9	39.6	26.8
15	As 5, and 412 lb. Sulphate Amm. all applied in Autumn	62.2	62.8	62.9	60.8	48.6	25.3	25.0	37.7	28.2
16	As 5, and 550 lb. Nitrate of Soda	62.1	62.2	63.4	61.5	54.0	40.2	40.9	47.5	35.2 ††
17 {	Minerals alone as 5 or 412 lb. Sulphate of Ammonia	A63.8	62.7	61.9	61.9	47.9	36.7	39.3	47.0	A28.1 *
18 {	alone in alternate years	M63.0	61.8	61.6	62.1	30.3	6.4	9.8	13.9	M12.3
19	Rape Cake (1,889 lb.)	61.8	61.1	61.5	60.5	42.1	36.6	37.8	43.0	22.0‡
20	As 7, without Super.	62.9	—	—	—	39.4	—	—	—	18.6 §

† Includes straw, cavings, and chaff. * A=Ammonia series. M=Mineral series.

** Twenty-six years only, 1900-25. †† Forty-one years only, 1885-1925. ‡ Thirty-three years only, 1893-1925. § Eighteen years only, 1906-1925 (no crop in 1912 and 1914).

§§ Complete mineral manure : 3½ cwt. Super., 200 lb. Sulph. Potash, 100 lb. Sulph. Soda, 100 Sulph. Magnesia. Sulphate of Ammonia is applied as to one third in Autumn and two-thirds in Spring except for Plot 15. Nitrate of Soda is all given in Spring, there being two applications at an interval of a month on Plot 16.

BARLEY—HOOS FIELD, 1932

Plot.	Manuring (Amounts stated are per acre).	Dressed Grain, bushels per acre (in some cases estimated from half or quarter bushel).		Total Grain, cwt. per acre.		76 Years' Average, 1852-1928 Dressed Grain per acre bush. ‖	Bushel weight in lb. (in some cases estimated from half or quarter bushel).		Total Straw, cwt. per acre.		76 Years' Average, 1852-1928 Total straw per per acre cwt.†
		Plumage-Archer.	Spratt-Archer.	Plumage-Archer.	Spratt-Archer.		Plumage-Archer.	Spratt-Archer.	Plumage-Archer.	Spratt-Archer.	
1O	Unmanured	8.2	6.1	5.0	4.8	13.4	52.9	54.2	7.7	7.2	7.8
2O	Superphosphate only (3½ cwt.)	20.5	19.4	11.4	11.6	19.0	53.9	53.6	11.3	11.7	9.8
3O	Alkali Salts only (200 lb. Sulphate of Potash; 100 lb. Sulphate of Soda; 100 lb. Sulphate of Magnesia. ..	6.9	5.7	4.3	4.4	14.3	52.9	54.0	8.6	7.7	8.7
4O	Complete Minerals; as 3O with Superphosphate (3½ cwt.)	10.9	14.0	6.5	8.8	19.0	53.2	54.1	10.5	10.7	11.2
5O	Potash (200 lb.) and Superphosphate (3½ cwt.)	16.9	14.8	9.6	9.7	15.5	52.5	54.1	12.3	13.6	9.4
1A	Ammonium Salts only (206 lb. Sulphate of Ammonia) ..	14.1	6.8	8.8	5.9	23.7	53.3	52.5	10.9	9.6	13.7
2A	Superphosphate and Amm. Salts	34.3	23.6	20.8	15.4	35.8	54.5	52.4	19.2	17.0	20.4
3A	Alkali Salts and Amm. Salts	4.8	7.2	4.0	6.0	25.8	53.5	53.5	12.8	11.4	16.0
4A	Complete Minerals and Amm. Salts	34.2	39.0	18.8	22.3	39.3	53.5	53.9	18.2	23.1	23.6
5A	Potash Super and Amm. Salts	27.3	33.0	16.1	20.0	33.8	54.2	54.0	23.3	27.5	21.7
1AA	Nitrate of Soda only (275 lb.)	13.4	8.8	8.8	8.2	24.3*	54.1	53.2	14.7	13.1	15.4*
2AA	Superphosphate and Nitrate of Soda..	34.7	26.7	20.2	17.7	38.8*	55.1	53.9	20.2	17.2	23.1*
3AA	Alkali Salts and Nitrate of Soda	12.1	6.3	7.7	5.8	24.5*	52.4	53.5	13.8	12.6	16.6*
4AA	Complete Minerals and Nitrate of Soda	29.2	34.1	17.0	20.1	37.7*	54.8	54.1	18.6	23.6	23.6*
1AAS	As Plot 1AA and Silicate of Soda (400 lb.)	23.5	12.4	13.8	9.6	30.2*	53.4	54.0	16.2	14.7	18.2*
2AAS	As Plot 2AA and Silicate of Soda (400 lb.)	34.0	22.3	19.3	15.6	39.7*	55.0	54.8	17.3	19.8	23.9*
3AAS	As Plot 3AA and Silicate of Soda (400 lb.)	13.4	9.4	8.4	7.9	31.2*	53.2	54.5	14.9	13.8	19.9*
4AAS	As Plot 4AA and Silicate of Soda (400 lb.)	30.6	32.0	17.5	19.5	39.9*	54.4	53.9	19.4	22.6	25.4*
1C	Rape Cake only (1,000 lb.)	27.6	21.9	15.8	13.7	35.5	53.8	53.3	19.5	17.5	20.6
2C	Superphosphate and Rape Cake	39.9	35.5	21.1	22.6	38.1	53.0	54.1	21.3	23.4	22.0
3C	Alkali Salts and Rape Cake	22.6	18.8	13.0	11.6	33.7	54.0	53.4	17.3	19.0	20.4
4C	Complete Minerals and Rape Cake	30.5	39.0	17.0	21.6	37.5	54.3	53.2	20.9	25.6	22.6
7-1	Unmanured after dung (14 tons) for 20 years (1852-71) ..	15.5	20.0	8.7	12.3	22.5‡	52.9	54.1	11.6	14.8	13.5‡
7-2	Farmyard manure (14 tons)	34.0	41.6	19.6	25.2	44.6	54.0	54.6	24.7	38.1	28.1
6-1	Unmanured since 1852	4.0	5.5	2.9	4.5	14.7	54.8	54.5	6.4	8.4	8.6
6-2	Ashes from Laboratory furnace	5.6	9.0	3.7	6.5	15.7	54.8	53.8	7.6	9.1	9.3
1N	Nitrate of Soda only (275 lb.)	12.2	3.9	7.8	3.8	28.7§	51.8	53.0	13.6	9.4	17.8§
2N	Nitrate of Soda only (275 lb.)	22.2	13.0	12.5	9.8	31.7§§	52.0	54.0	16.6	15.1	20.0§§

In 1912 all plots were fallowed. ‖ 1 cwt. 2.15 bushels. † Total straw includes straw, cavings and chaff. * Sixty years 1868-1928. ‡ 56 years, 1872-1928. § 75 years, 1853-1928. §§ 69 years, 1859-1928.

In 1932 the same procedure of sowing in widely spaced drills (18 ins. apart) was adopted as in 1930 and 1931. The strips sown with Plumage-Archer in 1931 were sown with Spratt-Archer in 1932 and vice versa. The two varieties were again sown by the half-drill strip method, the whole of the area of each variety being included in the weighed produce.

FOUR-COURSE ROTATION EXPERIMENT, ROTHAMSTED

RESIDUAL VALUES OF HUMIC AND PHOSPHATIC FERTILISERS

The Rotation experiment in Great Hoos field commenced in 1930, was designed primarily for investigating the residual effects of certain humic and phosphatic fertilisers. Previous rotation experiments, at Rothamsted and elsewhere, suffered from a radical defect in design, which resulted in large experimental errors. The arrangement of these experiments was such that with the same crop, the same treatment fell repeatedly on the same plot of land, and repetitions thus did nothing to eliminate permanent soil differences between the plots. The present experiment avoids this defect by ensuring that the period of the cycle of crop rotation differs from the period of the cycle of manurial treatment.

The cropping follows a Norfolk Rotation, involving a four year cycle of barley, seeds, wheat, swedes.* The seeds mixture is Commercial White Clover and Italian Rye-grass, selected in order to lessen the risk of Clover sickness. To minimise the risk of Frit-fly attack in the subsequent wheat crop, the seeds ley is ploughed in before the middle of August.

There are four areas (termed " Series "), each bearing one crop of the rotation, so that all four crops are represented annually.

Treatments.

The treatments compared are :

Humic fertilisers	1. Dung. 2. Adco compost. 3. Straw and artificials.
Phosphatic fertilisers	4. Superphosphate. 5. Rock phosphate (Gafsa).

Any given plot receives always the same treatment, but the treatment is applied to the plot only once in five years. The period of the manurial cycle (five years) thus differs from that of the crop rotation (four years).

Information is thus obtained of the effect of the fertilisers, not only in the year of application, but also in the first, second, third and fourth years after application.

Each " series " of the experiment comprises twenty-five plots, and in the fifth year of the experiment and in succeeding years, all plots will have been treated, and there will be represented for each treatment plots which have had application of fertilisers in the current year, and one, two, three, and four years previously. The harvest results for 1930-33, therefore, belong to the preparatory period, and will not be included in the final analysis.

There is no replication in any one year, but this will be provided by carrying on the experiment over a fixed period. In twenty years, on any given plot each stage of the treatment will have occurred once with every crop.

The quantities of fertilisers to be applied are calculated as follows :

Dung and Adco are each given in quantities which supply 50 cwt. of organic matter per acre. As much straw is applied as went to make the calculated amount of Adco, *i.e.*, that amount which gives 50 cwt. of organic matter per acre in the form of Adco. The quantity of straw applied will in general give a considerably greater amount of organic matter than the Dung or Adco, since there is a loss of organic matter during the maturation of these fertilisers.

The Adco is made in a pit or bin, so that there is no outside unrotted portion. To prevent straw (applied as chaff) blowing away, it is thoroughly soaked before application, and moistened subsequently if necessary.

The nutrient-content of the three humic fertilisers is equalised by adding sulphate of ammonia, muriate of potash and superphosphate, to raise the applications to 1.8 cwt. N. per acre, 3.0 cwt. K_2O per acre, and 1.2 cwt. P_2O_5 per acre. The artificials given with the straw are applied in three doses, to minimise loss by leaching.

The phosphatic fertilisers of treatments 4 and 5 are given at the rate of 1.2 cwt. total P_2O_5 per acre, and with them are given sulphate of ammonia at the rate of 1.8 cwt. N. per acre, and muriate of potash at the rate of 3.0 cwt. K_2O per acre.

The rock phosphate is Gafsa, ground so that 90 per cent. passes through the 120 mesh.

The artificials given with the humic fertilisers are all applied with them in the first year of the manurial cycle.

The phosphatic fertilisers of treatments 4 and 5 are applied only in the first year of the manurial cycle, but the accompanying sulphate of ammonia and muriate of potash are applied one fifth annually throughout the cycle.

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* It has been decided to substitute potatoes for swedes in 1932 and following years.

Time of Application of Fertilisers.

In determining the time of application of the fertilisers, the principle followed has been to give the fertilisers to each crop at a time when they are likely to be most effective.

The scheme adopted is as follows :

(1) *Wheat.*—Dung and Adco and accompanying artificials in one dose in the Autumn.

Straw in one dose in Autumn, but accompanying artificials split into three doses, one applied in Autumn, the remainder through the Winter.

Treatments 4 and 5. Phosphates and potash in seed-bed.

Sulphate of Ammonia of treatments 4 and 5, split into two parts, one applied in the seed-bed, the other as a spring top dressing.

(2) *Clover.*—Dung and Adco and accompanying artificials in one dose in Autumn, unless plant is very weak, when the manures should be split into two or three doses.

Straw and artificials—application to be determined by state of plant, but to be completed by the end of January.

Treatments 4 and 5. Phosphates and potash in the Autumn.

Sulphate of Ammonia in two doses, one in Autumn, and one in Spring.

(3) *Barley and Potatoes.*—Dung and Adco and accompanying artificials in one dose in Autumn.

Straw in one dose in Autumn, and accompanying artificials in three doses, one in Autumn, and the remaining two through the winter.

Treatments 4 and 5. All artificials to be given in the seed-bed.

Arrangement of Plots.

The experiment consists of four series of plots, each series growing one crop of the Norfolk rotation. Each series has 25 plots, in 5 blocks of 5 plots each. Each treatment is assigned to one plot in each block, chosen at random ; and each block has one treated plot in each year, chosen initially at random ; finally each treatment is applied once in each year to one plot in each series.

Hence treatments are assigned as to five randomised blocks of five plots each in each series, but a Latin Square scheme determines the year of application of the treatment in each series.

The plots are approximately 1/40th acre in area (.02436 acre in series A, B and C, but .02335 acre in series D).

MANURES APPLIED.

Season 1931-2.

Treatment.	Organic Fertilisers.	Artificial Fertilisers.		
	Organic Matter (cwt. per acre).	N. cwt. per acre as Sulphate of Amm.	K_2O cwt. per acre as Mur. of Potash.	P_2O_5 cwt. per acre as Superphosphate.
1 . .	50 (as F.Y.M.)	0.775	1.030	0.716
2 . .	50 (as Adco)	0.434	1.569	0.048
3 . .	150.95 (as Straw)	1.053	0.330	0.654
4 . .	None	0.36	0.6	1.2
5 . .	None	0.36	0.6	1.2 (as Gafsa rock phos.)

DATES OF APPLICATION.

Wheat.—Treatments 1 and 2 ; Nov. 2nd. Treatment 3 ; straw, Nov. 4th, artificials Nov. 2nd, Nov. 4th, Jan. 25th, April 5th. Treatments 4 and 5 ; minerals, Nov. 5th, sulphate of ammonia, Nov. 5th, April 5th.

Clover.—Treatments 1 and 2 ; Nov. 2nd, Jan. 25th. Treatment 3 ; straw, Nov. 7th, April 29th, artificials, Nov. 2nd, Nov. 7th, Dec. 7th, Jan. 25th, April 29th. Treatments 4 and 5 ; minerals, Nov. 5th, sulphate of ammonia, Nov. 5th, April 11th.

Barley.—Treatments 1 and 2 ; Dec. 7th. Treatment 3 ; straw, Dec. 12th,* artificials Dec. 7th, Jan. 25th, Mar. 15th. Treatments 4 and 5 ; minerals, April 5th.

Potatoes.—Treatments 1 and 2 ; Nov. 2nd, Nov. 4th. Treatment 3 ; straw, Dec. 7-15th, artificials, Nov. 2nd, Nov. 4th, Dec. 7th, Jan. 5th. Treatments 4 and 5; minerals, April 11th.

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* Applied after ploughing.

PLAN AND YIELDS

Potatoes—AP, Plots 1-25.
Planted, April 12th. Lifted, Sept. 30th.
Variety, Ally.

Yields in lb.

N.W.

5 400 —	**2** 277 III	**1** 409 I	**3** 264 —	**4** 367 II
5 321 II	**1** 217 —	**3** 335 III	**4** 299 —	**2** 270 I
3 258 II	**2** 201 —	**5** 284 —	**4** 427 I	**1** 251 III
1 305 II	**3** 196 —	**4** 272 III	**5** 225 I	**2** 238 —
4 288 —	**1** 159 —	**5** 164 III	**3** 232 I	**2** 176 II

Barley—AB, Plots 26-50.
Seed sown, Mar. 12th. Harvested, Aug. 15th.
Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

N.W.

3 76.0 77.2 II	**2** 74.4 67.6 III	**5** 79.2 99.2 —	**4** 85.5 95.2 I	**1** 65.9 79.8 —
4 86.2 99.6 III	**2** 89.1 96.9 I	**1** 61.4 67.9 II	**5** 78.8 98.0 —	**3** 70.1 79.9 —
1 109.7 156.6 I	**4** 80.5 91.0 —	**3** 65.1 69.4 —	**5** 88.2 95.2 III	**2** 80.2 80.5 II
4 88.2 99.2 —	**5** 86.1 101.1 II	**3** 74.5 69.8 I	**2** 55.0 52.8 —	**1** 78.9 82.3 III
2 62.2 58.8 —	**4** 81.5 85.5 II	**3** 74.8 68.8 III	**1** 56.4 53.6 —	**5** 89.5 93.5 I

Wheat—AW, Plots 51-75.
Seed sown, Nov. 5th. Harvested, Aug. 15th.
Variety, Yeoman.

Yields in lb., grain above, straw below.

N.W.

3 77.8 120.0 III	**4** 88.9 127.6 —	**1** 78.1 110.1 —	**2** 94.0 152.0 I	**5** 77.8 135.8 II
3 73.9 104.8 —	**4** 86.4 132.4 II	**5** 86.4 126.4 III	**2** 69.0 100.8 —	**1** 82.6 187.1 I
2 75.6 115.4 III	**4** 82.1 126.1 —	**3** 77.9 113.4 II	**1** 63.3 97.2 —	**5** 79.4 136.6 I
5 84.4 129.9 —	**1** 73.1 105.4 III	**3** 69.8 93.8 —	**4** 78.6 118.1 I	**2** 72.1 116.2 II
4 77.2 161.5 III	**2** 59.5 72.0 —	**1** 75.6 103.4 II	**5** 80.1 107.2 —	**3** 81.8 129.8 I

Seeds Hay—AH, Plots 76-100.
Seed sown, April 22nd. Cut, June 22nd.

Yields in lb., green weights.

N.W.

4 142.0 II	**2** 105.5 III	**5** 142.0 I	**3** 71.5 —	**1** 76.0 —
5 168.0 —	**2** 95.5 —	**1** 95.0 II	**4** 139.0 I	**3** 112.0 III
2 196.0 I	**1** 113.0 III	**5** 158.0 —	**4** 142.0 —	**3** 131.0 II
2 120.0 II	**4** 163.0 —	**1** 77.5 —	**5** 126.5 III	**3** 45.0 I
5 159.0 II	**2** 96.5 —	**3** 80.5 —	**1** 278.0 I	**4** 162.0 III

Treatment symbols in heavy type, year of cycle in roman figures (see note on next page).

SUMMARY OF RESULTS, 1932

Manure.	Year of Cycle.	Wheat cwt. per acre.		Potatoes tons per acre.	Barley cwt. per acre.		Seeds Hay cwt. per acre dry matter.
		Grain.	Straw.		Grain.	Straw.	
Manure as F.Y.M.	—	28.6	40.4	3.98	24.2	29.2	19.3
	—	23.2	35.6	2.91	20.7	19.6	19.6
	I	30.3	68.6	7.50	40.2	57.4	70.6
	II	27.7	37.9	5.59	22.5	24.9	24.1
	III	26.8	38.6	4.60	28.9	30.2	28.7
Manure as Adco	—	25.3	36.9	3.69	20.2	19.3	24.2
	—	21.8	26.4	4.36	22.8	21.6	24.5
	I	34.4	55.7	4.94	32.7	35.5	49.8
	II	26.4	42.6	3.23	29.4	29.5	30.5
	III	27.7	42.3	5.07	27.3	24.8	26.8
Manure as Straw	—	27.1	38.4	4.84	25.7	29.3	18.1
	—	25.6	34.4	3.59	23.8	25.4	20.4
	I	30.0	47.6	4.25	27.3	25.6	11.4
	II	28.5	41.6	4.74	27.8	28.3	33.2
	III	28.5	44.0	6.14	27.4	25.2	28.4
Super.	—	32.6	46.8	5.48	29.5	33.4	36.0
	—	30.1	46.2	5.27	32.3	36.4	41.4
	I	28.8	43.3	7.82	31.3	34.9	35.3
	II	31.7	48.5	6.72	29.9	31.3	36.0
	III	28.3	59.2	4.99	31.6	36.5	41.1
Rock Phosphate	—	30.9	47.6	7.32	29.0	36.4	42.6
	—	29.3	39.3	5.21	28.9	35.9	40.1
	I	29.1	50.1	4.12	32.8	34.3	36.0
	II	28.5	49.8	5.88	31.6	37.1	40.4
	III	31.7	46.3	3.00	32.3	34.9	32.1

The number I denotes application of manure at the beginning of the present season (1931-2); II application in the previous season, etc. The plots above the lines have not yet had any manure, except those due to receive superphosphate and rock phosphate, which in the season 1931-2 received one fifth of their quinquennial total of potash and nitrogen. In the two previous seasons these plots, like the corresponding plots due to receive organic manures, were untreated.

SIX COURSE ROTATION EXPERIMENT

ROTHAMSTED AND WOBURN

This experiment is designed to furnish data on the effect of varying amounts of the three standard fertilisers, nitrogen, phosphate, and potash, on the yield of six crops of a rotation in the different weather conditions of successive years.

Rotation.

The six courses of the rotation are : barley, clover hay, wheat, potatoes, forage-crop, sugar-beet. The forage-crop consists of equal parts (1 bushel per acre each) of rye, beans and vetches. It is sown in autumn, cut green and followed by a catch crop of mustard. The mustard is ploughed in in early autumn, and followed by rye to be ploughed in before sowing sugar-beet. After wheat, rye is sown and ploughed in in spring before planting potatoes.

The variety of barley used is Plumage-Archer, and of wheat Yeoman II.

Arrangement.

There are six areas, called " series," in Long Hoos IV at Rothamsted, which are cropped in this rotation so that each crop is represented every year and a similar set in Stackyard at Woburn. There are fifteen plots of 1/40th acre in each series, each of which receives a different treatment. Thus there is no replication of a given crop with a given treatment in any one year. Plots do not receive the same treatments throughout, but on each plot the fifteen treatments follow one another in a definite order in successive years, and in this way cumulative effects of a treatment are avoided.

Treatments.

The fifteen treatments are :

Nitrogen set.	4, 3, 2, 1, 0 units of N, each with 2 units P and 2 units K.
Phosphate set.	4, 3, 2, 1, 0 units of P, each with 2 units K and 2 units N.
Potash set.	4, 3, 2, 1, 0 units of K, each with 2 units N and 2 units P.

1 unit of N=0.15 cwt. of N per acre.
1 unit of P= 0.15 cwt. of P_2O_5 per acre.
1 unit of K=0.25 cwt. of K_2O per acre.

The fertilisers used are Sulphate of Ammonia, Superphosphate and Muriate of Potash. The amount of Superphosphate applied is calculated on the basis of total P_2O_5 content.

The potassic and phosphatic fertilisers are applied to the autumn sown crops, wheat and forage-mixture, and to the clover, sown under barley in the previous spring, in the Autumn, and the nitrogenous fertiliser is given as a spring top dressing. The spring sown crops receive all their fertilisers at the time of sowing.

Within each of the three sets of treatments, the treatments 4, 3, 2, 1, 0 units follow each other in that order in successive years.

On series 2, 4, 6 the order of the sets of treatments is N, P, K, and on series 1, 3, 5 the order is N, K, P, *i.e.*, on plots of series 2, 4, 6 treatment ON is followed by treatment 4P, OP by 4K and OK by 4N, while on series 1, 3, 5, ON is followed by 4K, OK by 4P, and OP by 4N.

Continuance of the Experiment.

In 1929-30 the six crops of the rotation at Rothamsted were scattered in various fields of the farm, so that the experiment proper started on its permanent site in Long Hoos IV in season 1930-31, while at Woburn in 1929-30 only potatoes, barley, and sugar beet were grown.

After 30 years on the same land, each plot will have completed 5 rotations by crops, and 2 by treatments. If continued for a further period, it will be necessary to omit one stage of the crop rotation on each series, without breaking the sequence of manurings. After two such breaks the experiment could be continued until every crop with every treatment had occurred on each plot.

Estimate of Error.

Although there is no actual replication, an estimate of error can be made from the deviations of the yield/quantity of fertiliser curve, from a smooth form.

ROTHAMSTED, 1932

Potatoes—BP, Plots 1-15.

Manures applied, April 11th. Planted, April 12th. Lifted, Sept. 30th. Variety, Ally.

Yields in lb.

N.

2P 387	4N 472	4K 467	3K 451	1K 404
3N 436	1P 408	2N 419	4P 465	0K 359
0P 427	1N 432	0N 355	2K 408	3P 427

Clover—BC, Plots 31-45.

Manures applied, Nov. 9th, Mar. 21st. Seed sown, April 29th. Cut, June 17th. Ploughed, Aug. 15th.

Yields in lb., green weights.

N.

1K 85	4P 86	4N 124	1P 86	2N 95
2K 92	0K 102	3N 113	3K 104	4K 97
3P 85	2P 91	0P 98	1N 90	0N 81

Forage—BF, Plots 61-75.

Manures applied, Oct. 16th, Mar. 21st. Seed sown, Oct. 16th. Harvested, June 4th.

Yields in lb., green weights.

N.

3P 185	4P 168	0P 153	4N 171	0N 141
2K 204	0K 189	1P 179	4K 182	3K 186
1K 177	2P 176	3N 176	1N 163	2N 178

Barley—BB, Plots 16-30.

Manures applied, March 19th. Seed sown, March 12th. Harvested, Aug. 15-16th. Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

N.

2N 99.5 101.8	3P 98.5 112.5	1P 96.2 112.1	2P 100.9 113.8	2K 98.2 101.1
4P 94.9 109.4	1N 101.4 111.4	0P 95.6 107.6	4N 103.2 120.0	3N 99.2 107.5
0N 99.1 103.1	4K 96.6 110.4	3K 94.4 111.4	1K 94.7 104.6	0K 91.6 91.1

Wheat—BW, Plots 46-60.

Manures applied, Oct. 16th, Mar. 21st. Seed sown, Oct. 16th. Harvested, Aug. 15-16th. Variety, Yeoman II.

Yields in lb., grain above, straw below.

N.

2P 76.6 161.6	4K 80.8 165.8	0K 74.6 168.6	3N 68.2 170.2	1N 80.9 156.6
0P 90.0 167.8	3K 75.4 171.3	1K 80.7 169.3	2N 82.9 166.4	0N 83.9 148.1
1P 72.0 176.2	4N 57.2 182.1	2K 72.9 175.6	4P 73.6 173.4	3P 76.9 168.4

Sugar Beet—BS, Plots 76-90.

Manures applied, May 5th. Seed sown, May 19th. Lifted, Nov. 4th. Variety, Kuhn.

Yields in lb., roots (dirty) above, tops centre, sugar percentages below.

N.

3K 524 786 16.82	4K 540 703 17.27	2K 599 754 17.16	4N 438 890 16.93	4P 514 863 16.64
1P 524 815 16.70	2P 504 804 17.10	3N 499 904 17.04	1N 401 719 16.70	2N 464 848 16.70
0P 560 880 16.70	1K 559 873 16.59	0K 522 813 16.13	3P 601 923 16.47	0N 596 973 16.19

WOBURN, 1932

Forage—CF, Plots 1-15.

Manures applied, Oct. 23rd, Mar. 21st. Seed sown, Oct. 23rd. Harvested, May31-June 1st.

Yields in lb., green weights.

1N 92.8	3K 122.0	2K 116.2	1K 114.0	2P 104.2
2N 121.2	4K 114.2	4P 112.5	4N 162.8	1P 138.2
0N 88.8	3P 133.8	0K 129.8	0P 136.5	3N 146.5

Potatoes—CP, Plots 31-45.

Manures applied, April 6th. Planted, April 7th. Lifted, Sept. 27th. Variety, Ally.

Yields in lb.

2N 311	3K 286	2K 513	0K 253	0P 322
4K 293	1N 283	4P 176	4N 521	1P 359
0N 259	1K 412	3P 434	3N 490	2P 322

Barley—CB, Plots 61-75.

Manures applied, Mar. 21st. Seeds sown, Mar. 17th. Harvested, Sept. 2nd. Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

0K 31.0 72.0	4P 44.0 87.0	1P 44.8 103.5	3N 60.5 114.8	2N 56.0 122.5
3P 39.0 82.0	1K 43.8 88.5	4N 64.0 116.5	0N 25.8 105.0	4K 49.0 128.5
2K 49.2 93.5	2P 44.2 104.0	0P 40.2 90.0	3K 53.0 109.0	1N 30.8 86.5

Sugar Beet—CS, Plots 16-30.

Manures applied, May 10th. Seed sown, May 10th. Lifted, Nov. 2-4th. Variety, Kuhn.

Yields in lb., roots (dirty) above, tops centre, sugar percentages below.

1K 335 202 16.76	4N 410 257 16.30	3P 521 378 17.78	2N 613 370 18.58	1P 568 313 18.30
0K 385 215 16.70	3N 538 340 16.87	0N 581 369 17.44	4K 674 420 17.73	3K 625 364 18.35
2K 435 331 17.21	1N 467 369 17.44	4P 630 521 17.78	2P 623 473 18.24	0P 637 396 17.67

Clover—CC, Plots 46-60.

Manures applied, Nov. 20th, Mar. 21st. Seed sown, May 7th. Cut, June 27th.

Yields in lb., green weights.

0N 86.5	4P 86.0	2P 90.5	4K 87.0	4N 54.0
1N 92.0	2N 98.0	0P 95.0	2K 85.5	3N 47.5
3P 90.0	1P 99.0	3K 81.5	0K 72.0	1K 77.5

Wheat—CW, Plots 76-90.

Manures applied, Oct. 28th, Mar. 21st. Seed sown, Oct. 23rd. Harvested, Aug. 11-12th. Variety, Yeoman.

Yields in lb., grain above, straw below.

4N 18.0 88.0	0K 12.8 73.2	3P 17.5 83.8	4P 8.2 57.0	0P 7.0 57.0
1K 16.5 93.0	3N 20.2 88.0	2N 18.2 85.8	4K 12.2 68.0	3K 11.0 68.2
2K 18.0 98.0	0N 11.0 67.0	1N 17.0 76.2	1P 15.5 79.2	2P 18.5 73.5

ROTHAMSTED, 1932

1. Mean yields per acre and increments in yield per cwt. of N, P_2O_5 and K_2O.

		Average, 1930-1	1932	Standard error, 1932			Average, 1930-1.	1932	Standard error, 1932.
Sugar Beet Roots, (washed) tons	Yield.	6.61	7.17		**Clover Hay** Dry Matter, cwt.	Yield.	25.8	22.5	
	N	2.20	−2.01	1.61		N	22.3	**17.0**	3.0
	P	1.04	−0.15	1.61		P	3.3	−3.9	3.0
	K	—0.12	0.00	0.96		K	2.3	0.8	1.8
Tops, tons	Yield.	9.43	14.94		**Wheat.** Grain, cwt.	Yield.	19.2*	27.3	
	N	5.26	0.22	2.84		**N**	16.4*	**−15.8**	4.1
	P	−0.68	0.87	2.84		P	1.4	−6.6	4.1
	K	−0.70	−2.19	1.70		K	3.6	1.0	2.5
Sugar Percentage	Yield.	17.36	16.74		Straw cwt.	Yield.	39.3*	60.0	
	N	−0.76	**1.21**	0.50		N	41.0*	**19.4**	3.4
	P	−0.29	−0.23	0.50		P	3.6	0.8	3.4
	K	0.12	**1.00**	0.30		K	5.4	−0.5	2.1
Barley Grain, cwt.	Yield.	23.6	34.9		**Potatoes** tons	Yield.	7.02	7.52	
	N	11.2	1.5	1.8		N	1.77	**2.83**	0.83
	P	−1.5	0.1	1.8		P	−0.44	1.14	0.83
	K	−0.4	1.4	1.0		K	4.48	**1.88**	0.50
Straw cwt.	Yield.	28.5	38.5		**Forage** Dry Matter, cwt.	Yield.	39.6	30.3	
	N	16.2	7.1	3.7		N	24.8	8.4	4.3
	P	9.5	1.1	3.7		P	−0.8	4.2	4.3
	K	4.0	**6.5**	2.2		K	−2.4	−0.4	2.6

* 1931 only.
Significant results in heavy type. Negative sign means depression.

2. Average percentage increments in yield for each application of N, P_2O_5 and K_2O.

	N		P		K		Standard error, 1932
	Average 1930-1	1932	Average 1930-1	1932	Average 1930-1	1932	
Sugar Beet—Roots (washed)	4.97	−4.20	2.39	−0.31	−0.51	−0.01	3.36
Tops	8.38	0.22	−1.03	0.88	−1.88	−3.67	2.85
Sugar Percentage	0.44	**1.09**	0.25	−0.21	0.18	**1.50**	0.45
Barley—Grain	7.34	0.63	−0.74	0.06	−0.50	1.00	0.75
Straw	8.74	2.75	4.56	0.42	3.56	**4.23**	1.43
Clover Hay—Dry matter	10.82	**11.32**	1.94	—2.62	2.62	0.91	2.00
Wheat—Grain	12.83*	**−8.68**	0.21	−3.63	3.50	0.92	2.28
Straw	15.58*	**4.85**	0.22	0.20	2.14	−0.22	0.86
Potatoes	4.07	**5.65**	−1.73	2.27	15.78	**6.26**	1.65
Forage—Dry matter	10.13	4.16	−0.04	2.08	−2.08	−0.29	2.14

* 1931 only.
Significant results in heavy type. Negative sign means depression.

https://doi.org/10.23637/ERADOC-1-64

WOBURN, 1932

1.—Mean yields per acre and increments in yield per cwt. of N, P_2O_5 and K_2O.

		Average 1930-1.	1932.	Standard error 1932.			Average 1930-1.	1932.	Standard error 1932.
Sugar Beet Roots (washed) tons	Yield.	5.33	6.08		**Clover Hay** Dry matter cwt.	Yield.	24.4*	23.2	
	N	2.20	−2.04	1.68		N	5.9*	**−18.4**	7.0
	P	0.04	−0.46	1.68		P	−1.1*	−6.0	7.0
	K	1.06	**3.95**	1.01		K	5.4*	3.4	4.2
Tops tons	Yield.	7.10	6.33		**Wheat** Grain cwt.	Yield.	11.2†	5.3	
	N	3.14	−3.01	1.91		N	16.5†	4.1	3.2
	P	−0.40	3.75	1.91		P	−2.4†	1.0	3.2
	K	2.27	**4.08**	1.15		K	−2.2†	−1.0	1.9
Sugar percentage	Yield.	16.86	17.54		Straw cwt.	Yield.	27.2†	27.5	
	N	−1.01	−1.90	1.21		N	36.5†	12.8	9.2
	P	0.16	−0.20	1.21		P	2.1†	1.1	9.2
	K	0.54	1.46	0.73		K	−7.9†	−5.0	5.5
Barley Grain, cwt.	Yield.	22.2	16.1		**Potatoes** tons	Yield.	10.98	6.23	
	N	16.8	**25.2**	4.0		N	5.95	**8.70**	3.65
	P	0.5	0.3	4.0		P	2.13	−2.61	3.65
	K	2.6	**6.4**	2.4		K	1.41	−0.33	2.19
Straw cwt.	Yield.	44.6	35.8		**Forage** Dry matter, cwt.	Yield.	41.0†	27.4	
	N	28.0	12.2	7.6		N	27.6†	**30.0**	4.9
	P	−0.8	−6.5	7.6		P	12.7†	−7.8	4.9
	K	4.6	**19.1**	4.5		K	0.1†	−2.0	3.0

* 1931 only, and in this year the crop was Tares. † 1931 only.
Significant results in heavy type. Negative sign means depression.

2.—Average percentage increments in yield for each application of N, P_2O_5 and K_2O.

	N		P		K		Standard error, 1932.
	Average 1930-1.	1932.	Average 1930-1.	1932.	Average 1930-1.	1932.	
Sugar Beet—Roots (washed)	6.32	−5.03	−0.81	−1.14	4.23	**16.24**	4.14
Tops	6.62	−7.14	−1.46	8.88	6.87	**16.13**	4.53
Sugar percentage	0.00	−1.62	0.16	−0.17	0.80	2.08	1.04
Barley—Grain	11.28	**23.52**	0.08	0.31	2.74	**10.02**	3.74
Straw	9.68	5.11	0.00	−2.71	2.50	**13.33**	3.17
Clover Hay—dry matter	3.68*	**−11.87**	−0.70*	−3.85	5.48*	3.66	4.58
Wheat—Grain	22.01†	11.58	−3.18†	2.85	−4.99†	−4.56	9.13
Straw	20.02†	6.98	1.15†	0.58	−7.28†	−4.58	5.04
Potatoes	8.07	**20.95**	2.86	−6.28	3.17	−1.33	8.78
Forage—dry matter	10.03†	**16.45**	4.65†	−4.29	0.06†	−1.83	2.70

* 1931 only, and in this year the crop was Tares. † 1931 only.
Significant results in heavy type. Negative sign means depression.

Replicated Experiments at Rothamsted

HAY

Temporary Leys.—Clover, ryegrass and fallow, following barley, and preceding wheat.

RH—Fosters—1932

Plan and yields in lb.—First crop, green weights.

1 8

238 R 216 S O	L.F. I.F. O I.F. L.F. O S	188 C 172 O S	311 CR 307 S O
L.F. L.F. O I.F. I.F. O S	240 R 233 S O	286 CR 318 S O	133 C 100 S O
286 CR 296 O S	212 C 200 O S	220 R 186 S O	L.F. I.F. O I.F. L.F. S O
149 C 169 S O	278 CR 315 S O	I.F. L.F. O L.F. I.F. S O	218 R 236 O S

W ↑

57 4

Second crop, green weights.

14	13	L.F.	I.F.				54
		I.F.	L.F.	51	70	73	
L.F.	L.F.					49	16
I.F.	I.F.	13	12	71	74		
	77			13	12	L.F.	I.F.
66		78	94			I.F.	L.F.
			96	I.F.	L.F.	13	
*	*	74		L.F.	I.F.		18

*The crop on these two plots was too small to be weighed.

SYSTEM OF REPLICATION: 4 × 4 Latin square for different leys, with plots sub-divided into two for nitrogen in 1931, and half plots sub-divided into two after first cut, one half being summer fallowed, the other cut a second time. The plots without leys were sub-divided for light fallow (L.F.) and intensive fallow (I.F.).

AREA OF EACH QUARTER-PLOT: 0.02618 acre (59.5 × 44.0 links).

TREATMENTS: No ley (O), Clover (C), Ryegrass (R), and Clover and Ryegrass (CR). In 1931 half-plots received no nitrogen (O) and sulphate of ammonia (S) at the rate of 0.2 cwt. N per acre.

SEED SOWN: April 23rd, 1931. Cut: 1st crop, June 22nd; 2nd crop, August 29th.

PREVIOUS CROP: Barley.

SUMMARY OF RESULTS

DRY MATTER

	Ryegrass	Clover	Clover and Ryegrass	*Mean*
FIRST CROP Cwt. per acre				
No Nitrogen ..	26.6	20.0	39.0	*28.5*
Nitrogen	29.0	19.3	36.9	*28.4*
Mean	*27.8*	*19.6*	*37.9*	*28.4*
Difference ..	*+2.4*	*−0.7*	*−2.1*	*−0.1*
Per Cent.				
No Nitrogen ..	93.4	70.2	137.0	*100.2*
Nitrogen	102.1	67.8	129.6	*99.8*
Mean	*97.7*	*69.0*	*133.3*	*100.0*
Difference ..	*+8.7*	*−2.4*	*−7.4*	*−0.4*
SECOND CROP Cwt. per acre				
No Nitrogen ..	2.7	6.3	12.9	*7.3*
Nitrogen	3.2	9.1	12.7	*8.3*
Mean	*2.9*	*7.7*	*12.8*	*7.8*
Difference ..	*+0.5*	*+2.8*	*−0.2*	*+1.0*
Per Cent.				
No Nitrogen ..	34.5	80.6	165.1	*93.4*
Nitrogen	40.6	116.8	162.4	*106.6*
Mean	*37.5*	*98.7*	*163.7*	*100.0*
Difference ..	*+6.1*	*+36.2*	*−2.7*	*+13.2*

CONCLUSIONS

The differences between the different leys are significant, but the significance of the residual nitrogen effects is doubtful.

BARLEY

Variety Trial.

Comparison of Early and Late sowing.

Effect of Superphosphate and Sulphate of Ammonia.

RB—Fosters, 1932

Plan and yields in lb.

	Treatment.	Grain.	Straw.		Treatment.	Grain.	Straw.	
48	CN—L	43.6	41.9		CN—E	27.9	29.1	96
	BN—L	49.9	44.6		C—PL	25.6	21.1	
	B——L	44.6	37.9		B—PL	37.3	32.0	
	CN—E	35.4	31.9		CNPE	29.2	30.8	
	CNPL	38.8	36.4		A——E	35.6	33.9	
	ANPE	52.2	53.6		ANPL	40.8	52.5	
	B—PL	44.6	44.1		B——E	33.6	29.4	
	ANPL	43.7	62.1		BN—L	41.1	33.4	
	CNPE	35.6	33.4		A—PE	37.9	36.6	
	A——L	41.4	58.1	N	AN—L	40.3	51.7	
	BNPE	44.7	43.8	↑	CNPL	26.8	24.7	
	AN—E	51.1	58.1		C—PE	22.1	20.4	
	BN—E	51.6	48.6		C——E	21.4	27.1	
	B—PE	46.4	43.1		B——L	37.0	33.3	
	AN—L	42.1	59.9		A—PL	39.3	56.4	
	BNPL	57.3	61.2		ANPE	49.4	47.1	
	A—PL	44.6	62.6		C——L	27.5	23.2	
	C—PL	36.5	35.5		BNPE	45.8	41.7	
	C—PE	33.4	30.9		BNPL	39.4	35.3	
	A—PE	48.6	49.9		CN—L	28.2	25.8	
	B——E	39.8	38.5		BN—E	42.9	37.3	
	C——L	28.1	30.9		B—PE	35.2	31.6	
	A——E	49.1	57.1		A——L	32.4	45.6	
	C——E	36.1	36.1		AN—E	49.0	55.5	
	AN—E	59.6	74.4		ANPE	48.9	53.1	
	CN—L	34.5	44.8		BNPL	32.1	38.9	
	A—PL	46.6	73.4		A——L	33.5	49.8	
	C——L	27.0	32.0		B—PE	37.3	35.2	
	CN—E	43.6	41.6		BN—E	40.2	37.8	
	B——E	50.8	47.2		A—PE	34.8	38.2	
	B—PL	44.6	46.1		C——E	19.6	20.2	
	B—PE	54.0	47.2		ANPL	39.3	62.2	
	CNPL	30.6	34.9		AN—L	33.6	52.4	
	B——L	49.7	46.6		AN—E	50.8	59.2	
	BNPL	51.5	50.2		A—PL	31.4	41.8	
	C——E	38.2	36.0		CNPL	16.6	19.9	
	C—PE	42.4	40.6		A——E	29.6	35.1	
	A——E	51.5	60.2		C—PE	22.6	23.2	
	BN—E	55.1	45.9		BN—L	31.9	28.6	
	AN—L	45.4	77.1		B——E	31.8	28.0	
	C—PL	35.4	36.6		C——L	9.4	12.8	
	A—PE	59.0	64.2		CN—L	13.6	15.4	
	ANPE	59.4	66.6		B—PL	32.0	24.5	
	CNPE	44.8	40.5		C—PL	12.2	12.8	
	BNPE	56.0	50.2		BNPE	41.1	35.1	
	ANPL	45.2	86.0		CN—E	27.2	24.8	
	A——L	40.9	80.1		B——L	29.4	25.4	
1	BN—L	36.2	41.8		CNPE	26.8	23.9	49

DETAILS.

SYSTEM OF REPLICATION : 4 randomised blocks of 24 plots each.

AREA OF EACH PLOT : 1/70th acre (144.3 × 9.9 links).

TREATMENTS AND VARIETIES :

All combinations of :

(*a*) { — No nitrogen.
N Sulphate of ammonia (0.2 cwt. N per acre).

(*b*) { — No phosphate.
P Superphosphate (0.5 cwt. P_2O_5 per acre).

(*c*) { E Early sowing (Mar. 4th).
L Late sowing (April 6th).

(*d*) { A Plumage-Archer.
B Victory.
C July.

SEED SOWN : Mar. 4th, 5th, 8th and April 6th.

HARVESTED : Aug. 10-30th.

PREVIOUS CROP : Seeds Hay.

SUMMARY OF RESULTS

		Early Sowing			Late Sowing		
		Plumage Archer	Victory	July	Plumage Archer	Victory	July
GRAIN Cwt. per acre							
No Sulph. Amm.	No Super. ..	25.9	24.4	18.0	23.2	25.1	14.4
	Super. ..	28.2	27.0	18.8	25.3	24.8	17.1
Sulph. Amm.	No Super. ..	32.9	29.6	21.0	25.2	24.8	18.7
	Super. ..	32.8	29.3	21.3	26.4	28.2	17.6
Per Cent.							
No Sulph. Amm.	No Super. ..	107.2	100.8	74.5	95.8	103.9	59.5
	Super. ..	116.6	111.8	77.9	104.6	102.5	70.9
Sulph. Amm.	No Super. ..	136.1	122.7	86.7	104.3	102.8	77.5
	Super. ..	135.7	121.3	88.2	109.2	116.6	72.9
STRAW Cwt. per acre							
No Sulph. Amm.	No Super. ..	29.1	22.4	18.6	36.5	22.4	15.4
	Super. ..	29.5	24.5	18.0	36.6	22.9	16.6
Sulph. Amm.	No Super. ..	38.6	26.5	19.9	37.7	23.2	20.0
	Super. ..	34.4	26.7	20.1	41.1	29.0	18.1
Per Cent.							
No Sulph. Amm.	No Super. ..	111.3	85.5	71.3	139.5	85.5	59.1
	Super. ..	112.8	93.8	68.7	139.9	87.6	63.3
Sulph. Amm.	No Super. ..	147.6	101.3	76.1	144.0	88.6	76.4
	Super. ..	131.6	102.0	76.8	157.0	110.8	69.2

Standard error of single entry: Grain, 1.359 cwt., or 5.62 per cent.
Straw, 1.562 cwt., or 5.98 per cent.

Differences between varieties

	Plumage Archer	Victory	July	*Mean*
		GRAIN. Cwt. per acre		
Early	29.9	27.6	19.8	*25.8*
Late	25.0	25.7	17.0	*22.6*
Mean	*27.5*	*26.6*	*18.4*	*24.2*
		Per cent.		
Early	123.9	114.2	81.8	*106.6*
Late	103.5	106.4	70.2	*93.4*
Mean	*113.7*	*110.3*	*76.0*	*100.0*
		STRAW. Cwt. per acre		
Early	32.9	25.0	19.2	*25.7*
Late	38.0	24.4	17.5	*26.6*
Mean	*35.4*	*24.7*	*18.3*	*26.2*
		Per cent.		
Early	125.8	95.6	73.2	*98.2*
Late	145.1	93.2	67.0	*101.7*
Mean	*135.5*	*94.4*	*70.1*	*100.0*

Standard error of single entry—Grain : 0.680 cwt., or 2.81 per cent.
Straw : 0.781 cwt., or 2.99 per cent.

Nitrogenous Effects

	Early	Late	*Mean*
	GRAIN. Cwt. per acre		
No Sulph. Amm.	23.7	21.6	*22.7*
Sulph. Amm.	27.8	23.5	*25.7*
Mean	*25.8*	*22.6*	*24.2*
	Per cent.		
No Sulph. Amm.	98.1	89.5	*93.8*
Sulph. Amm.	115.1	97. 2	*106.2*
Mean	*106.6*	*93.4*	*100.0*
	STRAW. cwt. per acre		
No Sulph. Amm.	23.7	25.1	*24.4*
Sulph. Amm.	27.7	28.2	*27.9*
Mean	*25.7*	*26.6*	*26.2*
	Per cent.		
No Sulph. Amm.	90.6	95.8	*93.2*
Sulph. Amm.	105.9	107.7	*106.8*
Mean	*98.2*	*101.7*	*100.0*

Standard error of single entry—Grain : 0.555 cwt., or 2.29 per cent.
Straw : 0.638 cwt., or 2.44 per cent.

Phosphatic Effects

	Early	Late	*Mean*
	GRAIN **cwt. per acre**		
No Super.	25.3	21.9	*23.6*
Super.	26.2	23.2	*24.7*
Mean	*25.8*	*22.6*	*24.2*
	Per cent.		
No Super.	104.7	90.6	*97.6*
Super.	108.6	96.1	*102.3*
Mean	*106.6*	*93.4*	*100.0*
	STRAW **cwt. per acre**		
No Super.	25.8	25.9	*25.9*
Super.	25.5	27.4	*26.4*
Mean	*25.7*	*26.6*	*26.2*
	Per cent.		
No Super.	98.8	98.9	*98.8*
Super.	97.6	104.6	*101.1*
Mean	*98.2*	*101.7*	*100.0*

Standard errors: Same as for nitrogenous effects.

CONCLUSIONS

The yields of Plumage Archer and Victory are significantly greater than those of July for both grain and straw. The yields of Plumage Archer are significantly greater than Victory in the case of the straw only, this difference being significantly greater for late sowing.

The early sowing gives a significantly greater yield of grain than the late sowing.

There is a significant response to sulphate of ammonia both by the grain and straw, and to superphosphate by the grain only. The response to sulphate of ammonia by the grain is significantly greater in the early sowings.

In yields of grain the three varieties show no significant differences in response to any of the factors tested.

WHEAT

Effect of spring and autumn application of nitrogen, in the form of sulphate of ammonia and cyanamide, in relation to previous temporary ley.

RW—Long Hoos, 1932

Sample weights in grams—Grain above, straw below.

1	SEL	SL	CEL	SE	—	CL	SL	CE	8
	822	819	792	685	657	807	672	632	
	1770	1654	1728	1536	1548	1789	1780	1467	
	CEL	CL	SEL	CE	—	SL	CL	SE	
	908	971	687	810	801	909	800	713	
	1938	1696	1656	1731	1378	2123	1858	1465	
	R–2		R–1		O–2		O–1		
	SE	—	—	SL	CE	SEL	—	CEL	
	954	899	872	751	922	834	897	775	
	1673	1476	1462	1836	1989	1955	1778	1576	
	CE	—	—	CL	SE	CEL	—	SEL	
	792	964	758	845	946	913	888	707	
	1447	1514	1554	1832	1881	1920	1708	1449	
	CE	SEL	CEL	SL	CEL	CE	CL	SEL	
	863	678	929	875	811	911	829	878	
	1557	1616	1730	1610	1540	1719	1538	1524	
N	SE	CEL	SEL	CL	SEL	SE	SL	CEL	
↑	961	816	834	1055	763	832	1028	809	
	1657	1489	1638	1815	1732	1610	2052	1478	
	O–1		R–2		R–1		O–2		
	SL	—	CE	—	CL	—	CE	—	
	754	961	952	1032	900	922	915	627	
	1883	1541	1670	1860	1692	1490	1722	1440	
	CL	—	SE	—	SL	—	SE	—	
	1015	839	880	995	952	776	784	810	
	1724	1522	1517	1781	1712	1362	1416	1430	
	CL	CE	SE	CEL	SEL	CE	SEL	SL	
	904	1001	755	811	772	935	654	638	
	1704	1684	1390	1764	1713	1662	1318	1178	
	SL	SE	CE	SEL	CEL	SE	CEL	CL	
	990	688	892	813	850	897	678	712	
	1662	1376	1682	1518	1596	1616	1332	1238	
	R–1		O–2		O–1		R–2		
	—	SEL	CL	—	—	CL	SE	—	
	951	884	882	972	778	1036	638	758	
	1444	1808	1547	1648	1314	1956	1219	1366	
	—	CEL	SL	—	—	SL	CE	—	
	970	954	906	760	903	880	689	644	
	1429	1680	1718	1600	1566	1730	1218	1188	
	—	SL	—	CEL	CEL	—	SL	SEL	
	962	824	701	780	838	923	656	624	
	1573	1538	1236	1655	1442	1478	1309	1466	
	—	CL	—	SEL	SEL	—	CL	CEL	
	1173	786	774	672	805	828	798	599	
	1870	1343	1286	1445	1562	1358	1384	1276	
	O–2		O–1		R–2		R–1		
	SE	SEL	SL	CE	CE	SL	—	CE	
	854	827	864	815	717	790	685	577	
	1482	1516	1668	1524	1211	1446	1220	980	
	CE	CEL	CL	SE	SE	CL	—	SE	
	656	728	753	735	818	843	606	561	
121	1218	1382	1493	1566	1482	1606	1300	1248	128

DETAILS

SYSTEM OF REPLICATION : 4 × 4 Latin square for different leys, with each plot sub-divided into four for times of application of nitrogen, and each quarter plot sub-divided into two for kind of nitrogen.

AREA OF EACH EIGHTH PLOT : 1/80th acre (39.5 × 31.6 links).

MAIN PLOT TREATMENTS : Clover (O), 1 cut and 2 cuts ; clover and ryegrass (R), 1 cut and 2 cuts.

QUARTER PLOT TREATMENTS : Nitrogenous dressings of 0.3 cwt. N. per acre applied early (E), late (L), both early and late (EL), or no nitrogen (—).

EIGHTH PLOT TREATMENTS : Sulphate of ammonia (S) and Cyanamide (C).

HARVESTING : By sampling method ; 16 one-metre lengths per eighth-plot, drills set 6 ins. apart.

VARIETY : Victor.

MANURES APPLIED : Early, October 29th, 1931 ; late, March 24th.

SEED SOWN : October 31st.

HARVESTED : Aug. 17th-20th.

PREVIOUS CROP : Temporary ley.

SUMMARY OF RESULTS

GRAIN

		Clover		Clover and Ryegrass		*Mean*
		1 Cut	2 Cuts	1 Cut	2 Cuts	
Cwt. per acre						
No Nitrogen		27.5	27.6	26.7	28.8	*27.6*
Early	Cyanamide	26.5	27.6	26.9	25.7	*26.7*
	Sulph. Amm.	27.0	27.3	22.6	26.9	*26.0*
	Mean	*26.8*	*27.4*	*24.8*	*26.3*	*26.3*
Late	Cyanamide	29.4	27.0	28.1	29.2	*28.4*
	Sulph. Amm.	25.9	29.9	27.3	25.5	*27.2*
	Mean	*27.6*	*28.4*	*27.7*	*27.4*	*27.8*
Early and Late	Cyanamide	26.3	26.6	25.8	27.4	*26.5*
	Sulph. Amm.	23.1	27.4	24.2	25.4	*25.0*
	Mean	*24.7*	*27.0*	*25.0*	*26.4*	*25.8*
Mean		*26.6*	*27.6*	*26.0*	*27.2*	*26.9*
Per cent.						
No Nitrogen		102.4	102.7	99.3	107.0	*102.8*
Early	Cyanamide	98.6	102.8	100.2	95.7	*99.3*
	Sulph. Amm.	100.4	101.4	84.0	99.9	*96.4*
	Mean	*99.5*	*102.1*	*92.1*	*97.8*	*97.9*
Late	Cyanamide	109.5	100.4	104.7	108.8	*105.8*
	Sulph. Amm.	96.3	111.4	101.7	94.8	*101.0*
	Mean	*102.9*	*105.9*	*103.2*	*101.8*	*103.4*
Early and Late	Cyanamide	97.8	99.0	95.8	101.8	*98.6*
	Sulph. Amm.	85.9	101.8	89.8	94.6	*93.0*
	Mean	*91.8*	*100.4*	*92.8*	*98.2*	*95.8*
Mean		*99.1*	*102.8*	*96.8*	*101.2*	*100.0*

Standard Errors : See next table.

STRAW

		Clover		Clover and Ryegrass		Mean
		1 Cut	2 Cuts	1 Cut	2 Cuts	
Cwt. per acre						
No Nitrogen		48.8	51.0	46.0	49.1	*48.7*
Early	Cyanamide	50.7	54.0	49.9	45.3	*50.0*
	Sulph. Amm.	51.5	50.4	47.1	48.1	*49.3*
	Mean	*51.1*	*52.2*	*48.5*	*46.7*	*49.6*
Late	Cyanamide	57.4	50.8	54.0	51.9	*53.5*
	Sulph. Amm.	57.6	60.7	53.2	48.1	*54.9*
	Mean	*57.5*	*55.8*	*53.6*	*50.0*	*54.2*
Early and Late	Cyanamide	51.6	53.4	50.8	52.6	*52.1*
	Sulph. Amm.	50.8	53.2	54.4	51.3	*52.4*
	Mean	*51.2*	*53.3*	*52.6*	*52.0*	*52.2*
Mean		*52.2*	*53.1*	*50.2*	*49.5*	*51.2*
Per cent.						
No Nitrogen		95.3	99.6	89.8	95.8	*95.1*
Early	Cyanamide	99.0	105.4	97.5	88.4	*97.6*
	Sulph. Amm.	100.5	98.4	92.0	93.9	*96.2*
	Mean	*99.8*	*101.9*	*94.8*	*91.2*	*96.9*
Late	Cyanamide	112.1	99.1	105.4	101.3	*104.5*
	Sulph. Amm.	112.6	118.5	104.0	93.9	*107.2*
	Mean	*112.4*	*108.8*	*104.7*	*97.6*	*105.9*
Early and Late	Cyanamide	100.7	104.4	99.2	102.7	*101.8*
	Sulph. Amm.	99.2	103.9	106.2	100.3	*102.4*
	Mean	*100.0*	*104.2*	*102.7*	*101.5*	*102.1*
Mean		*101.9*	*103.6*	*98.0*	*96.5*	*100.0*

Each yield in the above tables (except No N) is the mean of 4 eighth plots.

The standard errors of single whole plots (appropriate to direct comparisons between the different leys), to single quarter plots (appropriate to direct comparisons between times of application of nitrogen, and their interactions with leys), and to single eighth plots (appropriate to all comparisons involving the difference of cyanamide and sulphate of ammonia), are :

	Grain.	*Straw.*
Whole plots -	- 1.91 cwt., or 7.08 per cent.	2.40 cwt., or 4.70 per cent.
Quarter plots -	- 2.23 cwt., or 8.27 per cent.	4.01 cwt., or 7.84 per cent.
Eighth plots -	- 2.50 cwt., or 9.28 per cent.	3.62 cwt., or 7.07 per cent.

Mean of Cyanamide and Sulphate of Ammonia and all leys.

	Not Early	Early	*Mean*
GRAIN Cwt. per acre			
Not Late	27.6	26.3	*27.0*
Late	27.8	25.8	*26.8*
Mean	*27.7*	*26.0*	*26.9*
Per cent.			
Not Late	102.8	97.9	*100.4*
Late	103.4	95.8	*99.6*
Mean	*103.1*	*96.8*	*100.0*
STRAW Cwt. per acre			
Not late	48.7	49.6	*49.2*
Late	54.2	52.2	*53.2*
Mean	*51.4*	*50.9*	*51.2*
Per cent.			
Not late	95.1	96.9	*96.0*
Late	105.9	102.1	*104.0*
Mean	*100.5*	*99.5*	*100.0*

Standard errors of single entries: Grain, 0.556 cwt., or 2.07 per cent.
Straw, 1.00 cwt., or 1.96 per cent.

Difference of Cyanamide (+) and Sulphate of Ammonia (−)

	Clover		Clover + Ryegrass		
	1 Cut	2 Cuts	1 Cut	2 Cuts	*Mean*
GRAIN Cwt. per acre					
Early	−0.5	+0.4	+4.4	−1.1	*+0.8*
Late	+3.5	−3.0	+0.8	+3.7	*+1.2*
Early and Late ..	+3.2	−0.7	+1.6	+2.0	*+1.5*
Mean	*+2.1*	*−1.1*	*+2.3*	*+1.5*	*+1.2*
Per cent.					
Early	− 1.8	+ 1.4	+16.2	− 4.2	*+2.9*
Late	+13.2	−11.0	+ 3.0	+14.0	*+4.8*
Early and Late ..	+11.9	− 2.8	+ 6.0	+ 7.2	*+5.6*
Mean	*+ 7.8*	*− 4.1*	*+ 8.4*	*+ 5.7*	*+4.4*
STRAW Cwt. per acre					
Early	−0.8	+3.6	+2.8	−2.8	*+0.7*
Late	−0.2	−9.9	+0.8	+3.8	*−1.4*
Early and Late ..	+0.8	+0.2	−3.6	+1.3	*−0.3*
Mean	*0.0*	*−2.0*	*0.0*	*+0.6*	*−0.3*
Per cent.					
Early	− 1.5	+ 7.0	+ 5.5	− 5.5	*+1.4*
Late	− 0.5	−19.4	+ 1.4	+ 7.4	*−2.7*
Early and Late ..	+ 1.5	+ 0.5	− 7.0	+ 2.4	*−0.6*
Mean	*− 0.1*	*− 4.0*	*0.0*	*+ 1.4*	*−0.6*

Standard errors of single differences—Grain: 1.77 cwt., or 6.58 per cent.
Straw: 2.56 cwt., or 5.00 per cent.

CONCLUSIONS

The lower yield of straw on the plots with ryegrass is barely significant. There are no other direct effects of the temporary ley approaching significance, but the design of the experiment does not permit of very precise conclusions on these points.

Nitrogen given early significantly depresses the yield of grain, but not the straw, while nitrogen given late significantly raises the yield of the straw, but not the grain. The different leys produce no significant differences in the average nitrogen effects.

The sulphate of ammonia plots give significantly lower yields of grain than the cyanamide plots, and for both grain and straw the differences between sulphate of ammonia and cyanamide for the different leys and times of application are somewhat irregular.

WHEAT

Comparison of sulphate of ammonia (repeated and spring application) with cyanamide and dicyanodiamide (applied in autumn).

RW—Fosters, 1932

Plan and yields in lb., grain above, straw below.

129 133

D 72.2 92.8	S.S 55.4 73.9	O 36.6 48.2	C 67.9 79.1	S 73.0 91.5
O 36.4 46.6	C 46.9 60.1	S.S 46.8 63.5	S 54.9 74.6	D 68.5 89.2
S.S 71.5 91.2	S 55.6 67.6	D 71.6 92.1	O 67.5 80.8	C 78.4 101.6
S 68.9 88.6	O 53.2 62.6	C 69.8 91.2	D 79.6 102.1	S.S 77.2 110.3
C 82.0 106.2	D 81.0 112.8	S 76.0 105.5	S.S 87.9 123.9	O 70.9 87.4

W ↑

149 153

System of Replication : 5 × 5 Latin square.
Area of Each Plot : 1/40th acre (33.5 × 74.6 links).
Variety : Victor.
Treatments : No nitrogen (O), sulphate of ammonia in spring (S), and divided into six monthly dressings (November to April) (S.S.) ; cyanamide in autumn (C), and nitrogen applied in autumn, half as cyanamide and half as dicyanodiamide (D). N at the rate of 0.3 cwt. per acre.
Manures Applied : Divided dressings : November 24th, December 12th, January 25th, February 26th, March 15th, April 16th.
Spring Dressing : March 24th.
Autumn Dressing : October 28th.
Seed Sown : November 2nd.
Harvested : August 16th.
Previous Crop : Seeds Hay.

SUMMARY OF RESULTS

	No Nitrogen	S/Amm. Spring	S./Amm. Nov.-April	Cyan. Autumn	Cyan. + Dicy. Autumn	*Mean*	Standard Error
			GRAIN				
Cwt. per Acre . .	18.9	23.4	24.2	24.6	26.6	*23.6*	0.655
Per Cent. . .	80.2	99.5	102.7	104.5	113.0	*100.0*	2.78
			STRAW				
Cwt. per Acre . .	23.2	30.6	33.0	31.3	34.9	*30.6*	1.02
Per cent . .	75.9	99.8	108.0	102.2	114.1	*100.0*	3.32

CONCLUSIONS

Significant response to nitrogen, both in the grain and straw. The mixture of cyanamide and dicyanodiamide gives a significantly greater yield than the cyanamide alone. The differences between sulphate of ammonia in the spring and cyanamide in the autumn, and the differences due to variation in the time of application of the sulphate of ammonia, are not significant.

FORAGE MIXTURE

VARIATION IN PROPORTION OF OATS AND VETCHES.

RF—Great Knott, 1932

Plan and total produce in lbs. (weighed green).

20

BN	402	A—	235	AN	303
CN	419	E—	201	D—	325
A—	325	DN	286	E—	247
C—	363	AN	290	DN	316
E—	291	B—	271	BN	347
B—	368	C—	293	C—	339
AN	379	D—	271	A—	272
EN	304	CN	409	EN	236
DN	385	BN	401	CN	339
D—	356	EN	327	B—	288

50

N ↑

41

BN	390	C—	420
C—	373	BN	439
DN	388	EN	301
A—	297	D—	394
E—	272	E—	331
AN	373	DN	417
CN	377	B—	409
D—	338	A—	276
B—	325	CN	456
EN	300	AN	443

1

21

System of Replication : 5 randomised blocks of 10 plots each.

Area of Each Plot : 1/80th acre (126.3 × 9.9 links).

Treatments : All combinations of :

(*a*) Seedings (1 unit=50 lb. per acre).

	A	B	C	D	E
Oats (units) ..	4	3	2	1	0
Vetches (units) ..	0	1	2	3	4

(*b*) — No nitrogen.
N 0.3 cwt. N per acre as sulphate of ammonia.

Basal Manuring : Muriate of potash at the rate of 0.5 cwt. K_2O per acre, and superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.

Manures Applied : March 3rd-4th.

Seed Sown : March 11th-12th.

Harvested : July 11th-12th.

Previous Crop : Beans followed by wheat which was ploughed in.

SUMMARY OF RESULTS

FRESH MATERIAL

	4 Oats 0 Vetches	3 Oats 1 Vetches	2 Oats 2 Vetches	1 Oats 3 Vetches	0 Oats 4 Vetches	*Mean*
			Cwt. per acre			
Without Nitrogen ..	200.7	237.3	255.4	240.6	191.7	*225.1*
With Nitrogen ..	255.4	282.7	285.7	256.0	209.7	*257.9*
Mean	*228.1*	*260.0*	*270.6*	*248.3*	*200.7*	*241.5*
			Per Cent.			
Without Nitrogen ..	83.1	98.2	105.8	99.6	79.4	*93.2*
With Ntirogen ..	105.8	117.0	118.3	106.0	86.8	*106.8*
Mean	*94.4*	*107.6*	*112.0*	*102.8*	*83.1*	*100.0*

Standard error of single entry: 8.97 cwt., or 3.70 per cent.

TOTAL DRY MATTER

Determined on single samples from each plot, Oats and Vetches being separated in the sample

		4 Oats 0 Vetches	3 Oats 1 Vetches	2 Oats 2 Vetches	1 Oats 3 Vetches	0 Oats 4 Vetches	*Mean*
Cwt. per acre							
Oats	Without Nitrogen	42.9	36.6	30.5	21.7		*32.9*
	With Nitrogen ..	53.5	44.4	41.0	26.0		*41.2*
Vetches	Without Nitrogen		11.0	18.4	23.9	28.6	*20.5*
	With Nitrogen ..		8.6	14.9	19.1	30.9	*18.4*
Total Dry Matter	Without Nitrogen ..	42.9	47.6	48.9	45.6	28.6	*42.7*
	With Nitrogen ..	53.5	53.1	55.8	45.2	30.9	*47.7*
	Mean	*48.2*	*50.4*	*52.4*	*45.4*	*29.8*	*45.2*

Standard error single entry: Total dry matter : 1.71 cwt., or 3.78 per cent.

PERCENTAGE NITROGEN IN DRY MATTER

(Replicates Bulked)

	4 Oats 0 Vetches	3 Oats 1 Vetches	2 Oats 2 Vetches	1 Oats 3 Vetches	0 Oats 4 Vetches
OATS					
Without Nitrogen ..	1.145	1.329	1.287	1.401	—
With Nitrogen ..	1.158	1.197	1.247	1.361	—
VETCHES					
Without Nitrogen ..	—	2.702	2.725	2.865	3.061
With Nitrogen ..	—	2.659	2.761	2.908	2.993

CONCLUSIONS

The differences between the different seedings are significant. Sulphate of ammonia produces a significant increase in the yield of green produce of all mixtures, the increase being significantly greater when oats predominate. The results indicate that for green produce the optimum mixture without nitrogen is 102 lbs. oats and 98 lbs. vetches per acre (± 4.9 lbs.), and that the optimum mixture with nitrogen is 123 lbs. oats and 77 lbs. vetches per acre (± 7.0 lbs.). The difference between these optima is significant.

The total dry matter of the first three mixtures is significantly increased by the application of sulphate of ammonia. Total dry matter reaches a maximum with a seeding rate of 110 lbs. oats and 90 lbs. vetches where no nitrogen is given, and with a mixture somewhat richer in oats when nitrogen is given.

The total nitrogen content of the crop is not appreciably altered by the application of nitrogen, and the nitrogen percentage of the oats is actually somewhat lower on the plots receiving nitrogen. The total nitrogen content is a maximum for a mixture of 50 lbs. oats and 150 lbs. vetches per acre. (See Fig. 1, p. 27).

WINTER FORAGE

DIFFERENT SEEDS MIXTURES.

RF—Fosters, 1931-2

Plan and yields in lb.—Green weights (1st cut above, 2nd cut below).

S ↑

145 W		G		B		R		O		O		G		W		R		B 164
4 170 172	**3** 68 231	**1** 94 172	**2** 220 170	**1** 44 176	**3** 85 219	**1** 32 170	**3** 48 228	**4** 167 123	**3** 68 167	**4** 193 118	**1** 32 101	**1** 96 162	**3** 119 176	**4** 192 139	**2** 178 124	**4** 210 91	**1** 44 199	**1** 51 170	**4** 216 176
1 28 129	**2** 152 118	**4** 198 172	**3** 117 189	**4** 200 206	**2** 215 194	**2** 193 115	**4** 192 108	**1** 46 113	**2** 210 84	**3** 88 133	**2** 214 67	**4** 280 192	**2** 269 189	**1** 28 156	**3** 82 221	**3** 128 187	**2** 267 85	**2** 258 244	**3** 155 248
3 58 214	**2** 233 86	**1** 24 114	**4** 238 83	**1** 54 148	**4** 292 146	**2** 266 39	**3** 105 108	**1** 133 143	**3** 164 183	**1** 66 178	**4** 300 190	**4** 250 102	**2** 255 122	**2** 302 124	**3** 109 238	**1** 136 84	**4** 322 66	**1** 271 156	**2** 418 163
1 43 142	**4** 259 61	**3** 81 150	**2** 230 101	**2** 248 162	**3** 57 165	**4** 240 43	**1** 70 68	**2** 306 144	**4** 295 165	**3** 108 186	**2** 254 156	**1** 37 138	**3** 87 178	**1** 77 198	**4** 248 101	**3** 131 121	**2** 290 63	**3** 236 163	**4** 376 160
205 R		W		B		O		G		B		W		R		O		G 224	

System of Replication : 4 randomised blocks of 5 plots each, for different crops, with each plot sub-divided into four for seed mixtures.

Area of Each Sub-Plot : 1/50th acre (28.6 × 70 links).

Main Plot Treatments : Rye (R), six-rowed barley (B), grey winter oats (O), wheat (W), and Italian ryegrass (G).

Quarter Plot Treatments : 4 bushels of cereal (or 60 lb. ryegrass) (1); 2 bushels of cereal (or 30 lb. ryegrass), 1 of beans, 1 of vetches (2); 4 bushels of cereal (or 60 lbs. ryegrass), undersown with trefoil (3); 2 bushels of cereal (or 30 lb. ryegrass), 1 of beans, 1 of vetches, undersown with trefoil (4).

Basal Manuring : 3 cwt. sulphate of ammonia (1½ cwt. at sowing, 1½ cwt. in spring), 3 cwt. superphosphate and 2 cwt. 30 per cent. potash manure salt.

Seed Sown : July 23rd, 1931. Cut: 1st crop, November 17th-18th, 1931 ; 2nd crop, May 24th, 1932.

Previous Crop : Temporary leys.

SUMMARY OF RESULTS

First Crop

	Cwt. per acre					Per cent.				
	1	2	3	4	*Mean*	1	2	3	4	*Mean*
GREEN MATERIAL										
Wheat	13.1	91.0	35.5	94.9	*58.6*	17.6	122.4	47.8	127.7	*78.8*
Ryegrass	66.3	135.4	71.0	128.2	*100.2*	89.2	182.2	95.5	172.6	*134.9*
Rye ..	21.9	111.0	38.3	101.4	*68.2*	29.4	149.4	51.5	136.5	*91.7*
Barley	24.0	108.8	45.2	112.5	*72.6*	32.3	146.4	60.8	151.4	*97.7*
Oats ..	31.7	109.4	43.8	102.9	*71.9*	42.7	147.2	58.9	138.5	*96.8*
Mean ..	*31.4*	*111.1*	*46.7*	*108.0*	74.3	*42.2*	*149.5*	*62.9*	*145.3*	100.0
DRY MATTER										
Wheat	1.9	9.7	5.1	11.6	*7.1*	21.2	108.6	57.4	129.8	*79.3*
Ryegrass	8.6	16.0	9.6	14.6	*12.2*	96.1	178.5	107.4	163.5	*136.4*
Rye ..	3.7	13.4	6.0	12.2	*8.8*	41.2	149.8	67.4	136.1	*98.6*
Barley	3.1	11.9	5.8	11.6	*8.1*	35.0	133.6	64.9	129.8	*90.8*
Oats ..	3.9	13.1	4.9	12.0	*8.5*	43.7	146.1	54.9	134.8	*94.9*
Mean ..	*4.2*	*12.8*	*6.3*	*12.4*	8.9	*47.4*	*143.3*	*70.4*	*138.8*	100.0

Standard errors of single entries—Green material : 7.34 cwt., or 9.88 per cent.
Dry matter : Not available.

Second Crop

	Cwt. per acre					Per cent.				
	1	2	3	4	*Mean*	1	2	3	4	*Mean*
GREEN MATERIAL										
Wheat	59.9	52.1	87.2	55.4	*63.6*	91.0	79.1	132.5	84.1	*96.7*
Ryegrass	70.5	74.2	79.4	77.0	*75.3*	107.1	112.8	120.7	117.0	*114.4*
Rye ..	79.2	45.8	96.8	40.2	*65.5*	120.4	69.6	147.2	61.2	*99.6*
Barley	75.1	84.4	91.3	80.1	*82.7*	114.1	128.2	138.8	121.7	*125.7*
Oats ..	40.9	28.2	59.1	39.1	*41.8*	62.2	42.9	89.8	59.4	*63.6*
Mean ..	*65.1*	*56.9*	*82.8*	*58.3*	*65.8*	*99.0*	*86.6*	*125.8*	*88.7*	*100.0*
DRY MATTER										
Wheat	12.6	10.3	17.3	10.0	*12.6*	94.7	77.0	130.6	75.4	*94.4*
Ryegrass	16.0	16.3	17.5	16.8	*16.6*	121.0	123.3	132.2	126.6	*125.8*
Rye ..	18.0	8.9	19.7	8.4	*13.8*	136.1	67.2	148.4	63.4	*103.8*
Barley	13.1	14.2	16.4	12.5	*14.0*	98.8	107.0	123.8	94.4	*106.0*
Oats ..	9.5	6.5	12.7	8.3	*9.2*	71.9	49.2	95.7	62.6	*69.8*
Mean ..	*13.8*	*11.2*	*16.7*	*11.2*	*13.2*	*104.5*	*84.7*	*126.1*	*84.5*	*100.0*

Standard errors of single entries—Green material : 4.23 cwt., or 6.4 per cent.
Dry matter : Not available.

CONCLUSIONS (Green Material)

In the autumn crop the yield of rye grass is significantly greater than all the cereals, but there are no significant differences between the cereals.

In the spring crop the yields of barley and rye grass are on the average significantly greater than the other types of crop and wheat and rye significantly greater than the oats.

In the autumn crop the yields of mixtures containing beans and vetches are significantly greater than those without beans and vetches. The yields of mixtures without beans and vetches are significantly increased by trefoil.

In the spring crop the rye, wheat and oats mixtures containing beans and vetches yield significantly lower than those without beans and vetches, the effect being most marked in the case of the rye. As before the yields of mixtures without beans and vetches are significantly increased by trefoil.

FORAGE

EXPERIMENT ON TIMES OF CUTTING

RF—Great Knott, 1932

Plan and yields in lb.—Dry matter.

51 54

3O 74.4 3S 95.8	2S 63.5 2O 61.4	1S 23.6 1O 18.9	4S 93.2 4O 90.6
1O 20.7 1S 22.5	4O 92.2 4S 99.9	3O 73.8 3S 82.5	2S 56.2 2O 51.0
4O 111.6 4S 108.8	1O 18.8 1S 24.0	2S 65.1 2O 58.6	3O 77.6 3S 87.4
2S 61.2 2O 54.6	3O 79.2 3S 86.1	4S 83.0* 4O 80.5	1O 16.5 1S 19.8

W ↑

79 82

*Estimated.

System of Replication : 4 × 4 Latin square with plots split for sulphate of ammonia.
Area of Each Sub-Plot : 1/80th acre (50 links × 25 links).
Treatments :
1=Cut second week in June. (June 11th.) 3=Cut three weeks after 2. (July 22nd.)
2=Cut three weeks after 1. (July 1st.) 4=Cut three weeks after 3. (August 12th.)
Sulphate of ammonia (S) at the rate of 0.3 cwt. N per acre.
Basal Dressing : Muriate of potash at the rate of 0.5 cwt. K_2O per acre, and superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.
Manures Applied : March 3rd-4th. Seed Sown : March 11th.
Previous Crop : Beans, followed by wheat which was ploughed in.

SUMMARY OF RESULTS : DRY MATTER

	(1) Cut 2nd week in June.	(2) Cut three weeks after (1).	(3) Cut three weeks after (2).	(4) Cut three weeks after (3).	*Mean*	Standard Error
Cwt. per acre						
No Sulph. of Amm. ..	13.4	40.3	54.5	66.9	*43.8*	
Sulph. of Amm. ..	16.0	43.9	62.8	68.7	*47.8*	
Mean	*14.7*	*42.1*	*58.6*	*67.8*	*45.8*	*1.84*
Difference	*+2.6*	*+3.6*	*+8.3*	*+1.8*	*+4.0*	*1.54*
Per cent.						
No Sulph. of Amm. ..	29.2	87.9	118.9	146.1	*95.5*	
Sulph. of Amm. ..	35.0	95.9	137.1	150.0	*104.5*	
Mean	*32.1*	*91.9*	*128.0*	*148.0*	*100.0*	*4.03*
Difference	*+5.8*	*+8.0*	*+18.2*	*+3.9*	*+9.0*	*3.36*

CONCLUSIONS

The effects of times of cutting and of nitrogen on the dry matter are both significant, the increase with nitrogen being significantly greatest at the third cutting.

POTATOES

Effect of Autumn ploughing and sowing of rye.
Application of dung.
Nitrogenous fertiliser : sulphate of ammonia, single and double dressings.
Potassic fertiliser : sulphate of potash, single and double dressings.

RP—Gt. Knott, 1932.

Plan and yields in lb.

1	2N 338	2K 246	1N2K 304		1N2K 305	1N 315	2K 234		1N 332	2N 325	2N2K 339	9
O	2N2K 349	2N1K 355	1N 293	AD	O 248	2N1K 344	2N 375	OD	O 298	1K 279	2K 274	
	1K 249	O 239	1N1K 300		2N2K 359	1K 261	1N1K 315		1N1K 333	2N1K 352	1N2K 312	
	1N 330	2N2K 346	O 248		O 250	1N2K 322	1K 259		1N1K 308	1N 314	2N1K 374	
AR	1N2K 272	2N1K 349	2K 264	A	1N 300	2K 250	1N1K 309	ARD	1N2K 296	2N 340	O 257	
	2N 328	1K 248	1N1K 320		2N 326	2N2K 327	2N1K 349		2K 256	1K 240	2N2K 313	
	1N 322	2N2K 338	2N1K 336		1N1K 314	O 263	2N 328		O 230	1K 217	2K 250	W ↑
ARD	2N 318	2K 253	1N1K 412	OD	2N2K 370	1N2K 311	2N1K 342	AR	1N2K 295	1N1K 297	2N2K 321	
	O 285	1N2K 312	1K 258		2K 276	1N 329	1K 276		2N 320	1N 301	2N1K 340	
	1N2K 336	2K 278	1N 344		1N1K 313	O 255	2K 340		1N1K 306	2K 255	1N2K 316	
OD	2N2K 330	2N1K 354	2N 347	AR	1N 314	2N2K 355	2N1K 310	AD	O 252	2N 333	2N2K 320	
	1N1K 277	O 258	1K 267		2N 359	1N2K 323	1K 241		1N 285	2N1K 334	1K 223	
	1N2K 282	1N1K 323	2N2K 335		1N 334	1N1K 308	O 246		2N1K 261	1N2K 252	O 198	
AD	1N 278	2N 331	2K 249	ARD	1K 248	2K 261	2N1K 309	O	1N 269	2K 187	2N2K 295	
	O 152	2N1K 296	1K 232		2N2K 300	2N 300	1N2K 232		1N1K 190	2N 287	1K 187	
	1N2K 261	1K 207	O 212		2N1K 284	2N 234	1N1K 232		1K 181	2N 284	1N1K 264	
A	2N2K 313	2N 316	2K 219	O	O 227	1N 227	2N2K 256	A	2N2K 235	2K 233	O 229	
154	2N1K 316	1N1K 279	1N 243		1N2K 250	1K 191	2K 207		2N1K 237	1N2K 217	1N 231	162

DETAILS

System of Replication: 3 randomised blocks of 6 plots, each sub-divided into 9 sub-plots.
Area of each Sub-Plot: 1/90th acre. (63½ × 17½ links.)
Main Plot Treatments: No autumn cultivation (O), autumn ploughing (A), autumn ploughing with a catch crop of rye (AR), alone and in combination with dung; the dung is applied to the autumn ploughed plots before the autumn ploughing, otherwise before the spring ploughing. Dung at the rate of 15 tons per acre in autumn (less in spring proportionately to loss of weight in clamp). All plots spring ploughed.
Sub-Plot Treatments: Sulphate of ammonia at the rate of 0, 0.4 and 0.8 cwt. N. per acre, and sulphate of potash at the rate of 0, 0.8 and 1.6 cwt., K_2O per acre, in all combinations.
Basal manuring: Superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.
Manures Applied: April 7th. **Potatoes Planted:** April 7th-8th.
Variety: Ally. **Potatoes Lifted:** September 29th.
Previous Crop: Beans.

GENERAL SUMMARY.

		No dung.			Dung.		
		Not Autumn ploughed.	Autumn ploughed.	Autumn ploughed and Rye.	Not Autumn ploughed.	Autumn ploughed.	Autumn ploughed and Rye.
Tons per acre							
No sulph. amm.	No potash ..	8.90	9.25	9.82	10.98	8.72	10.55
	Single potash	8.39	8.66	9.46	11.01	9.59	10.00
	Double potash	8.56	9.40	11.44	11.08	9.88	10.32
Single sulph. amm.	No potash	10.56	10.36	12.65	13.47	11.76	12.99
	Single potash	9.66	11.41	12.46	12.37	12.65	13.77
	Double potash	10.80	10.71	11.92	12.83	12.10	11.25
Double sulph. amm.	No potash ..	11.50	12.41	13.48	13.40	13.92	12.84
	Single potash	12.07	12.07	13.38	14.03	13.04	13.65
	Double potash	12.05	11.73	13.70	13.91	13.58	12.73
Per Cent.							
No sulph. amm.	No potash ..	77.1	80.1	85.1	95.1	75.6	91.4
	Single potash	72.7	75.0	82.0	95.4	83.1	86.6
	Double potash	74.2	81.4	99.1	96.0	85.6	89.4
Single sulph. amm.	No potash	91.5	89.8	109.6	116.7	101.9	112.6
	Single potash	83.7	98.9	108.0	107.2	109.6	119.3
	Double potash	93.6	92.8	103.3	111.2	104.9	97.5
Double sulph. amm.	No potash ..	99.6	107.5	116.8	116.1	120.6	111.2
	Single potash	104.6	104.6	116.0	121.6	112.9	118.3
	Double potash	104.4	101.6	118.7	120.5	117.6	110.3

Each yield in the above table is the mean of 3 sub-plots. The standard errors of the yields of single whole plots (appropriate to direct comparisons of dung and cultivations) and of single sub-plots (appropriate to comparisons involving potash and nitrogen and their interactions with dung and cultivations) are:

Whole plots: 0.909 tons or 7.88 per cent.
Sub-plots: 0.860 tons or 7.45 per cent.

MEAN OF ALL CULTIVATIONS

		No Sulph. Amm.	Single Sulph. Amm.	Double Sulph. Amm.	*Mean*
		Tons per acre			
No Dung	No potash	9.32	11.19	12.46	*10.99*
	Single potash	8.84	11.18	12.51	*10.84*
	Double potash	9.80	11.14	12.49	*11.14*
	Mean	*9.32*	*11.17*	*12.49*	*10.99*
Dung	No potash	10.08	12.74	13.39	*12.07*
	Single potash	10.20	12.93	13.57	*12.23*
	Double potash	10.43	12.06	13.41	*11.97*
	Mean	*10.24*	*12.58*	*13.46*	*12.09*
		Per Cent.			
No Dung	No potash	80.8	97.0	108.0	*95.3*
	Single potash	76.6	96.9	108.4	*94.0*
	Double potash	84.9	96.6	108.2	*96.6*
	Mean	*80.8*	*96.8*	*108.2*	*95.3*
Dung	No potash	87.4	110.4	116.0	*104.6*
	Single potash	88.4	112.0	117.6	*106.0*
	Double potash	90.3	104.5	116.1	*103.6*
	Mean	*88.7*	*109.0*	*116.6*	*104.7*

Standard errors: See previous table.

MEAN OF ALL CULTIVATIONS, DUNG AND NO DUNG

	No Sulph. Amm.	Single Sulph. Amm.	Double Sulph. Amm.	*Mean*
	Tons per acre			
No potash	9.70	11.97	12.92	*11.53*
Single potash	9.52	12.06	13.04	*11.54*
Double potash	10.11	11.60	12.95	*11.55*
Mean	*9.78*	*11.88*	*12.97*	*11.54*
	Per Cent.			
No potash	84.1	103.7	112.0	*99.9*
Single potash	82.5	104.4	113.0	*100.0*
Double potash	87.6	100.5	112.2	*100.1*
Mean	*84.7*	*102.9*	*112.4*	*100.0*

Standard error of single entry: 0.203 tons, or 1.76 per cent.

MEAN OF ALL LEVELS OF NITROGEN AND POTASH

	Not Autumn ploughed	Autumn ploughed	Autumn ploughed and Rye	*Mean*
	Tons per acre			
No Dung	10.28	10.67	12.04	*10.99*
Dung	12.56	11.69	12.01	*12.09*
Mean	*11.42*	*11.18*	*12.02*	*11.54*
	Per Cent.			
No Dung	89.0	92.4	104.3	*95.2*
Dung	108.9	101.3	104.0	*104.7*
Mean	*99.0*	*96.9*	*104.2*	*100.0*

Standard error of single entry: 0.525 tons, or 4.55 per cent.

CONCLUSIONS

The rye crop failed. The response to dung, 1.10 tons, is significant, but the autumn ploughing produced no significant effects. (The design of the experiment precludes a very precise verdict on these points.)

Significant response to both dressings of sulphate of ammonia, 2.10 tons for the single dressing and 1.09 tons additional for the double dressing, the additional response being significantly less than the initial response.

Potash produced no apparent effects, nor is there any evidence of interaction between the artificial fertilisers, and the dung or cultivations.

SUGAR BEET

Effect of nitrate of soda, applied at various times. Early and late application of minerals. Ordinary and intensive inter-drill cultivation.

RS—Great Knott, 1932

Plan and yields in lb.

32

Treatment.	Roots (unwashed).	Tops.	Sugar per cent.
N_2LB	278	250	17.96
N_2EB	250	230	18.92
— LA	242	212	19.04
N_3LA	278	222	18.81
— LB	221	174	18.92
— EA	282	224	19.04
— EB	221	161	19.27
N_1LB	259	182	18.92
N_2EA	257	279	18.35
N_1LA	248	245	19.15
N_3LB	245	177	19.10
N_3EB	234	192	19.21
N_2LA	276	255	18.64
N_1EB	251	258	18.35
N_1EA	266	266	18.35
N_3EA	263	251	19.04
N_1EA	266	257	18.81
N_1LB	251	216	18.24
— EA	264	197	18.70
N_3LA	261	202	19.61
N_3EA	278	234	19.10
N_1LA	271	319	18.47
N_3LB	248	228	18.75
N_2LA	270	288	18.47
N_2EA	262	245	18.81
N_2LB	256	212	19.21
— EB	215	159	19.15
— LA	242	192	19.27
N_2EB	272	226	19.04
— LB	224	186	18.92
N_1EB	233	207	18.70
N_3EB	252	205	18.07

1

W ↑

64

Treatment.	Roots (unwashed).	Tops.	Sugar per cent.
— EA	268	269	18.81
N_3EA	264	283	18.24
N_1EA	268	328	17.73
N_1LA	277	296	18.52
N_2LB	251	254	18.01
— LB	242	224	18.58
— EB	223	194	18.58
N_3EB	241	216	18.64
N_2EA	252	296	17.78
N_2EB	247	226	18.30
N_1EB	239	223	18.70
N_2LA	268	264	18.47
— LA	226	186	18.70
N_1LB	244	244	18.35
N_3LB	239	249	18.01
N_3LA	256	286	18.24
N_3LB	236	252	17.61
N_2LB	262	250	18.75
N_1EA	269	287	18.47
N_1LA	258	297	18.24
— LA	263	250	18.92
N_2LA	271	302	18.24
N_3EA	263	264	18.52
N_3LA	270	278	18.70
— EB	215	179	18.67
N_2EA	269	246	18.47
N_2EB	242	213	18.35
N_1EB	251	230	18.24
N_3EB	254	241	18,24
— EA	235	224	18.81
N_1LB	260	261	18.35
— LB	232	192	18.58

33

SYSTEM OF REPLICATION : 4 randomised blocks of 16 plots each.
AREA OF EACH PLOT : 1/138th acre. (106.1 × 6.8 links.)
VARIETY : Kuhn.
TREATMENTS : All combinations of :

— No nitrogen.
N_1 Nitrogen 3 weeks before sowing.
N_2 Nitrogen at sowing.
N_3 Nitrogen half at sowing, half at singling.

E Basal minerals 3 weeks before sowing.
L Basal minerals at sowing.
A Ordinary cultivation.
B Intensive inter-drill cultivation.

Nitrate of soda at the rate of 0.6 cwt. N per acre.
BASAL MINERALS : Super. at the rate of 0.5 cwt. P_2O_5 per acre, and potash manure salt at the rate of 1.0 cwt. K_2O per acre.
BEET SOWN : May 19th.
BEET LIFTED : November 3rd-4th.
PREVIOUS CROP : Beans.
CULTIVATIONS :

Ordinary : Sufficient hand or light horse hoeing to keep down weeds. Actual cultivations : June 20th, July 7th, horse hoe. July 9th, 13th, 14th, 15th, hand hoe. Intensive : Ordinary cultivation, plus an intensive cultivation with horse or motor implements as nearly as possible at ten-day intervals from singling. Actual additional cultivations : July 14th, 22nd, August 2nd, motor hoe. August 13th, 27th with small motor cultivator.

SUMMARY OF RESULTS

		No Nitrogen	Nitrogen 3 weeks before sowing	Nitrogen at sowing	½ N. at sowing ½ N. at singling	*Mean of Nitrogens*	*Mean*
ROOTS (Washed) Tons per acre							
Ordinary cultivation	Early basal ..	13.97	14.21	13.84	14.22	*14.09*	*14.06*
	Late basal ..	12.95	14.04	14.44	14.17	*14.22*	*13.90*
	Mean	*13,46*	*14.12*	*14.14*	*14.19*	*14.15*	*13.98*
Intensive inter-drill cultivation	Early basal ..	11.64	12.96	13.44	13.06	*13.16*	*12.78*
	Late basal ..	12.22	13.48	13.93	12.88	*13.43*	*13.13*
	Mean	*11.93*	*13.22*	*13.68*	*12.96*	*13.29*	*12.95*
Mean of both cultivations		*12.70*	*13.67*	*13.92*	*13.58*	*13.72*	*13.47*
Per Cent.							
Ordinary cultivation	Early basal ..	103.7	105.5	102.8	105.6	*104.6*	*104.4*
	Late basal ..	96.2	104.2	107.3	105.2	*105.6*	*103.2*
	Mean	*100.0*	*104.9*	*105.0*	*105.4*	*105.1*	*103.8*
Intensive inter-drill cultivation	Early basal ..	86.4	96.3	99.8	97.0	*97.7*	*94.9*
	Late basal ..	90.7	100.1	103.4	95.6	*99.7*	*97.5*
	Mean	*88.6*	*98.2*	*101.6*	*96.3*	*98.7*	*96.2*
Mean of both cultivations		*94.3*	*101.5*	*103.3*	*100.8*	*101.9*	*100.0*
TOPS Tons per acre							
Ordinary cultivation	Early basal ..	14.07	17.53	16.41	15.90	*16.61*	*15.98*
	Late basal ..	12.92	17.82	17.07	15.19	*16.70*	*15.75*
	Mean	*13.50*	*17.68*	*16.74*	*15.54*	*16.66*	*15.86*
Intensive inter-drill cultivation	Early basal ..	10.68	14.13	13.78	13.16	*13.69*	*12.94*
	Late basal ..	11.96	13.90	14.88	13.95	*14.24*	*13.67*
	Mean	*11.32*	*14.02*	*14.33*	*13.56*	*13.97*	*13.30*
Mean of both cultivations		*12.41*	*15.85*	*15.53*	*14.55*	*15.31*	*14.58*
Per Cent.							
Ordinary cultivation	Early basal ..	96.5	120.2	112.5	109.1	*113.9*	*109.6*
	Late basal ..	88.6	122.2	117.0	104.2	*114.5*	*108.0*
	Mean	*92.6*	*121.2*	*114.8*	*106.6*	*114.2*	*108.8*
Intensive inter-drill cultivation	Early basal ..	73.2	96.9	94.4	90.2	*93.8*	*88.7*
	Late basal ..	82.0	95.3	102.0	95.7	*97.7*	*93.8*
	Mean	*77.6*	*96.1*	*98.2*	*92.9*	*95.8*	*91.2*
Mean of both cultivations		*85.1*	*108.6*	*106.5*	*99.8*	*105.0*	*100.0*

Standard errors of single entries—Roots : 0.276 tons, or 2.05 per cent.
Tops : 0.693 tons, or 4.75 per cent.

SUGAR PERCENTAGE

		No Nitrogen	Nitrogen 3 weeks before sowing	Nitrogen at sowing	½ N at sowing ½ N at singling	*Mean of Nitrogens*	*Mean*
Ordinary cultivation	Early basal ..	18.84	18.34	18.35	18.72	*18.47*	*18.56*
	Late basal ..	18.98	18.60	18.46	18.84	*18.63*	*18.72*
	Mean	*18.91*	*18.47*	*18.40*	*18.78*	*18.55*	*18.64*
Intensive inter-drill cultivation	Early basal ..	18.92	18.50	18.65	18.54	*18.56*	*18.65*
	Late basal ..	18.75	18.46	18.48	18.37	*18.44*	*18.52*
	Mean	*18.84*	*18.48*	*18.56*	*18.46*	*18.50*	*18.58*
Mean of both cultivations		*18.88*	*18.48*	*18.48*	*18.62*	*18.52*	*18.61*
Per Cent.							
Ordinary cultivation	Early basal ..	101.2	98.5	98.6	100.6	*99.2*	*99.7*
	Late basal ..	102.0	99.9	99.2	101.2	*100.1*	*100.6*
	Mean	*101.6*	*99.2*	*98.9*	*100.9*	*99.7*	*100.2*
Intensive inter-drill cultivation	Early basal ..	101.6	99.4	100.2	99.6	*99.7*	*100.2*
	Late basal ..	100.7	99.2	99.3	98.7	*99.1*	*99.5*
	Mean	*101.2*	*99.3*	*99.8*	*99.2*	*99.4*	*99.8*
Mean of both cultivations		*101.4*	*99.2*	*99.3*	*100.0*	*99.5*	*100.0*

Standard error of single entry: 0.168 or 0.903 per cent.

CONCLUSIONS

Significantly greater yield with ordinary cultivation, both for roots(1.03 tons or 7.6 per cent.) and tops (2.56 tons or 17.6 per cent.). The difference in sugar percentage is small and not significant, being 0.06 or 0.4 per cent. greater for ordinary cultivation.

Significant response to nitrogen both for roots and tops, set off by a significant reduction in sugar percentage, this response (to 0.6 cwt. N per acre) being at the rate of 1.70 tons per acre, or 12.7 per cent. per cwt. N for the roots, with a corresponding reduction of 0.60 or 3.2 per cent. in sugar percentage. In the case of the tops the response to nitrogen given half at singling is significantly less than when given at or before sowing. The similar difference in the roots is not large enough to be significant.

No significant differences between early and late applications of the basal manures, though the individual treatment means are somewhat more irregular than expectation.

KALE

EFFECT OF AMMONIUM HUMATE, SULPHATE OF AMMONIA AND HUMIC ACID.

RK—Great Harpenden, 1932

Plan and yields in lb.—green weights.

1 5

4 738	1 560	5 580	2 601	3 616
5 750	2 573	3 659	4 595	1 448
1 733	4 603	2 605	3 699	5 446
3 762	5 601	4 585	1 532	2 486
2 822	3 719	1 551	5 521	4 565

W ↑

21 25

SYSTEM OF REPLICATION : 5 × 5 Latin square.
AREA OF EACH PLOT : 1/50th acre. (10 yds × 9 yds 2 ft.) Kale drilled in rows spaced 18 inches apart, not thinned.
VARIETY : Thousand Head.
TREATMENTS :
- 1=No nitrogen.
- 2=Sulph. Amm. at the rate of 0.145 cwt. N per acre.
- 3=Sulph. Amm.
- 4=Ammonium humate
- 5=Humic acid

} at the rate of 0.4 cwt. N per acre.

MANURES APPLIED : June 14th.
BASAL DRESSING : Super. at the rate of 0.5 cwt. P_2O_5 per acre, and 30 per cent. potash manure salt at the rate of 1.0 cwt. K_2O per acre.
SEED SOWN : June 10th.
KALE CUT : November 19th.
PREVIOUS CROP : Rye, fed off by sheep.

SUMMARY OF RESULTS

	No Nitrogen	S/Amm. 0.145cwt. N.	S/Amm. 0.4 cwt. N.	Amm. Hum. 0.4 cwt. N.	Humic Acid 0.4 cwt. N.	*Mean*	Standard Error
Fresh Material—							
Tons per acre . .	12.61	13.78	15.42	13.78	12.94	*13.70*	0.382
Per cent.	92.0	100.6	112.5	100.5	94.4	*100.0*	2.78
*Percentage of Dry Matter in Fresh**	14.88	15.30	14.17	15.22	15.00	*14.91*	—

* Replicates bulked.

CONCLUSIONS

Significant response of fresh material to nitrogen. The yield with ammonium humate is the same as with the small dressing of sulphate of ammonia, and significantly less than with the large dressing of sulphate of ammonia. The yield with humid acid is not significantly different from that with no nitrogen, but neither is its difference from that with ammonium humate fully significant.

KALE

VARIATION IN TIME OF CUTTING

RK—Great Harpenden, 1932

Plan and yields in lb.—Green Weights.

74	3 661	4 672	1 683	5 696	2 721	70
	1 609	5 674	2 720	4 654	3 750	
	5 508	2 649	4 725	3 780	1 799	
	2 578	3 761	5 695	1 674	4 690	
54	4 513	1 663	3 720	2 709	5 650	50
	I	II	III	IV	V	

N ↑

System of Replication : 5 × 5 Latin square.

Area of Each Plot in Column I, 0.0095 acres (28 × 34 links); II, 0.0118 acres (28 × 42 links); III, IV, V, 0.0126 acres (28 × 45 links).

Variety : Marrow stem kale.

Cuttings :
1=Cut November 21st.
2=Cut December 20th.
3=Cut January 16th.
4=Cut February 13th.
5=Cut March 13th.

Basal Manuring : 16 tons dung, 2 cwt. sulphate of ammonia, 3 cwt. superphosphate, and 3 cwt. potash manure salt per acre.

Seed Sown : May 6th.

Previous Crop : Spring oats.

SUMMARY OF RESULTS

	Cut on Nov. 21st	Cut on Dec. 20th	Cut on Jan. 16th	Cut on Feb. 13th	Cut on Mar. 13th	*Mean*	Standard Error
Fresh material—							
Tons per acre	25.68	25.30	27.50	24.37	24.14 †	*25.40*	0.643
Leaf stem ratio	0.455*	0.425	0.495	0.347	0.302	*0.405*	0.0396

* Replicates bulked.

† Including 2.92 tons dead leaves (determined by sampling).

For percentage dry matter, and percentage nitrogen and fibre in dry matter, see p. 28. These percentages were determined on bulked replicates.

CONCLUSIONS

The significantly greater yield of fresh material in the third cutting is due to the wet condition of the crop at this harvesting. The leaf-stem ratio shows a significant reduction with the later cuttings, the high value of the third cutting being also due to the wet condition of the leaves. The yields of total dry matter, total nitrogen, and total fibre are given on p. 28.

KALE

EFFECT OF THINNING
ORDINARY AND INTENSIVE CULTIVATION
RK—Great Harpenden, 1932

Plan and yields in lb., green weights (excluding edge rows).

26	UO	649	TI	844	38
	TI	525	UI	830	
	TO	605	TO	854	
	UI	605	UO	952	
	TO	627	TI	771	
	UI	639	UO	909	
	TI	598	UI	852	
	UO	701	TO	840	
	TI	608	TI	761	
	UI	646	TO	850	
	UO	672	UI	862	
37	TO	600	UO	923	49

N ↑

System of Replication : 6 randomised blocks of 4 plots each.

Area, excluding edge rows : 3/200 acre (165 × 9.06 links). Five rows in each plot. Edge rows harvested separately. 30 feet discarded from plots 26-37.

Variety : Marrow stem.

Treatments :

U=Unthinned. (In 2 ft. rows).
T=Thinned (18 ins.).
O=Ordinary cultivation. (June 2nd-4th, horse hoe.)
I=Intensive cultivation. (July 4th, 19th, 27th, motor hoe.)

Basal Manuring : Dung at the rate of 16 tons per acre, sulphate of ammonia at the rate of 2 cwt. per acre, superphosphate and potash manure salt at the rate of 3 cwt. per acre.

Seed Sown : May 6th.

Kale Cut : November 14th and 18th.

Previous Crop : Spring oats, under-sown with seeds fed off by sheep.

YIELDS OF GREEN MATERIAL (EDGE ROWS EXCLUDED)

	Tons per acre.			Per cent.		
	Unthinned.	Thinned.	*Mean.*	Unthinned.	Thinned.	*Mean.*
Ordinary cultivation	27.65	25.18	*26.42*	108.5	98.8	*103.6*
Intensive cultivation	25.51	23.63	*24.57*	100.1	92.7	*96.4*
Mean	*26.58*	*24.40*	*25.50*	*104.3*	*95.7*	*100.0*

Standard Error of single entry: 0.323 tons or 1.27 per cent.
Standard Error per plot: 0.790 tons or 3.10 per cent. (edge rows discarded).
0.896 tons or 3.52 per cent. (edge rows included).

The discarding of the edge rows has significantly reduced the error.

ANALYSIS OF SAMPLES

	Ordinary cultivation, Unthinned.	Ordinary cultivation, Thinned.	Intensive cultivation, Unthinned.	Intensive cultivation, Thinned.
Ratio Leaf/stem (green material)	0.430	0.603	0.415	0.579
Percentage dry matter* : Leaves (green) . .	13.6	12.3	12.8	12.3
Stems (green) . .	14.4	13.6	14.3	13.7

* Replicates bulked.

CONCLUSIONS

Thinning and intensive cultivation both reduce the yield of green material significantly.

Replicated Experiments at Woburn

SUGAR BEET

Effect of nitrate of soda applied at various times.
Early and late application of minerals.
Ordinary and intensive interdrill cultivation.

W S—Butt Close, 1932. Plan and yields in lb.

	Treat-ment.	Roots (un-washed)	Tops	Sugar per cent.
1	**N_2LB**	548	619	17.56
	N_2EA	588	742	18.24
	N_3EB	637	754	17.50
	N_1EA	720*	836*	17.73*
	N_1EB	674	827	17.44
	N_2EB	677	784	17.21
	N_3LB	702	744	17.78
	N_1LA	686*	878*	18.07*
	—EA	610	575	18.35
	—EB	611	564	18.24
	—LB	548	642	18.24
	—LA	593	577	18.18
	N_2LA	724	708	17.78
	N_1LB	661	761	17.44
	N_3LA	736	730	17.90
	N_3EA	672	775	18.35
	N_3LB	663	682	18.52
	N_2EA	602	620	18.24
	—EB	552	552	18.47
	N_3LA	668	654	18.64
	N_1EA	630	699	17.78
	N_2LB	608	758	18.35
	N_1LA	585	740	18.35
	N_2EB	693	744	17.90
	—LA	547	582	18.75
	N_2LA	638	644	18.81
	—EA	570	537	18.47
	– LB	552	568	18.70
	N_3EA	565	708	18.13
	N_3EB	625	650	18.52
	N_1EB	543	722	18.35
32	**N_2LB**	530	761	17.90

W
↑

Treat-ment.	Roots (un-washed).	Tops	Sugar per cent.	
—LA	572	532	18.35	*33*
N_1EA	595	702	18.47	
N_2LB	608	808	17.73	
N_3LB	578	794	17.73	
N_1LA	687	760	17.96	
N_3EB	636	828	18.47	
N_2EB	740	821	17.56	
N_3EA	730	853	17.61	
N_1EB	664	906	17.90	
N_2EA	673	922	17.78	
—LB	726	701	17.78	
—EA	673	686	18.30	
—EB	648	628	17.96	
N_2LA	834	824	17.78	
N_3LA	758	878	17.33	
N_1LB	654	888	17.48	
N_1LB	688	763	17.90	
N_3EA	688	728	18.30	
N_3EB	706	735	18.18	
N_1EB	699	689	18.01	
—LB	646	633	18.13	
N_1EA	765	715	18.13	
N_3LB	679	724	18.24	
—EA	640	590	18.81	
N_2EB	769	708	18.24	
N_1LA	694	689	18.58	
N_3LA	762	724	18.01	
– EB	649	570	18.47	
– LA	641	590	18.47	
N_2LA	748	710	18.52	
N_2LB	733	696	18.18	
N_2EA	569	663	18.07	*64*

* Plots 4 and 8 received an additional $\frac{1}{2}$N at singling by mistake. The yields were rejected on analysis.

Plots 33 to 64 are to the East of and contiguous to plots 1 to 32.

SYSTEM OF REPLICATION : 4 randomised blocks of 16 plots each.

AREA OF EACH PLOT : 1/50th acre (180 × 11.1 links). VARIETY : Kuhn.

TREATMENTS : All combinations of—

—	No nitrogen.
N_1	Nitrogen 3 weeks before sowing.
N_2	Nitrogen at sowing.
N_3	Nitrogen half at sowing, half at singling.
E	Basal minerals 3 weeks before sowing.
L	Basal minerals at sowing.
A	Ordinary cultivation.
B	Intensive inter-drill cultivation.

Nitrate of soda at the rate of 0.6 cwt. per acre.

BASAL MINERALS : Super. at the rate of 0.5 cwt. P_2O_5 per acre and 30 per cent. potash manure salt at the rate of 1.0 cwt. $K_2 0$ per acre.

BEET SOWN : May 6th-12th. BEET LIFTED : Nov. 7th-12th. PREVIOUS CROP : Brussel Sprouts.

CULTIVATIONS :

Ordinary. Sufficient hand or horse hoeing to keep down weeds. Actual cultivations : June 6th-7th, 17th, July 4th, 15th, August 18th, horse hoe. Intensive inter-drill cultivation. Ordinary cultivation, plus an intensive cultivation with horse or motor implements as nearly as possible at ten-day intervals from singling. Actual additional cultivations : July 21st, 29th, August 5th, 18th.

SUMMARY OF RESULTS

		No Nitrogen	Nitrogen 3 weeks before sowing	Nitrogen at sowing	½ N at sowing ½ N at singling	*Mean of Nitrogens*	*Mean*
ROOTS (washed)							
Tons per acre							
Ordinary cultivation	Early basal . .	11.37	12.04*	11.08	12.11	*11.75*	*11.65*
	Late basal . .	10.72	11.89*	13.42	13.33	*12.88*	*12.34*
	Mean	*11.04*	*11.97*	*12.25*	*12.72*	*12.31*	*11.99*
Intensive inter-drill cultivation	Early basal . .	11.22	11.76	13.12	11.87	*12.25*	*11.99*
	Late basal . .	11.26	11.55	11.38	11.95	*11.62*	*11.53*
	Mean	*11.24*	*11.66*	*12.25*	*11.91*	*11.94*	*11.76*
Mean of both cultivations		*11.14*	*11.81*	*12.25*	*12.31*	*12.12*	*11.88*
Per cent.							
Ordinary cultivation	Early basal . .	95.6	101.3*	93.3	101.9	*98.8*	*98.0*
	Late basal . .	90.3	100.1*	113.0	112.2	*108.4*	*103.9*
	Mean	*93.0*	*100.7*	*103.1*	*107.0*	*103.6*	*101.0*
Intensive inter-drill cultivation	Early basal . .	94.4	99.0	110.5	99.9	*103.1*	*100.9*
	Late basal . .	94.8	97.2	95.8	100.6	*97.9*	*97.1*
	Mean	*94.6*	*98.1*	*103.1*	*100.3*	*100.5*	*99.0*
Mean of both cultivations		*93.8*	*99.4*	*103.1*	*103.6*	*102.0*	*100.0*
TOPS							
Tons per acre							
Ordinary cultivation	Early basal . .	13.32	15.70*	16.44	17.10	*16.41*	*15.64*
	Late basal . .	12.73	16.24*	16.10	16.66	*16.33*	*15.43*
	Mean	*13.03*	*15.97*	*16.28*	*16.88*	*16.38*	*15.54*
Intensive inter-drill cultivation	Early basal . .	12.91	17.54	17.06	16.56	*17.05*	*16.02*
	Late basal . .	14.20	17.71	16.08	16.43	*16.74*	*16.10*
	Mean	*13.55*	*17.62*	*16.57*	*16.49*	*16.89*	*16.06*
Mean of both cultivations		*13.29*	*16.80*	*16.42*	*16.69*	*16.64*	*15.80*
Per cent.							
Ordinary cultivation	Early basal . .	84.3	99.4*	104.1	108.2	*103.9*	*99.0*
	Late basal . .	80.6	102.8*	101.9	105.5	*103.4*	*97.7*
	Mean	*82.4*	*101.1*	*103.0*	*106.8*	*103.6*	*98.3*
Intensive inter-drill cultivation	Early basal . .	81.7	111.0	108.0	104.8	*107.9*	*101.4*
	Late basal . .	89.8	112.1	101.8	104.0	*106.0*	*101.9*
	Mean	*85.8*	*111.6*	*104.9*	*104.4*	*107.0*	*101.6*
Mean of both cultivations		*84.1*	*106.3*	*103.9*	*105.6*	*105.3*	*100.0*

* The yield of one plot of each of these treatments was estimated.

Standard Errors of single entries—Roots : 0.415 tons, or 3.49 per cent.
Tops : 0.519 tons, or 3.29 per cent.

SUGAR PERCENTAGE

		No Nitrogen	Nitrogen 3 weeks before sowing	Nitrogen at sowing	½ N at sowing ½ N at singling	*Mean of Nitrogens*	*Mean*
Ordinary cultivation	Early basal . .	18.48	18.05*	18.08	18.10	*18.08*	*18.18*
	Late basal . .	18.44	18.22*	18.22	17.97	*18.14*	*18.21*
	Mean	*18.46*	*18.14*	*18.15*	*18.04*	*18.11*	*18.20*
Intensive inter-drill cultivation	Early basal . .	18.28	17.92	17.73	18.17	*17.94*	*18.02*
	Late basal . .	18.21	17.68	17.96	18.07	*17.90*	*17.98*
	Mean	*18.24*	*17.80*	*17.84*	*18.12*	*17.92*	*18.00*
Mean of both cultivations		*18.35*	*17.97*	*18.00*	*18.08*	*18.02*	*18.10*
Per cent.							
Ordinary cultivation	Early basal . .	102.1	99.7*	99.9	100.0	*99.9*	*100.4*
	Late basal . .	101.9	100.7*	100.7	99.3	*100.2*	*100.6*
	Mean	*102.0*	*100.2*	*100.3*	*99.6*	*100.0*	*100.5*
Intensive inter-drill cultivation	Early basal . .	101.0	99.0	97.9	100.4	*99.1*	*99.6*
	Late basal . .	100.6	97.7	99.2	99.8	*98.9*	*99.3*
	Mean	*100.8*	*98.4*	*98.6*	*100.1*	*99.0*	*99.4*
Mean of both cultivations		*101.4*	*99.3*	*99.4*	*99.9*	*99.5*	*100.0*

* The yield of one plot of each of these treatments was estimated.

Standard Error of single entry : 0.138, or 0.765 per cent.

CONCLUSIONS

Both the roots and tops show a significant response to nitrate of soda, set off by a significant reduction in sugar percentage, but there are no significant differences between the different times of application. The response of the roots (to 0.6 cwt. N. per acre) is at the rate of 1.63 tons or 13.7 per cent. per cwt. N., the corresponding reduction in sugar percentage being 0.55 or 3.2 per cent.

The higher yield of tops in the case of the inter-drill cultivation is not quite significant, and there is a non-significant reduction of 0.23 tons or 2.0 per cent. in the roots and a significant reduction of 0.20 or 1.1 per cent. in the sugar percentage by intensive cultivation.

There are no significant average differences between early and late applications of basal manures, but with the roots the intensive inter-drill cultivation does significantly better in conjunction with early application of basal manures than with the late application, though in view of the wide discrepancies between the corresponding differences for the separate nitrogenous treatments the reality of the effect seems doubtful.

KALE

EFFECT OF AMMONIUM HUMATE, SULPHATE OF AMMONIA AND HUMIC ACID.

WK—Butt Close, 1932.

Plan and yields in lb., green weights.

65 69

4 574	**1** 608	**5** 634	**3** 714	**2** 585
2 992	**3** 910	**4** 851	**1** 791	**5** 647
3 992	**4** 982	**2** 949	**5** 933	**1** 970
5 886	**2** 893	**1** 815	**4** 897	**3** 858
1 754	**5** 682	**3** 748	**2** 785	**4** 737

85 89

S ↑

SYSTEM OF REPLICATION : 5 × 5 Latin square.

AREA OF EACH PLOT : 1/50th acre (16 yds. 5 ins. × 6 yds.). Kale drilled in rows 22 inches apart, not thinned.

VARIETY : Garton's Thousand head.

TREATMENTS :

1=No nitrogen.
2=Sulphate of ammonia at the rate of 0.145 cwt. N per acre.
3=Sulphate of ammonia } At the rate 0.4 cwt. N per acre.
4=Ammonium humate } At the rate 0.4 cwt. N per acre.
5=Humic Acid } At the rate 0.4 cwt. N per acre.

BASAL MANURING : Superphosphate at the rate of 0.5 cwt. P_2O_5 per acre and potash manure salt at the rate of 1.0 cwt. K_2O per acre.

MANURES APPLIED : June 6th.

SEED SOWN : June 4th.

KALE CUT : December 20th-January 31st.

PREVIOUS CROP : Brussel sprouts.

SUMMARY OF RESULTS

	No Nitrogen	S/Amm. 0.145 cwt. N.	S/Amm. 0.4 cwt. N.	Amm. humate 0.4 cwt. N.	Humic acid 0.4 cwt. N.	*Mean*	Standard Error
Green Material—							
Tons per acre ..	18.31	19.55	19.63	18.79	17.59	*18.78*	*0.649*
Per cent	97.5	104.1	104.6	100.1	93.7	*100.0*	*3.46*
Percentage dry matter in fresh—							
Leaves	14.2	14.1	14.0	14.3	14.1	*14.1*	—
Stems	19.7	19.4	18.8	19.0	19.8	*19.3*	—
Ratio Leaf/Stem (green)	1.157	1.122	1.046	1.088	1.177	*1.118*	—

CONCLUSIONS

The differences between the treatments are not significant.

KALE

AVAILABILITY OF NITROGEN IN DUNG.

WK—Lansome, 1932

Plan and yields in lb.—Green weights.

1 8

D2 230	**O3** 258	**O2** 242	**D0** 194	**O0** 145	**D1** 268	**D3** 285	**O1** 185
D0 167	**D1** 176	**D3** 314	**O2** 196	**D2** 230	**O1** 198	**O3** 231	**O0** 136
O3 240	**O2** 189	**D2** 280	**O0** 127	**D1** 240	**D0** 212	**O1** 148	**D3** 298
D1 155	**D0** 142	**O1** 194	**D2** 222	**O3** 255	**D3** 318	**O0** 118	**O2** 208
O2 180	**D2** 212	**D0** 204	**D3** 285	**O1** 171	**O0** 152	**D1** 258	**O3** 251
O0 124	**O1** 176	**O3** 247	**D1** 155	**D3** 283	**O2** 170	**D2** 254	**D0** 208
O1 177	**D3** 306	**O0** 146	**O3** 249	**D0** 203	**D2** 260	**O2** 184	**D1** 206
D3 275	**O0** 145	**D1** 289	**O1** 213	**O2** 248	**O3** 274	**D0** 249	**D2** 258

57 64

NW ↑

System of Replication : 8 × 8 Latin square.

Area of Each Plot : 0.004591 acre (20 × 10 ft.). 100 plants per plot, spaced 2 × 1 ft. Plants weighed individually at harvest. No paths or guard rows.

Variety : Marrow stem.

Treatments : Sulphate of ammonia at the rate of 0 (0), 0.2 (1), 0.4 (2), and 0.8 cwt. (3) N per acre, with and without dung (D and O) at the rate of 15 tons per acre. Basal (plots receiving no dung) : superphosphate at the rate of 0.5 cwt. P_2O_5 per acre, and 30 per cent. potash manure salt at the rate of 1.0 cwt. K_2O per acre.

Manures Applied : May 17th. Dung, March 27th and 28th.

Seed Sown in Glass House on March 7th ; transplanted on May 17th-18th.

Kale Cut : October 4th, 5th, 19th ; November 1st and 18th.

Previous Crop : Wheat.

SUMMARY OF RESULTS.

FRESH MATERIAL

(See diagram on p. 29.)

	No S/Amm.	S/Amm. 0.2 cwt. N.	S/Amm. 0.4 cwt. N.	S/Amm. 0.8 cwt. N.	*Mean*
		Tons per acre			
No Dung	13.29	17.76	19.67	24.36	*18.77*
Dung	19.19	21.24	23.67	28.74	*23.21*
Mean	*16.24*	*19.50*	*21.67*	*26.55*	*20.99*
		Per cent.			
No Dung	63.3	84.6	93.7	116.0	*89.4*
Dung	91.4	101.2	112.8	136.9	*110.6*
Mean	*77.4*	*92.9*	*103.2*	*126.5*	*100.0*

Standard Error of single entry: 0.713 tons, or 3.40 per cent.

CONCLUSIONS

The effects of dung and sulphate of ammonia are both significant. There is no significant departure from proportionality in the response to increasing dressings of sulphate of ammonia, though the low value of the yield of plots without sulphate of ammonia or dung is suggestive, nor is there any significant difference in the response to sulphate of ammonia in the presence and absence of dung. The results indicate that the dung supplied produced the same increase in yield as 0.34 cwt. N. per acre as sulphate of ammonia ; if it is assumed that the whole effect of the dung was due to the additional available nitrogen supplied then 22 per cent. of the nitrogen in the dung appears to be in available form.

Replicated Experiments at Outside Centres

GRASSLAND. MEADOW HAY

(Basic Slag Committee)

W. H. Limbrick, Esq., Badminton Farm, Badminton, Gloucester, 1932.
(GH). Third Season.

System of Replication : 5 × 5 Latin square. Plots split for muriate of potash. For plan, see 1931 Report.
Area of each Sub-plot : 1/20th acre.
Soil : Light red loam, 8 ins. deep.
Treatments :
O=No phosphate.
S=Superphosphate.
M=Mineral phosphate.
L=Low soluble slag (citric solubility 23.0 per cent.).
H=High soluble slag (citric solubility 96.5 per cent.).
Phosphatic dressings at the rate of 1 cwt. P_2O_5 per acre, and muriate of potash at the rate of 1 cwt. per acre.
Manures Applied : Phosphates in 1930, potash in 1931.
Hay Cut : June 22nd.
Hay Weighed : June 27th-28th.

Actual weights in lb., (green weights).

Row.	O	M	L	H	S	O	M	L	H	S
	With muriate of potash					Without muriate of potash				
I. ..	250	247	264	250	269	255	264	280	255	260
II. ..	246	226	215	211	234	230	208	237	245	216
III. ..	226	236	219	247	235	230	241	208	231	209
IV. ..	224	224	201	245	246	221	182	232	241	261
V. ..	307	295	238	283	280	255	246	254	257	262

SUMMARY OF RESULTS

DRY MATTER

	No phosphate	Mineral phosphate	Low sol. slag	High sol. slag	Super.	*Mean*	Standard Error
			Cwt. per acre				
Without mur. pot.	32.5	31.2	33.1	33.6	33.0	*32.7*	
With mur. pot. ..	34.2	33.5	31.1	33.8	34.5	*33.4*	
Mean	*33.4*	*32.3*	*32.1*	*33.7*	*33.8*	*33.0*	0.808
Difference ..	*+1.7*	*+2.3*	*−2.0*	*+0.2*	*+1.5*	*+0.7*	1.341
			Per cent.				
Without mur. pot.	98.4	94.3	100.1	101.6	99.9	*98.8*	
With mur. pot. ..	103.6	101.5	94.0	102.2	104.5	*101.2*	
Mean	*101.0*	*97.9*	*97.0*	*101.8*	*102.2*	*100.0*	2.44
Difference ..	*+5.2*	*+7.2*	*−6.1*	*+0.6*	*+4.6*	*+2.4*	4.06

CONCLUSIONS

No significant effects.

GRASSLAND. MEADOW HAY

(Basic Slag Committee)

W. Eydes, Esq., Walton Lodge Farm, Walton, Chesterfield, Derby, 1932. (DH). Third Season.

SYSTEM OF REPLICATION : 5×5 Latin square. Plots split for muriate of potash. For plan, see 1931 Report.

AREA OF EACH SUB-PLOT : 1/30th acre. Soil : Clay, 6 ins. deep.

TREATMENTS :
- O=No phosphate.
- S=Superphosphate.
- M=Mineral phosphate.
- L=Low soluble slag (citric solubility 23.0 per cent.).
- H=High soluble slag (citric solubility 96.5 per cent.).

PHOSPHATIC DRESSINGS at the rate of 1 cwt. P_2O_5 per acre, and muriate of potash at the rate of 0.5 cwt. K_2O per acre.

MANURES APPLIED : Phosphate 1930, Potash 1931.

HAY CUT : July 22nd.

Actual weights in lb.—Green weights.

Row.	O	M	L	H	S	O	M	L	H	S
	With Muriate of Potash.					Without Muriate of Potash.				
I.	80	85	99	129	114	73	88	110	127	108
II.	91	122	108	114	124	90	119	106	116	128
III.	129	133	108	118	139	124	124	117	129	146
IV.	103	144	130	109	133	112	124	127	120	120
V.	119	146	112	84	152	121	128	89	108	107

SUMMARY OF RESULTS

DRY MATTER

	No Phosphate.	Mineral Phosphate.	Low Soluble Slag.	High Soluble Slag.	Superphosphate.	*Mean*	Standard Error.
			Cwt. per acre				
Without potash ..	20.1	22.4	21.1	23.2	22.8	*21.9*	
With potash ..	20.4	24.0	21.5	21.5	25.4	*22.5*	
Mean	*20.2*	*23.2*	*21.3*	*22.4*	*24.1*	*22.2*	*0.78*
Difference ..	*+0.3*	*+1.6*	*+0.4*	*−1.7*	*+2.6*	*+0.6*	*1.12*
			Per cent.				
Without potash ..	90.3	100.9	94.8	104.5	102.6	*98.6*	
With potash ..	91.5	107.8	96.8	96.8	114.1	*101.4*	
Mean	*90.9*	*104.4*	*95.8*	*100.6*	*108.4*	*100.0*	*3.51*
Difference ..	*+1.2*	*+6.9*	*+2.0*	*−7.7*	*+11.5*	*+2.8*	*5.04*

CONCLUSIONS

The response to phosphate is definitely significant, but the differences between the different kinds of phosphate are not significant. The response to potash is not significant.

BARLEY

EFFECT OF NITROGENOUS FERTILISERS, SULPHATE OF POTASH AND SUPERPHOSPHATE

G. H. Nevile, Esq., Wellingore Hall, Lincs, 1932 (VB)

Sample weights in grammes (grain above and straw below).

57	K 458 459	PK 383 340	PK 402 425	O 521 630	K 428 442	PK 500 670	O 414 458	PK 416 464	64
56	P 391 367	O 462 470	K 379 434	P 462 557	O 430 490	P 462 549	K 440 442	P 452 548	49
41	P 412 456	K 508 518	O 442 384	K 570 648	O 441 408	PK 365 394	P 442 399	PK 412 396	48
40	PK 468 490	O 596 690	P 546 570	PK 596 564	K 468 508	P 410 438	O 450 394	K 464 512	33
25	K 562 506	P 472 467	O 505 458	PK 529 536	PK 515 600	K 482 692	O 426 508	P 415 429	32
24	PK 406 362	O 456 468	K 480 472	P 434 433	P 443 538	O 478 600	K 437 516	PK 472 613	17
9	O 478 472	P 474 481	O 490 510	K 462 506	K 459 469	O 441 572	O 444 568	PK 500 574	16
8	K 540 524	PK 354 347	PK 484 499	P 584 551	P 446 408	PK 354 451	P 479 713	K 428 432	1

Plan showing Nitrogenous Treatments applied to whole plots.

O	N	S	H
N	S	H	O
H	O	N	S
S	H	O	N

SYSTEM OF REPLICATION : 4 × 4 Latin square with plots sub-divided into four for potash, superphosphate, neither, or both.

AREA OF EACH SUB-PLOT : 1/200th acre.

SOIL : Light loam on Lincoln heath. Oolitic limestone.

VARIETY : Plumage-Archer.

TREATMENTS :

O=No nitrogen.
N=Nitrate of soda
S=Sulphate of ammonia
H=Soluble ammonium humate
} At the rate of 0.2 cwt. N per acre.
K=Sulphate of potash at the rate of 0.6 cwt. K_2O per acre.
P=Superphosphate at the rate of 0.4 cwt. P_2O_5 per acre.

Plots harvested by sampling method (8 metre lengths per sub-plot, drills set 6 ins. apart).

BASAL MANURING : Very light dressing dung.

MANURES APPLIED : March 10th.

BARLEY SOWN : March 10th.

HARVESTED : August 25th.

PREVIOUS CROP : Linseed.

SUMMARY OF RESULTS

	No Nitrogen	Sulph. of Amm.	Nitrate of Soda	Ammonium Humate	*Mean*
GRAIN Cwt. per acre					
No potash or Super	30.3	29.0	33.3	29.4	*30.5*
Sulphate of Potash	30.4	32.3	29.3	31.6	*30.9*
Superphosphate	28.0	31.0	29.3	31.3	*29.9*
Potash and Super.	27.4	31.4	30.8	27.3	*29.2*
Mean	*29.0*	*30.9*	*30.7*	*29.9*	*30.1*
Per cent.					
No Potash or Super . .	100.7	96.2	110.5	97.6	*101.3*
Sulphate of Potash	100.9	107.1	97.4	104.8	*102.5*
Superphosphate	92.8	102.8	97.4	104.0	*99.2*
Potash and Super.	90.9	104.2	102.2	90.6	*97.0*
Mean	*96.3*	*102.6*	*101.9*	*99.2*	*100.0*
STRAW Cwt. per acre					
No potash or Super. . .	30.9	30.3	40.6	30.1	*33.0*
Sulphate of Potash	31.2	34.8	33.9	32.0	*33.0*
Superphosphate	26.2	33.1	37.0	32.7	*32.3*
Potash and Super.	28.1	35.8	34.1	28.1	*31.5*
Mean	*29.1*	*33.5*	*36.4*	*30.7*	*32.4*
Per cent.					
No potash or Super. . .	95.3	93.4	125.2	92.8	*101.7*
Sulphate of Potash	96.3	107.2	104.5	98.7	*101.7*
Superphosphate	80.9	102.1	113.9	100.8	*99.4*
Potash and Super.	86.7	110.4	105.1	86.5	*97.2*
Mean	*89.8*	*103.3*	*112.2*	*94.7*	*100.0*

Each yield in the above table is the mean of 4 quarter plots. The standard errors of the yields of single whole plots (appropriate to direct comparisons of nitrogenous dressings) and of single quarter plots (appropriate to comparisons involving potash, superphosphate, and their interactions with nitrogen) are :

Grain.	Whole plots :	1.93 cwt., or	6.4 per cent.
	Quarter plots :	3.22 cwt., or	10.7 per cent.
Straw.	Whole plots :	2.40 cwt., or	7.4 per cent.
	Quarter plots :	5.03 cwt., or	15.5 per cent.

CONCLUSIONS

The response to sulphate of ammonia and nitrate of soda is significant in the case of the straw, but not so in the case of the grain, the mean of these two forms of nitrogen being also significantly above ammonium humate for the straw. There are no other significant effects.

BARLEY

EFFECT OF NITROGENOUS FERTILISERS, SULPHATE OF POTASH AND SUPERPHOSPHATE

H. B. Bescoby, Esq., South-Eastern Agricultural College, Wye, Kent, 1932

(ZB)

Sample weights in grammes (grain above and straw below).

8 64

P 535 661	**O** 572 704	**O** 622 717	**K** 527 673	**P** 456 573	**K** 414 454	**K** 500 608	**P** 525 681
K 484 561	**PK** 471 574	**P** 524 649	**PK** 491 631	**PK** 539 710	**O** 432 520	**O** 443 555	**PK** 495 655
PK 418 521	**P** 554 620	**O** 594 692	**PK** 478 564	**O** 646 919	**P** 656 842	**P** 341 403	**PK** 507 701
O 391 408	**K** 604 717	**P** 594 657	**K** 409 484	**K** 501 610	**PK** 558 731	**K** 525 707	**O** 514 640
O 485 607	**K** 620 757	**P** 577 752	**O** 597 784	**PK** 489 599	**P** 427 504	**O** 443 540	**PK** 453 585
P 666 809	**PK** 529 682	**K** 500 667	**PK** 500 624	**K** 381 441	**O** 375 393	**P** 517 623	**K** 499 621
K 447 543	**P** 546 661	**P** 418 475	**K** 523 611	**PK** 575 760	**P** 563 818	**O** 389 444	**PK** 454 532
PK 502 657	**O** 578 706	**O** 626 737	**PK** 650 781	**K** 371 496	**O** 642 1054	**P** 626 771	**K** 475 551

1 57

Plan showing Nitrogenous Treatments applied to whole plots.

O	N	H	S
H	O	S	N
N	S	O	H
S	H	N	O

SYSTEM OF REPLICATION : 4 × 4 Latin square with plots sub-divided into four for potash, superphosphate, both, or neither.

AREA OF EACH SUB-PLOT : 1/200 acre.

SOIL : Calcareous loam.

VARIETY : Plumage-Archer.

TREATMENTS :

O = No nitrogen.

N = Nitrate of soda } At the rate
S = Sulphate of ammonium } of 0.2 cwt.
H = Soluble ammonia humate } total N per acre.

K = Sulphate of potash at the rate of 0.6 cwt. K_2O per acre.

P = Superphosphate at the rate of 0.4 cwt. P_2O_5 per acre.

Plots harvested by sampling method (8 metre lengths per sub-plot, drills set 7 ins. apart).

MANURES APPLIED : March 11th.

BARLEY SOWN : March 9th.

HARVESTED : August 11th.

PREVIOUS CROP : Potatoes.

SUMMARY OF RESULTS

	No Nitrogen	Sulph. of Amm.	Nitrate of Soda	Ammonium Humate	*Mean*
GRAIN					
Cwt. per acre					
No Potash or Super. . .	27.0	31.7	31.7	26.5	*29.2*
Sulphate of Potash	24.5	27.3	28.6	28.6	*27.2*
Superphosphate	30.5	32.2	29.3	27.2	*29.8*
Potash and Super	26.5	28.8	29.4	28.8	*28.4*
Mean	*27.1*	*30.0*	*29.8*	*27.8*	*28.7*
Per cent.					
No Potash or Super. . .	94.2	110.6	110.5	92.4	*101.9*
Sulphate of Potash	85.4	95.1	99.8	99.6	*95.0*
Superphosphate	106.6	112.5	102.3	95.0	*104.1*
Potash and Super	92.4	100.4	102.6	100.6	*99.0*
Mean	*94.6*	*104.6*	*103.8*	*96.9*	*100.0*
STRAW					
Cwt. per acre					
No Potash or Super. . .	31.2	41.5	42.2	30.9	*36.5*
Sulphate of Potash	28.5	34.0	36.8	33.6	*33.2*
Superphosphate	36.3	41.1	37.5	32.1	*36.7*
Potash and Super.	31.8	37.3	38.8	36.4	*36.1*
Mean	*32.0*	*38.5*	*38.8*	*33.2*	*35.6*
Per cent.					
No Potash or Super . .	87.7	116.4	118.6	86.6	*102.3*
Sulphate of Potash	80.0	95.4	103.4	94.4	*93.3*
Superphosphate	101.9	115.3	105.2	90.0	*103.1*
Potash and Super.	89.1	104.8	109.0	102.0	*101.2*
Mean	*89.7*	*108.0*	*109.0*	*93.3*	*100.0*

Each yield in the above table is the mean of 4 quarter plots. The standard errors of the yields of single whole plots (appropriate to direct comparisons of nitrogenous dressings) and of single quarter plots (appropriate to comparisons involving potash, superphosphate, and their interactions with nitrogen) are :

Grain. Whole plots : 2.63 cwt., or 9.2 per cent.
Quarter plots : 4.40 cwt., or 15.4 per cent.
Straw. Whole plots : 4.21 cwt., or 11.8 per cent.
Quarter plots : 6.47 cwt., or 18.2 per cent.

CONCLUSIONS

The response to sulphate of ammonia and nitrate of soda is just significant in the case of the straw, but not so in the case of the grain. There are no other significant effects.

BARLEY

EFFECT OF NITROGENOUS FERTILISERS, SULPHATE OF POTASH AND SUPERPHOSPHATE

J. M. Templeton, Esq., Sparsholt Farm Institute, 1932 (SB)

Sample weights in grammes (grain above and straw below).

57 64

P 441 433	O 468 481	K 373 339	P 241 221	P 431 415	O 542 537	PK 480 497	P 458 509
K 471 475	PK 455 519	O 222 199	PK 339 303	K 379 381	PK 433 435	O 549 584	K 411 395
K 376 380	O 461 518	O 475 551	K 536 637	K 568 671	PK 575 633	K 560 604	PK 381 373
PK 362 368	P 537 549	P 530 600	PK 482 556	O 452 592	P 480 565	P 532 568	O 418 442
P 474 510	K 515 595	P 348 355	PK 389 399	O 376 356	P 473 542	PK 431 541	O 415 521
O 686 752	PK 560 741	O 434 423	K 572 533	PK 382 355	K 411 443	P 718 745	K 400 428
O 471 585	K 668 646	PK 648 624	P 530 400	O 521 431	PK 486 499	PK 660 604	P 497 421
PK 459 581	P 406 677	K 356 375	O 535 597	K 512 410	P 586 642	K 521 541	O 620 596

1 8

Plan showing Nitrogenous Treatments applied to whole plots.

H	O	S	N
O	S	N	H
N	H	O	S
S	N	H	O

SYSTEM OF REPLICATION : 4 × 4 Latin square with plots sub-divided into four for potash, superphosphate, both, or neither.
AREA OF EACH SUB-PLOT : 1/200th acre.
SOIL : Flinty loam on chalk.
VARIETY : Plumage-Archer.
TREATMENTS :
O=No nitrogen.
N=Nitrate of soda } At the rate
S=Sulphate of ammonia } of 0.2 cwt.
H=Soluble ammonium humate } total N per acre.
K=Sulphate of potash at the rate of 0.6 cwt. K_2O per acre.
P=Superphosphate at the rate of 0.4 cwt. P_2O_5 per acre.
Plots harvested by sampling method (8 metre lengths per sub-plot, drills set 7½ ins. apart).
MANURES APPLIED : March 26th.
BARLEY SOWN : March 19th.
HARVESTED : August 16th.
PREVIOUS CROP : Seeds.

SUMMARY OF RESULTS

	No Nitrogen	Sulph. of Amm.	Nitrate of Soda	Ammonium Humate	*Mean*
GRAIN Cwt. per acre					
No Potash or Super. ..	21.9	24.9	29.0	24.0	*25.0*
Sulphate of Potash	22.0	25.9	24.2	27.6	*24.9*
Superphosphate	22.8	27.2	25.4	24.9	*25.1*
Potash and Super.	22.8	23.6	29.6	22.4	*24.6*
Mean	*22.4*	*25.4*	*27.0*	*24.7*	*24.9*
Per cent.					
No Potash or Super. ..	88.1	99.9	116.6	96.6	*100.3*
Sulphate of Potash	88.2	104.1	97.1	111.0	*100.1*
Superphosphate	91.8	109.5	101.9	100.1	*100.8*
Potash and Super.	91.5	94.8	118.8	89.8	*98.7*
Mean	*89.9*	*102.0*	*108.6*	*99.4*	*100.0*
STRAW Cwt. per acre					
No Potash or Super. ..	21.8	28.7	33.0	23.2	*26.7*
Sulphate of Potash	22.2	27.3	26.6	26.4	*25.6*
Superphosphate	22.6	31.8	25.9	26.1	*26.6*
Potash and Super.	21.3	27.6	32.6	23.4	*26.2*
Mean	*22.0*	*28.9*	*29.5*	*24.8*	*26.3*
Per cent.					
No Potash or Super. ..	82.9	109.0	125.5	88.3	*101.4*
Sulphate of Potash	84.6	104.0	101.2	100.5	*97.6*
Superphosphate	86.1	121.1	98.6	99.3	*101.3*
Potash and Super.	81.0	105.0	124.0	88.9	*99.7*
Mean	*83.7*	*109.8*	*112.3*	*94.2*	*100.0*

Each yield in the above table is the mean of 4 quarter plots. The standard errors of the yields of single whole plots (appropriate to direct comparisons of nitrogenous dressings) and of single quarter plots (appropriate to comparisons involving potash, superphosphate, and their interactions with nitrogen) are :

Grain.	Whole plots :	2.67 cwt., or 10.7 per cent.
	Quarter plots :	4.52 cwt., or 18.2 per cent.
Straw.	Whole plots :	2.77 cwt., or 10.5 per cent.
	Quarter plots :	4.54 cwt., or 17.3 per cent.

CONCLUSIONS

The response to sulphate of ammonia and nitrate of soda is significant in the case of the straw, but barely so in the case of the grain. The response to ammonium humate is not significant, and is significantly below the other forms of nitrogen in the case of the straw. There are no other clear significant effects, though the yields of the individual treatments are somewhat more irregular than expectation, particularly in the case of the straw.

POTATOES

EFFECT OF SULPHATE OF AMMONIA AND OF SULPHATE OF POTASH

G. Major, Esq., Newton Farm, Wisbech, 1932

Plan and actual weights in lb.

A					B
1N 0K 630	0N 0K 620	2N 2K 575	1N 1K 601	2N 0K 583	1N 0K 650
1N 2K 598	0N 2K 554	2N 1K 510	0N 0K 558	2N 2K 575	1N 2K 601
0N 1K 619	2N 0K 579	1N 1K 571	0N 2K 597	2N 1K 618	0N 1K 602
1N 1K 623	2N 0K 613	1N 0K 608	0N 0K 599	0N 1K 637	1N 2K 649
1N 2K 582	0N 2K 619	0N 1K 566	2N 0K 618	1N 0K 644	1N 1K 642
2N 1K 583	0N 0K 555	2N 2K 541	2N 1K 525	0N 2K 558	2N 2K 631
C					D

SYSTEM OF REPLICATION: 4 randomised blocks of 9 plots each.
AREA OF EACH PLOT: 1/60th acre.
SOIL: Deep heavy silt.
VARIETY: King Edward.
TREATMENTS: Sulphate of ammonia (N) at the rate of 0, 0.4 and 0.8 cwt. N per acre, sulphate of potash (K) at the rate of 0, 1.0 and 2.0 cwt. K_2O per acre.
BASAL MANURING: Superphosphate at the rate of 1.0 cwt. P_2O_5 per acre.
MANURES APPLIED: March 18th.
POTATOES PLANTED: March 18th.
POTATOES LIFTED: November 11th.
PREVIOUS CROP: Peas.

SUMMARY OF RESULTS

	No Sulph. Pot.	Single Sulph. Pot.	Double Sulph. Pot.	*Mean*
Tons per acre				
No Sulph. Amm.	11.75	12.21	11.73	*11.90*
Single Sulph. Amm.	12.76	12.28	12.24	*12.43*
Double Sulph. Amm.	12.06	11.26	11.70	*11.68*
Mean	*12.19*	*11.92*	*11.89*	*12.00*
Per cent.				
No. Sulph. Amm.	97.9	101.8	97.8	*99.2*
Single Sulph. Amm.	106.3	102.3	102.0	*103.6*
Double Sulph. Amm.	100.5	93.9	97.5	*97.3*
Mean	*101.6*	*99.3*	*99.1*	*100.0*

Standard error for single entry: 0.318 tons, or 2.65 per cent.

CONCLUSIONS

The single dressing of sulphate of ammonia is followed by a significant rise in yield, but there is an even greater falling off with the double dressing. The decrease following treatment with sulphate of potash is not significant.

POTATOES

EFFECT OF SULPHATE OF AMMONIA, SULPHATE OF POTASH AND SUPERPHOSPHATE

H. Inskip, Esq., Stanford, Biggleswade, 1932

	1					61	
	— 0S 0K	2S 1K —	— 0S 1K	— 0S 2K	1S 0K —	— 1S 1K	
C	— 1S 2K	2S 0K —	1S 0K —	0S 0K —	— 1S 2K	— 2S 2K	A
	0S 2K —	— 2S 2K	1S 1K —	0S 1K —	— 2S 0K	2S 1K —	
	— 1S 2K	— 1S 1K	0S 2K —	2S 1K —	2S 2K —	0S 0K —	
D	— 2S 1K	0S 0K —	— 2S 0K	2S 0K —	1S 1K —	— 1S 0K	B
	— 0S 1K	— 2S 2K	1S 0K —	1S 2K —	— 0S 1K	— 0S 2K	
	12					72	

In each plot the half receiving no superphosphate is left blank, and the dressing of sulphate of ammonia and sulphate of potash applied to the whole plot is indicated by a symbol in the half receiving superphosphate.

System of Replication : 4 randomised blocks, each of 9 plots split for superphosphate.

Area of Each Sub-Plot : 1/100th acre.

Soil : Sandy gravel.

Variety : Great Scot.

Treatments : Sulphate of ammonia (S) at the rate of 0, 0.3 and 0.6 cwt. N per acre, sulphate of potash (K) at the rate of 0, 0.5 and 1.0 cwt. K_2O per acre, and superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.

Basal Manuring : 1 ton of shoddy per acre given in early spring on furrow and ploughed in deep.

Manures Applied : March 31st.

Potatoes Planted : March 31st.

Potatoes Lifted : September 20th-21st.

Previous Crop : Wheat with clover undersown.

Actual weights in lb.

Block.	0S 0K	0S 1K	0S 2K	1S 0K	1S 1K	1S 2K	2S 0K	2S 1K	2S 2K
Without Superphosphate									
A ..	254	276	244	241	250	254	260	280	284
B ..	272	267	266	279	287	291	286	288	269
C ..	270	248	256	272	253	281	290	270	297
D ..	292	259	280	310	334	292	291	283	310
With Superphosphate									
A ..	235	259	247	239	266	270	284	291	296
B ..	283	293	265	279	306	289	275	297	295
C ..	267	266	268	266	286	324	281	278	291
D ..	293	262	272	291	279	281	279	279	314

SUMMARY OF RESULTS

		No Sulph. Pot.	1 cwt. Sulph. Pot.	2 cwt. Sulph. Pot.	*Mean*
Tons per acre					
Without Super	No Sulph. Amm. . .	12.14	11.72	11.67	*11.84*
	1½ cwt. Sulph. Amm.	12.30	12.54	12.48	*12.44*
	3 cwt. Sulph. Amm. . .	12.58	12.51	12.95	*12.68*
	Mean	*12.34*	*12.26*	*12.37*	*12.32*
With Super	No Sulph. Amm.	12.03	12.05	11.74	*11.94*
	1½ cwt. Sulph. Amm.	12.00	12.69	12.99	*12.56*
	3 cwt. Sulph. Amm. . .	12.49	12.78	13.35	*12.87*
	Mean	*12.17*	*12.51*	*12.69*	*12.46*
Per cent.					
Without Super	No Sulph. Amm. . .	98.0	94.6	94.2	*95.6*
	1½ cwt. Sulph. Amm.	99.3	101.2	100.7	*100.4*
	3 cwt. Sulph. Amm.	101.5	101.0	104.5	*102.3*
	Mean	*99.6*	*98.9*	*99.8*	*99.4*
With Super	No Sulph. Amm. . .	97.1	97.3	94.8	*96.4*
	1½ cwt. Sulph. Amm.	96.8	102.4	104.8	*101.4*
	3 cwt. Sulph. Amm. . .	100.8	103.1	107.7	*103.9*
	Mean	*98.2*	*101.0*	*102.4*	*100.5*

Each yield in the above table is the mean of 4 half plots. The standard errors of the yields of single whole plots (appropriate to comparisons involving potash and nitrogen) and of single half plots (appropriate to the direct effect of super, and its interactions with potash and nitrogen) are :

Whole plots : 0.554 tons, or 4.47 per cent.
Half plots : 0.606 tons, or 4.89 per cent.

MEAN OF SUPERPHOSPHATE AND NO SUPERPHOSPHATE

	No Sulph. Pot.	1 cwt. Sulph. Pot.	2 cwt. Sulph. Pot.	*Mean*
Tons per acre				
No Sulph. Amm.	12.09	11.89	11.71	*11.89*
1½ cwt. Sulph. Amm.	12.15	12.62	12.73	*12.50*
3 cwt. Sulph. Amm.	12.53	12.64	13.15	*12.78*
Mean	*12.26*	*12.38*	*12.53*	*12.39*
Per cent.				
No. Sulph. Amm.	97.6	95.9	94.5	*96.0*
1½ cwt. Sulph. Amm.	98.0	101.8	102.8	*100.9*
3 cwt. Sulph. Amm.	101.2	102.1	106.1	*103.1*
Mean	*98.9*	*100.0*	*101.1*	*100.0*

Standard error of single entry: 0.277 tons, or 2.23 per cent.

CONCLUSIONS

The response to sulphate of ammonia is definitely significant. No other significant effects.

POTATOES

EFFECT OF SULPHATE OF AMMONIA, SULPHATE OF POTASH AND SUPERPHOSPHATE

H. Inskip, Esq., Stanford, Biggleswade, 1932

Plan and actual weights in lb.

	21			24
IA	NP 217	O 198	PK 277	NK 343
IB	N 128	NPK 316	K 248	P 144
IIB	K 269	P 117	NPK 271	N 135
IIA	O 132	PK 300	NK 313	NP 128
IIIB	N 139	P 137	K 249	NPK 431
IIIA	PK 284	O 168	NK 312	NP 128
	1			4

System of Replication : 3 randomised blocks each split into 2 sub-blocks, the highest order interaction being confounded with fertility differences.

Area of Each Plot : 1/60th acre.

Soil : Gravel, black soil, some shells ; rock close to surface.

Variety : Great Scott.

Treatments : Sulphate of ammonia (N) at the rate of 0.6 cwt. N per acre, sulphate of potash (K) at the rate of 1.5 cwt. K_2O per acre and superphosphate at the rate of 0.6 cwt. P_2O_5 per acre.

Manures Applied : March 31st.

Potatoes Planted : March 27th.

Potatoes Lifted : September 19th-20th.

Previous Crop : Parsnips.

SUMMARY OF RESULTS

INDIVIDUAL TREATMENTS

	Sub-blocks A				Sub-blocks B.				
	No manure	S/Amm. Super.	S/Amm. S/Pot.	Super., S/Pot.	S/Amm.	Super.	S/Pot.	S/Amm. S/Pot., Super.	*Mean*
Tons per acre ..	4.45	4.22	8.64	7.69	3.59	3.55	6.84	9.09	*6.01*
Per cent	74.0	70.3	143.8	127.9	59.7	59.1	113.8	151.3	*100.0*

The second order interaction is confounded with fertility differences ; comparisons involving this interaction will be affected by such differences.

MEAN OF PHOSPHATE AND NO PHOSPHATE

	No Sulph. Amm.	Sulph. Amm.	*Mean*
	Tons per acre		
No potash	4.00	3.91	*3.95*
Potash	7.26	8.87	*8.06*
Mean	*5.63*	*6.39*	*6.01*
	Per cent.		
No potash	66.6	65.0	*65.8*
Potash	120.9	147.5	*134.2*
Mean	*93.7*	*106.3*	*100.0*

Standard error of single entries: 0.389 tons, or 6.47 per cent.

CONCLUSIONS

The response to superphosphate, 0.26 tons per acre or 4.4 per cent., is not significant, that to potash, 4.11 tons per acre or 68.4 per cent., is highly so. The apparent response to sulphate of ammonia of 0.76 tons per acre or 12.6 per cent. cannot by itself be judged significant in view of the exceptionally high standard error ; the significant interaction with potash, however, is evidence of a real manurial effect.

POTATOES

EFFECT OF SULPHATE OF AMMONIA, SULPHATE OF POTASH AND SUPERPHOSPHATE

R. Starling, Esq., Northfield Farm, Little Downham, Ely, 1932

I	1N 1P —	0N 1P —	1N 2P —	— 0N 0P	— 0N 2P	— 1N 0P
II	0N 1P —	0N 2P —	1N 0P —	1N 1P —	— 1N 2P	0N 0P —
III	0N 0P —	— 1N 1P	0N 2P —	— 0N 1P	1N 0P —	1N 2P —
IV	1N 2P —	1N 0P —	1N 1P —	— 0N 2P	— 0N 0P	0N 1P —
V	1N 0P —	0N 0P —	— 0N 1P	— 1N 2P	1N 1P —	0N 2P —
VI	— 0N 2P	1N 2P —	0N 0P —	— 1N 0P	— 0N 1P	1N 1P —

In each plot the half receiving no sulphate of potash is left blank, and the dressing of superphosphate and sulphate of ammonia applied to the whole plot is indicated by a symbol in the half receiving sulphate of potash.

System of Replication : 6 × 6 Latin square, plots split for sulphate of potash.
Area of Each Sub-Plot : 1/100th acre.
Soil : Good black fenland.
Variety : Scotch Majestic.
Treatments : Superphosphate (P) at the rate of 0, 5, and 10 cwt. per acre, sulphate of ammonia (N) at the rate of 0 and 2 cwt. per acre, and sulphate of potash at the rate of 2 cwt. per acre.
Manures Applied : April 4th.
Potatoes Planted : April 6th.
Lifted : Oct. 7th.
Previous Crop : Wheat.

Actual Weights in lbs.

	Without Potash.						With potash.					
Row.	0N 0K	0N 1P	0N 2P	1N 0P	1N 1P	1N 2P	0N 0K	0N 1P	0N 2P	1N 0P	1N 1P	1N 2P
I ..	191	290	236	211	324	334	199	237	268	205	309	318
II ..	137	226	223	192	236	308	145	263	252	223	252	263
III ..	186	197	226	163	232	319	198	225	257	171	249	327
IV ..	158	187	230	242	240	319	165	197	209	206	265	301
V ..	207	201	245	227	304	296	225	210	221	225	290	321
VI ..	149	171	263	199	196	253	110	155	237	167	224	252

SUMMARY OF RESULTS

		No super.	Single super.	Double super.	*Mean*
	Tons per acre				
Without Sulph. Amm.	No Sulph. pot.	7.65	9.46	10.59	*9.23*
	Sulph pot.	7.75	9.58	10.74	*9.36*
With Sulph. Amm.	No Sulph. pot.	9.18	11.40	13.61	*11.40*
	Sulph. pot.	8.91	11.82	13.26	*11.33*
	Per cent.				
Without Sulph. Amm.	No Sulph. pot.	74.0	91.6	102.5	*89.4*
	Sulph. pot.	75.0	92.7	104.0	*90.6*
With Sulph. Amm.	No Sulph. pot.	88.9	110.4	131.7	*110.3*
	Sulph. pot.	86.2	114.5	128.4	*109.7*

Each yield in the above table is the mean of 6 half plots. The standard errors of the yields of single whole plots (appropriate to comparisons involving nitrogen and super.) and of single half plots (appropriate to the direct effect of potash and its interactions with nitrogen and super.) are :

Whole plots : 0.872 tons, or 8.44 per cent.
Half plots : 0.812 tons, or 7.86 per cent.

MEAN OF POTASH AND NO POTASH

	No super.	Single super.	Double super.	*Mean*
Tons per acre				
No Sulph. amm.	7.70	9.52	10.66	*9.30*
Sulph. amm.	9.04	11.61	13.44	*11.36*
Mean	*8.37*	*10.56*	*12.05*	*10.33*
Per cent.				
No Sulph. amm.	74.5	92.2	103.2	*90.0*
Sulph. amm.	87.6	112.4	130.0	*110.0*
Mean	*81.0*	*102.3*	*116.6*	*100.0*

Standard error of single entry: 0.356 tons, or 3.45 per cent.

CONCLUSIONS

Definitely significant response to sulphate of ammonia and to superphosphate. The response to superphosphate in the presence of sulphate of ammonia is greater than the response in the absence of sulphate of ammonia. Equally the response to sulphate of ammonia appears to increase regularly with increasing dressings of superphosphate. Plots with and without potash give practically equal total yield, with a standard error of only 1.3 per cent.

POTATOES

EFFECT OF SULPHATE OF AMMONIA, SULPHATE OF POTASH AND SUPERPHOSPHATE

J. A. Tribe, Esq., Willow Farm, near March, 1932

Plan and actual weights in lb.

IB		IA		IIB		IIA	
K 156	**NPK** 219	**O** 158	**NK** 195	**NPK** 243	**K** 151	**NK** 164	**O** 144
P 170	**N** 128	**PK** 228	**NP** 245	**N** 147	**P** 177	**NP** 212	**PK** 179
NP 160	**NK** 83	**NPK** 202	**K** 134	**NK** 152	**NP** 164	**P** 143	**K** 96
PK 102	**O** 66	**P** 154	**N** 108	**O** 125	**PK** 184	**N** 99	**NPK** 203
IIIA		IIIB		IVA		IVB	

SYSTEM OF REPLICATION : 4 randomised blocks each split into two sub-blocks, the highest order interaction being confounded with fertility differences.

AREA OF EACH PLOT : 1/60th acre.

SOIL : Light peaty fen of poor quality.

VARIETY : King Edward, once grown.

TREATMENTS : Sulphate of ammonia (N) at the rate of 0.4 cwt. N per acre, sulphate of potash (K) at the rate of 1.0 cwt. K_2O per acre and superphosphate (P) at the rate of 1.0 cwt. P_2O_5 per acre.

MANURES APPLIED : April 12th. POTATOES LIFTED : October 3rd.

POTATOES PLANTED : April 12th. PREVIOUS CROP : Wheat.

SUMMARY OF RESULTS

INDIVIDUAL TREATMENTS

	Sub-blocks A				Sub-blocks B				
	No manure	S/Amm. Super.	S/Amm. S/Pot.	Super. S/Pot.	S/Amm.	Super.	S/Pot.	S/Amm. Super. S/Pot.	*Mean*
Tons per acre ..	3.30	5.23	3.98	4.64	3.23	4.31	3.60	5.80	*4.26*
Per cent	77.5	122.7	93.3	108.9	75.7	101.2	84.4	136.2	*100.0*

The second order interaction is confounded with fertility differences ; comparisons involving this interaction will be affected by such differences.

MEAN OF POTASH AND NO POTASH

	No Sulph. Amm.	Sulph. Amm.	*Mean*
	Tons per acre		
No super.	3.45	3.60	*3.52*
Super.	4.48	5.52	*5.00*
Mean	*3.96*	4.56	*4.26*
	Per cent.		
No super.	80.9	84.5	*82.7*
Super.	105.0	129.5	*117.3*
Mean	*93.0*	*107.0*	*100.0*

MEAN OF PHOSPHATE AND NO PHOSPHATE

	No Sulph. Amm.	Sulph. Amm.	*Mean*
Tons per acre			
No Sulph. Pot.	3.81	4.23	*4.02*
Sulph. Pot.	4.12	4.89	*4.50*
Mean	*3.96*	*4.56*	*4.26*
Per cent.			
No Sulph. Pot.	89.3	99.2	*94.3*
Sulph. Pot.	96.6	114.8	*105.7*
Mean	*93.0*	*107.0*	*100.0*

MEAN OF NITROGEN AND NO NITROGEN

	No Sulph. Pot.	Sulph. Pot.	*Mean*
Tons per acre			
No super.	3.26	3.79	*3.52*
Super.	4.77	5.22	*5.00*
Mean	*4.02*	*4.50*	*4.26*
Per cent.			
No super.	76.6	88.9	*82.7*
Super.	112.0	122.6	*117.3*
Mean	*94.3*	*105.7*	*100.0*

Standard errors for the last three tables. Single entries: 0.120 tons, or 2.83 per cent.

CONCLUSIONS

Significant response to all three fertilisers, superphosphate giving an increase of 1.48 tons per acre or 34.6 per cent., sulphate of ammonia 0.60 tons per acre or 14.0 per cent., sulphate of potash 0.48 tons per acre or 11.4 per cent. The response to superphosphate is greater in the presence than in the absence of the two other nutrients, and the response to these is therefore greater in the presence than in the absence of superphosphate. This interaction is significant in the case of superphosphate and sulphate of ammonia, the two nutrients giving the highest returns.

POTATOES

EFFECT OF NITRATE OF SODA, SULPHATE OF POTASH AND SUPERPHOSPHATE

T. H. Ream, Esq., Portobello Farm, nr. Potton, 1932

Plan and actual weights in lb.

25			1
NKP 179 **NK** 198	**KP** 146 **K** 140	**O** 143 **P** 143	**N** 156 **NP** 180
O 138 **P** 138	**NKP** 181 **NK** 172	**NP** 151 **N** 163	**K** 150 **KP** 151
K 142 **KP** 153	**N** 183 **NP** 172	**NKP** 177 **NK** 182	**O** 137 **P** 149
NP 174 **N** 193	**O** 136 **P** 136	**K** 140 **KP** 129	**NKP** 181 **NK** 166
32			8

System of Replication : 4 × 4 Latin square with plots split for superphosphate.
Area of each Sub-Plot : 1/80th acre.
Soil : Light sandy.
Variety : Sprouted Eclipse.
Treatments : Sulphate of potash (K) at the rate of 1.0 cwt. K_2O per acre, nitrate of soda (N) at the rate of 0.4 cwt. N per acre in two dressings, and superphosphate (P) at the rate of 0.5 cwt. P_2O_5 per acre.
Basal Manuring : Dunged on stubble, 20 tons per acre.
Manures Applied : March 17th, April 1st and May 25th.
Potatoes Planted : April 1st.
Potatoes Lifted : July 29th.
Previous Crop : Oats.

SUMMARY OF RESULTS

	No Potash or Nitrogen	Sulphate of Potash	Nitrate of Soda	Sulphate of Potash, and Nitrate of Soda	*Mean*
Tons per acre					
Without super. . .	4.95	5.11	6.20	6.41	*5.67*
With super	5.05	5.17	6.04	6.41	*5.67*
Per cent.					
Without super. . .	87.3	90.1	109.5	113.1	*100.0*
With super.	89.2	91.2	106.6	113.1	*100.0*

Each yield in the above table is the mean of 4 sub-plots. The standard errors of the yields of single whole plots (appropriate to comparisons involving potash and nitrogen) and of single half plots (appropriate to the direct effect of super, and its interactions with potash and nitrogen) are :

Whole plots : 0.278 tons, or 4.91 per cent.
Half plots : 0.341 tons, or 6.02 per cent.

MEAN OF SUPERPHOSPHATE AND NO SUPERPHOSPHATE

	No Nitrogen	Nitrogen	*Mean*
Tons per acre			
No potash	5.00	6.12	*5.56*
Potash	5.14	6.41	*5.77*
Mean	*5.07*	*6.27*	*5.67*
Per cent.			
No potash	88.2	108.0	*98.1*
Potash	90.6	113.1	*101.9*
Mean	*89.4*	*110.6*	*100.0*

Standard error of single entry: 0.139 tons, or 2.45 per cent.

CONCLUSIONS

Significant response to nitrate of soda, but not to potash. There is no evidence of any response to superphosphate.

SUGAR BEET

VARIETAL TRIAL

EFFECT OF SULPHATE OF AMMONIA, MURIATE OF POTASH AND SUPERPHOSPHATE

(National Institute of Agricultural Botany).

East Anglian Institute of Agriculture, Good Easter, Chelmsford, 1932.

BLOCK I	C NP	C N	A NK	B K	A K	C KP	C P	B NPK	B O	A N	B NP	C NK
BLOCK II	B NP	A NPK	C O	C N	C KP	A P	B NK	B N	B KP	C NP	A KP	A NK
BLOCK III	A NPK	A O	C O	C P	B NP	C N	A N	A NP	B N	B NPK	B O	C KP
BLOCK IV	A P	B KP	C K	A NPK	B N	B P	A K	B NP	A O	C KP	C NP	A NP

B P	B NK	B N	A O	C O	C NPK	A NPK	A KP	A NP	A P	C K	B KP	BLOCK I
B O	C P	B P	C NPK	A K	A N	A O	B NPK	C NK	B K	C K	A NP	BLOCK II
C NPK	C NK	B NK	A K	C K	A P	B P	B KP	C NP	B K	A KP	A NK	BLOCK III
B K	C P	C N	A NK	B NPK	B O	A N	C NPK	A KP	C O	B NK	C NK	BLOCK IV

The lower half of the plan should in reality be contiguous to and to the right of the upper half.

System of Replication : 4 randomised blocks of 24 plots each.
Area of Each Plot : .005165 acre.
Soil : London Clay.
Varieties :
- A=Kleinwanzleben E.
- B=Dippe W.1.
- C=Marsters.

Treatments : Sulphate of ammonia at the rate of 0.6 cwt. N per acre, muriate of potash at the rate of 0.75 cwt. K_2O per acre, and superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.
Basal Manuring : 12 loads dung applied to oat stubble in autumn, 1931.
Manures Applied : May 25th.
Beet Sown : May 20th.
Beet Lifted : November 23rd-December 1st.
Previous Crop : Spring oats.

Blocks.	O	K	P	N	NK	NP	KP	NKP
ROOTS (washed) lb.								
Kleinwanzleben E.								
I	162	152	173	184	112	190	140	175
II	162	164	175	178	193	166	158	155
III	127	141	142	168	171	157	148	139
IV	158	188	162	199	191	193	160	192
Dippe W.I.								
I	133	117	140	163	143	168	127	144
II	130	137	101	159	144	150	132	160
III	138	121	124	166	142	118	132	155
IV	128	147	143	174	159	157	139	153
Marsters.								
I	122	107	118	118	148	112	140	162
II	132	171	142	152	152	175	115	160
III	123	142	120	149	147	152	130	173
IV	146	151	138	165	136	173	152	195
SUGAR PERCENTAGE.								
Kleinwanzleben E.								
I	18.01	18.47	18.35	18.41	18.01	18.13	18.64	18.87
II	18.35	18.58	19.04	18.47	18.30	17.90	18.81	18.70
III	18.98	18.70	18.81	18.58	18.41	18.81	19.27	18.70
IV	18.41	18.07	18.01	17.67	18.30	17.84	19.04	17.90
Dippe W.I.								
I	19.27	19.84	20.01	19.84	19.78	19.61	19.49	19.27
II	20.29	20.29	20.06	19.89	19.61	18.81	19.84	19.66
III	20.06	19.84	20.29	19.72	20.12	19.84	20.12	19.95
IV	19.84	19.95	19.49	19.27	19.27	19.04	20.06	19.72
Marsters.								
I	19.72	19.49	19.61	18.87	18.92	18.92	19.84	19.49
II	20.18	19.15	20.18	19.95	19.49	19.84	19.84	19.78
III	19.95	19.49	20.46	19.89	19.84	19.38	20.12	20.29
IV	20.06	19.49	19.72	18.81	19.04	19.32	19.84	18.70
NUMBER OF ROOTS.								
Kleinwanzleben E.								
I	124	131	115	136	134	132	126	120
II	133	161	134	134	156	104	133	147
III	114	130	134	127	101	119	106	107
IV	127	145	109	139	138	132	132	148
Dippe W.I.								
I	145	156	152	124	136	140	137	146
II	147	152	138	138	142	142	145	135
III	139	107	125	140	133	133	125	138
IV	127	147	120	159	148	138	143	140
Marsters.								
I	113	91	123	121	126	103	129	120
II	138	149	139	141	128	144	126	125
III	119	118	127	127	107	102	129	129
IV	127	129	124	127	110	143	142	137

SUMMARY OF RESULTS

YIELDS UNADJUSTED FOR PLANT NUMBER

	O	K	P	N	NK	NP	KP	NKP	*Mean*
ROOTS (washed). Tons per acre									
Kleinwanzleben E.	13.16	13.94	14.09	15.75	14.41	15.25	13.09	14.28	*14.25*
Dippe W. I. . .	11.43	11.28	10.98	14.30	12.70	12.81	11.45	13.22	*12.27*
Marsters . .	11.30	12.34	11.19	12.62	12.60	13.22	11.60	14.91	*12.47*
Mean	*11.96*	*12.52*	*12.08*	*14.22*	*13.24*	*13.76*	*12.05*	*14.14*	*13.00*
Per cent.									
Kleinwanzleben E.	101.2	107.2	108.4	121.2	110.9	117.4	100.7	109.9	*109.6*
Dippe W. I. . .	87.9	86.8	84.4	110.0	97.7	98.6	88.1	101.7	*94.4*
Marsters . .	86.9	94.9	86.1	97.1	96.9	101.7	89.3	114.7	*96.0*
Mean	*92.0*	*96.3*	*93.0*	*109.4*	*101.8*	*105.9*	*92.7*	*108.8*	*100.0*
SUGAR PERCENTAGE									
Kleinwanzleben E.	18.44	18.46	18.55	18.28	18.26	18.17	18.94	18.54	*18.46*
Dippe W. I. . .	19.86	19.98	19.96	19.68	19.70	19.32	19.88	19.65	*19.75*
Marsters . .	19.98	19.40	19.99	19.38	19.32	19.36	19.91	19.56	*19.61*
Mean	*19.43*	*19.28*	*19.50*	*19.11*	*19.09*	*18.95*	*19.58*	*19.25*	*19.27*
Per cent.									
Kleinwanzleben E.	95.6	95.7	96.2	94.8	94.7	94.3	98.3	96.2	*95.7*
Dippe W. I. . .	103.1	103.7	103.6	102.1	102.2	100.3	103.1	101.9	*102.5*
Marsters . .	103.6	100.7	103.7	100.5	100.2	100.5	103.3	101.5	*101.8*
Mean	*100.8*	*100.0*	*101.2*	*99.2*	*99.0*	*98.3*	*101.6*	*99.9*	*100.0*

Standard errors single entry—Roots : 0.664 tons, or 5.11 per cent.
Sugar percentage : 0.149, or 0.773 per cent.

YIELDS ADJUSTED FOR DIFFERENCE IN PLANT NUMBER

ROOTS (Washed)

	O	K	P	N	NK	NP	KP	NKP	*Mean*
Tons per acre.									
Kleinwanzleben E.	13.46	13.44	14.46	15.61	14.36	15.68	13.40	14.31	*14.34*
Dippe W. I. . .	11.04	10.84	10.85	13.88	12.30	12.48	11.15	12.82	*11.92*
Marsters	11.61	12.76	11.32	12.71	13.20	13.59	11.58	15.06	*12.73*
Mean	*12.04*	*12.35*	*12.21*	*14.07*	*13.29*	*13.92*	*12.04*	*14.06*	*13.00*
Per cent.									
Kleinwanzleben E.	103.5	103.4	111.2	120.1	110.4	120.6	103.1	110.1	*110.3*
Dippe W. I. . .	84.9	83.4	83.5	106.8	94.7	96.0	85.8	98.6	*91.7*
Marsters	89.3	98.2	87.1	97.8	101.6	104.6	89.1	115.8	*97.9*
Mean	*92.6*	*95.0*	*93.9*	*108.2*	*102.2*	*107.1*	*92.7*	*108.2*	*100.0*

Standard error of single entry: 0.610 tons, or 4.69 per cent.

MAIN EFFECTS

YIELDS UNADJUSTED FOR PLANT NUMBER

All plots with	Kleinw.	Dippe	Marsters	*Mean*
ROOTS (washed)				
Tons per acre				
No Sulph. Amm.	13.57	11.28	11.61	*12.15*
Sulph. Amm.	14.92	13.26	13.34	*13.84*
No Mur. Pot.	14.56	12.38	12.08	*13.01*
Mur. Pot.	13.93	12.16	12.86	*12.98*
No Super.	14.31	12.43	12.21	*12.98*
Super.	14.18	12.12	12.73	*13.01*
Per cent.				
No Sulph. Amm.	104.4	86.8	89.3	*93.5*
Sulph. Amm.	114.8	102.0	102.6	*106.5*
No Mur. Pot.	112.0	95.2	93.0	*100.1*
Mur. Pot.	107.2	93.6	99.0	*99.9*
No Super.	110.1	95.6	94.0	*99.9*
Super.	109.1	93.2	98.0	*100.1*
SUGAR PERCENTAGE				
Actual				
No. Sulph. Amm.	18.60	19.92	19.82	*19.45*
Sulph. Amm.	18.31	19.59	19.41	*19.10*
No. Mur. Pot	18.36	19.71	19.68	*19.25*
Mur. Pot.	18.55	19.80	19.55	*19.30*
No Super.	18.36	19.80	19.52	*19.23*
Super.	18.55	19.70	19.71	*19.32*
Per cent.				
No Sulph. Amm.	96.5	103.4	102.8	*100.9*
Sulph. Amm.	95.0	101.6	100.7	*99.1*
No Mur. Pot.	95.2	102.2	102.1	*99.8*
Mur. Pot.	96.2	102.7	101.4	*100.1*
No Super.	95.2	102.8	101.3	*99.8*
Super.	96.2	102.2	102.2	*100.2*

Standard error single entry—Roots : 0.332 tons, or 2.55 per cent.
Sugar percentage : 0.074, or 0.386 per cent.

YIELDS ADJUSTED FOR DIFFERENCES OF PLANT NUMBER

ROOTS

All plots with	Klein.	Dippe.	Marsters	*Mean*
Tons per acre (washed)				
No Sulph. Amm.	13.69	10.97	11.82	*12.16*
Sulph. Amm.	14.99	12.87	13.64	*13.83*
No Mur. Pot.	14.80	12.06	12.31	*13.06*
Mur. Pot.	13.88	11.78	13.15	*12.94*
No Super.	14.22	12.02	12.57	*12.94*
Super.	14.46	11.83	12.89	*13.06*
Per cent.				
No Sulph. Amm.	105.3	84.4	90.9	*93.5*
Sulph. Amm.	115.3	99.0	105.0	*106.4*
No Mur. Pot.	113.9	92.8	94.7	*100.5*
Mur. Pot.	106.8	90.6	101.2	*99.5*
No Super.	109.4	92.5	96.7	*99.5*
Super.	111.3	91.0	99.2	*100.5*

Standard error single entry: 0.305 tons, or 2.34 per cent.

CONCLUSIONS

The yield of Kleinwanzleben E is significantly greater (1.88 tons or 14.4 per cent.) than the yield of the other varieties, but the sugar percentage is significantly lower (1.22 or 6.3 per cent.), though not sufficiently so to counteract the increase in yield, the total sugar being increased by 0.203 tons or 8.1 per cent.

There is a large significant increase of yield with nitrogen (1.69 tons or 13.0 per cent.) the effect of which is only slightly reduced by the (significant) depression of the sugar percentage (0.35 or 1.8 per cent.), the total sugar being increased 0.28 tons or 11.2 per cent.

Neither potash nor phosphate shows any significant average effect on yield, but the varieties show a differential response to potash which, however, only becomes significant when the yields are adjusted for variation in plant number—with Kleinwanzleben E there is a depression of yield and with Marsters an increase in the presence of potash.

Dippe W.I. has a significantly higher plant number than the other two varieties, and the differences for the different varieties between the adjusted yields cannot therefore be taken as being necessarily true measures of the varietal differences under field conditions.

SUGAR BEET

VARIETAL TRIAL

EFFECT OF SULPHATE OF AMMONIA, MURIATE OF POTASH AND SUPERPHOSPHATE

(National Institute of Agricultural Botany).

Norfolk Agricultural Station, Sprowston, Norwich, 1932

BLOCK I	A O	C KP	A K	B P	C NK	A NK	B K	B NP	B NPK	A NPK	B O	B N
BLOCK II	A NK	B NP	B P	A KP	C NK	A O	C K	C NPK	B NK	C N	A P	B NPK
BLOCK III	C O	A NK	A NPK	A N	B K	C P	B NPK	C NPK	B P	A KP	B NP	B NK
BLOCK IV	C P	A KP	C NPK	C O	C N	C NP	A NP	A NPK	A O	A K	B NK	C KP

C O	A NP	C NP	B KP	C P	C K	A N	A P	C NPK	A KP	C N	B NK	BLOCK I
C KP	B KP	C P	A K	B O	B N	A N	A NP	C O	C NP	A NPK	B K	BLOCK II
A P	C NK	A O	B O	C K	A NP	B N	B KP	C KP	A K	C N	C NP	BLOCK III
B NP	B O	C NK	A P	B P	A NK	C K	B KP	B K	B NPK	B N	A N	BLOCK IV

The lower half of the plan should in reality be contiguous to and to the right of the upper half.

System of Replication: 4 randomised blocks of 24 plots each.
Area of each Plot: 0.005165 acre.
Soil: Light Loam.
Varieties:
A=Kleinwanzleben E.
B=Dippe W.I.
C=Marsters.
Treatments: Sulphate of ammonia at the rate of 0.6 cwt. N per acre, muriate of potash at the rate of 0.75 cwt. K_2O per acre, and superphosphate at the rate of 0.5 cwt. P_2O_5 per acre.
Manures Applied: May 2nd.
Beet Sown: May 3rd.
Beet Lifted: November 7th-14th.
Previous Crop: Barley.

Actual weights in lb.

Blocks.	O	K	P	N	NK	NP	KP	NKP
ROOTS (washed)								
Kleinwanzleben E.								
I	134	140	133	148	144	135	159	156
II	78	152	132	111	149	165	136	135
III	164	164	155	155	146	153	150	157
IV	142	157	154	140	181	165	164	190
Dippe W.I.								
I	123	123	124	111	118	130	122	134
II	128	90	131	95	130	121	130	138
III	128	140	133	128	155	122	145	163
IV	124	143	122	132	135	145	130	145
Marsters								
I	99	131	127	116	99	115	105	144
II	138	124	129	114	113	143	123	128
III	130	136	136	135	138	129	140	163
IV	128	143	134	148	147	110	137	141
SUGAR PERCENTAGE								
Kleinwanzleben								
I	16.76	17.33	17.04	17.21	16.99	16.19	17.21	16.64
II	15.90	17.21	17.04	16.59	17.04	16.99	16.47	17.38
III	16.82	17.04	17.38	17.16	16.93	16.36	17.16	17.27
IV	17.38	17.84	17.33	17.21	17.61	17.50	17.04	17.50
Dippe W.I.								
I	18.30	17.90	17.44	18.01	17.67	17.78	17.73	17.61
II	17.73	17.73	17.38	17.16	17.61	17.67	17.38	17.38
III	17.78	18.30	18.41	17.50	17.16	17.38	17.61	17.96
IV	18.64	18.58	18.18	18.07	19.10	18.52	18.98	18.24
Marsters								
I	17.50	18.13	17.73	17.44	16.93	17.73	17.78	17.90
II	17.61	17.80*	17.50	17.04	17.16	17.84	17.73	17.56
III	18.35	17.50	18.13	17.21	17.78	17.61	17.50	17.44
IV	18.75	18.98	18.41	17.84	18.07	17.67	19.10	18.41
NUMBER OF ROOTS								
Kleinwanzleben								
I	120	119	92	92	82	90	92	110
II	64	110	91	90	110	92	100	107
III	113	88	98	73	74	104	78	86
IV	92	89	95	105	103	112	114	113
Dippe W.I.								
I	104	121	116	98	96	109	110	108
II	101	118	112	98	106	116	114	98
III	105	102	91	78	100	74	100	113
IV	98	101	101	101	101	115	94	112
Marsters								
I	66	100	94	70	51	82	84	80
II	72	74	96	82	57	82	78	65
III	91	94	74	99	88	90	85	93
IV	105	107	115	111	100	84	103	96

*Estimated

SUMMARY OF RESULTS

YIELDS UNADJUSTED FOR PLANT NUMBER

	O	K	P	N	NK	NP	KP	NKP	*Mean*
ROOTS (washed) **Tons per acre**									
Kleinwanzleben E.	11.19	13.24	12.40	11.97	13.40	13.35	13.16	13.78	*12.81*
Dippe W. I. ..	10.87	10.72	11.02	10.07	11.62	11.19	11.39	12.53	*11.18*
Marsters	10.70	11.54	11.36	11.08	10.74	10.74	10.91	12.44	*11.19*
Mean	*10.92*	*11.83*	*11.60*	*11.04*	*11.92*	*11.76*	*11.82*	*12.92*	*11.73*
Per cent.									
Kleinwanzleben E.	95.4	113.0	105.8	102.1	114.2	113.9	112.2	117.6	*109.3*
Dippe W. I. ..	92.7	91.4	94.0	85.9	99.1	95.4	97.1	106.9	*95.3*
Marsters	91.2	98.4	96.9	94.5	91.6	91.6	93.0	106.1	*95.4*
Mean	*93.1*	*100.9*	*98.9*	*94.2*	*101.6*	*100.3*	*100.8*	*110.2*	*100.0*
SUGAR PERCENTAGE									
Kleinwanzleben E.	16.72	17.36	17.20	17.04	17.14	16.76	16.97	17.20	*17.05*
Dippe W. I. ..	18.11	18.13	17.85	17.68	17.88	17.84	17.92	17.80	*17.90*
Marsters	18.05	*18.10	17.94	17.38	17.48	17.71	18.03	17.83	*17.82*
Mean	*17.63*	*17.86*	*17.66*	*17.37*	*17.50*	*17.44*	*17.64*	*17.61*	*17.59*
Per cent.									
Kleinwanzleben E.	95.0	98.7	97.8	96.9	97.5	95.3	96.5	97.8	*96.9*
Dippe W. I. ..	103.0	103.1	101.5	100.5	101.7	101.4	101.9	101.2	*101.8*
Marsters	102.6	*102.9	102.0	98.8	99.4	100.7	102.5	101.4	*101.3*
Mean	*100.2*	*101.6*	*100.4*	*98.7*	*99.5*	*99.1*	*100.3*	*100.1*	*100.0*

Standard errors single entry—Roots : 0.581 tons, or 5.0 per cent.
Sugar Percentage : 0.168 or 0.957 per cent.

* Sugar percentage of one plot of this treatment estimated.

YIELDS ADJUSTED FOR DIFFERENCE IN PLANT NUMBER

ROOTS (washed)

	O	K	P	N	NK	NP	KP	NKP	*Mean*
Tons per acre									
Kleinwanzleben E.	11.14	13.04	12.46	12.16	13.51	13.22	13.14	13.50	*12.77*
Dippe W. I. ..	10.65	10.21	10.70	10.13	11.45	10.92	11.08	12.12	*10.91*
Marsters	11.11	11.60	11.39	11.26	11.48	11.12	11.19	12.86	*11.50*
Mean	*10.97*	*11.62*	*11.52*	*11.18*	*12.15*	*11.75*	*11.80*	*12.83*	*11.73*
Per cent.									
Kleinwanzleben E.	95.0	111.2	106.2	103.7	115.2	112.7	112.1	115.1	*108.9*
Dippe W. I. ..	90.8	87.0	91.2	86.4	97.6	93.1	94.5	103.3	*93.0*
Marsters	94.7	98.9	97.2	96.0	97.9	94.8	95.4	109.6	*98.1*
Mean	*93.5*	*99.0*	*98.2*	*95.4*	*103.6*	*100.2*	*100.7*	*109.3*	*100.0*

Standard error : 0.538 tons, or 4.6 per cent.

https://doi.org/10.23637/ERADOC-1-64

MAIN EFFECTS

YIELDS UNADJUSTED TO PLANT NUMBER

All plots with	Kleinw.	Dippe	Marsters	*Mean*
ROOTS (washed)				
Tons per acre				
No Sulph. Amm.	12.50	11.00	11.13	*11.54*
Sulph. Amm.	13.13	11.35	11.25	*11.91*
No Mur. Pot.	12.23	10.79	10.97	*11.33*
Mur. Pot.	13.40	11.56	11.41	*12.12*
No Super.	12.45	10.82	11.01	*11.43*
Super.	13.17	11.53	11.36	*12.02*
Per cent.				
No Sulph. Amm.	106.6	93.8	94.9	*98.4*
Sulph. Amm.	111.9	96.8	96.0	*101.6*
No Mur. Pot.	104.3	92.0	93.6	*96.6*
Mur. Pot.	114.2	98.6	97.3	*103.4*
No Super.	106.2	92.3	93.9	*97.5*
Super.	112.4	98.3	96.9	*102.5*
SUGAR PERCENTAGE				
Actual				
No Sulph. Amm.	17.06	18.00	18.03	*17.70*
Sulph. Amm.	17.04	17.80	17.60	*17.48*
No Mur. Pot.	16.93	17.87	17.77	*17.52*
Mur. Pot.	17.17	17.93	17.86	*17.65*
No Super.	17.06	17.95	17.76	*17.59*
Super.	17.03	17.85	17.88	*17.59*
Per cent.				
No Sulph. Amm.	97.0	102.4	102.5	*100.6*
Sulph. Amm.	96.8	101.2	100.1	*99.4*
No Mur. Pot.	96.2	101.6	101.0	*99.6*
Mur. Pot.	97.6	102.0	101.5	*100.4*
No Super.	97.0	102.1	100.9	*100.0*
Super.	96.8	101.5	101.6	*100.0*

Standard error: Roots : 0.291 tons, or 2.5 per cent.
Sugar Percentage : 0.084 or 0.478 per cent.

YIELD ADJUSTED FOR DIFFERENCES OF PLANT NUMBER

ROOTS (washed)

All plots with	Kleinw.	Dippe	Marsters	*Mean*
Tons per acre				
No Sulph. Amm.	12.44	10.66	11.32	*11.47*
Sulph. Amm.	13.10	11.15	11.68	*11.97*
No Mur. Pot.	12.24	10.60	11.22	*11.35*
Mur. Pot.	13.30	11.21	11.78	*12.10*
No Super.	12.46	10.61	11.36	*11.48*
Super.	13.08	11.20	11.64	*11.97*
Per cent.				
No Sulph. Amm.	106.1	90.9	96.6	*97.9*
Sulph. Amm.	111.7	95.1	99.6	*102.1*
No Mur. Pot.	104.4	90.4	95.7	*96.8*
Mur. Pot.	113.4	95.6	100.5	*103.2*
No Super.	106.3	90.5	96.9	*97.9*
Super.	111.5	95.6	99.3	*102.1*

Standard error: 0.269 tons, or 2.3 per cent.

CONCLUSIONS

The yield of Kleinwanzleben is significantly greater than the yield of the other varieties, but the sugar percentage is significantly lower, though not sufficiently so to counteract the increase in yield.

Potash and phosphate both increase the yield significantly. For sugar percentage there is no increase with phosphate and with potash the increase is not quite significant.

The response to nitrogen is significant after allowance has been made for differences of plant number, but nitrogen significantly depresses the sugar percentage.

The magnitudes of these effects are shown in the following table :

	Roots.		*Sugar Percentage.*		*Total Sugar.*	
	tons	per cent.	actual	per cent.	tons	per cent.
Kleinw *minus* other varieties ..	+1.63	+14.0	−0.81	−4.6	+0.194	+9.4
Muriate of Potash	+0.79	+ 6.8	+0.13	+0.7	+0.154	+7.5
Superphosphate	+0.59	+ 5.0	0.00	0.0	+0.104	+5.0
Sulphate of Ammonia	+0.37	+ 3.2	−0.22	−1.3	+0.039	+1.9

Marsters has a significantly lower number of plants than either of the other two varieties, and the differences for the different varieties between the adjusted yields cannot therefore be taken as being necessarily true measures of the varietal differences under field conditions.

There is no evidence that the varieties respond differently to the different manures.

SUGAR BEET

SINGLING TO 7 INCHES AND 12 INCHES.

EFFECT OF SUPERPHOSPHATE AND MURIATE OF POTASH.

R. Starling, Esq., Northfield Farm, Little Downham, Ely, 1932

	I								II								
32	A K	A PK	A O	B P	B O	B K	B PK	A P	B O	A P	B P	A K	B K	A PK	A O	B PK	17
1	A K	B K	A PK	B O	A P	B PK	B P	A O	B O	A K	B PK	A PK	A O	B P	B K	A P	16
	III								IV								

System of Replication: 4 randomised blocks of 8 plots each.
Area of Each Plot: 1/60th acre.
Soil: Medium Fen.
Variety: Marsters.
Treatments: Singling to 7 ins. apart (A) or 12 ins. apart (B); the rows were 19½ ins. apart. Muriate of potash (K) at the rate of 0.75 cwt. K_2O per acre and superphosphate (P) at the rate of 0.5 cwt. P_2O_5 per acre.
Manures Applied: April 11th.
Beet Sown: April 11th.
Beet Lifted: November 22nd.
Previous Crop: Oats.

Actual weights in lb.

	A				B			
	O	P	K	PK	O	P	K	PK
	ROOTS (unwashed)							
I	814	867	827	827	843	761	798	838
II	795	871	860	804	843	841	843	855
III	850	825	780	816	747	843	842	822
IV	826	824	837	854	848	808	772	810
	TOPS*							
I	229	220	253	221	211	197	199	204
II	223	228	241	224	208	199	211	224
III	218	221	247	213	174	217	235	201
IV	233	220	205	247	226	213	219	211
	SUGAR PERCENTAGE							
I	15.73	15.45	15.33	15.39	16.24	16.64	16.36	15.96
II	15.45	16.47	16.19	15.79	16.59	15.56	15.79	15.96
III	15.79	15.96	16.24	15.79	16.02	15.73	15.39	16.02
IV	16.47	15.39	16.02	15.73	16.07	16.64	15.10	15.45

* Tops weighed on quarter area of each plot only.

SUMMARY OF RESULTS

	No Minerals	Super.	Potash	Super. Potash	*Mean*
ROOTS (washed)					
Tons per acre					
Singling to 7 ins. ..	20.48	21.11	20.59	20.57	*20.69*
Singling to 12 ins. ..	20.45	20.27	20.29	20.72	*20.43*
Mean	*20.46*	*20.69*	*20.44*	*20.64*	*20.56*
Per cent.					
Singling to 7 ins. ..	99.6	102.7	100.2	100.1	*100.6*
Singling to 12 ins. ..	99.4	98.6	98.7	100.8	*99.4*
Mean	*99.5*	*100.6*	*99.4*	*100.4*	*100.0*
TOPS					
Tons per acre					
Singling to 7 ins. ..	24.19	23.81	25.34	24.24	*24.40*
Singling to 12 ins. ..	21.94	22.12	23.14	22.50	*22.43*
Mean	*23.06*	*22.97*	*24.24*	*23.37*	*23.41*
Per cent.					
Singling to 7 ins. ..	103.3	101.7	108.2	103.5	*104.2*
Singling to 12 ins. ..	93.7	94.5	98.8	96.1	*95.8*
Mean	*98.5*	*98.1*	*103.5*	*99.8*	*100.0*
SUGAR PERCENTAGE					
Singling to 7 ins. ..	15.86	15.82	15.94	15.68	*15.82*
Singling to 12 ins. ..	16.23	16.14	15.66	15.85	*15.97*
Mean	*16.04*	*15.98*	*15.80*	*15.76*	*15.90*
Per cent.					
Singling to 7 ins. ..	99.7	99.5	100.2	98.6	*99.5*
Singling to 12 ins. ..	102.1	101.5	98.5	99.7	*100.4*
Mean	*100.9*	*100.5*	*99.4*	*99.2*	*100.0*

Standard errors of single entries—Roots: 0.406 tons, or 1.98 per cent.
Tops: 0.807 tons, or 3.45 per cent.
Sugar percentage: 0.224 or 1.41 per cent.

CONCLUSIONS

The narrower spacing gives a significantly higher yield of tops, but not of roots or sugar percentage. There are no significant differences due to nutrients applied.

SUGAR BEET

VARIETAL TRIAL
EFFECT OF MURIATE OF POTASH AND SUPERPHOSPHATE

J. A. Tribe, Esq., Willow Farm, near March, 1932

					I										II		
32	A P	A K	B PK	A PK	A O	B K	B P	B O	B K	A K	A PK	A O	B P	B PK	B O	A P	17
16	A O	A K	A PK	B P	A P	B PK	B K	B O	B P	B PK	B O	A O	A PK	A K	B K	A P	1
						III							IV				

SYSTEM OF REPLICATION : 4 randomised blocks of 8 plots each.
AREA OF EACH PLOT : 1/60th acre.
SOIL : Peaty Fen.
VARIETIES :
A=Kleinwanzleben E.
B=Marsters.
TREATMENTS : Muriate of potash (K) at the rate of 0.75 cwt. K_2O per acre and superphosphate (P) at the rate of 0.5 cwt. P_2O_5 per acre.
MANURES APPLIED : April 12th.
BEET SOWN : April 12th.
LIFTED : December 5-6th.
PREVIOUS CROP : Sugar Beet.

Actual weights in lb.

	Kleinwanzleben E.				Marsters.			
	O	K	P	PK	O	K	P	PK
				ROOTS (unwashed)				
I	524	554	542	505	512	484	506	501
II	473	454	506	497	465	455	503	514
III	517	568	493	564	429	452	458	465
IV	492	467	449	514	432	352	497	496
				TOPS				
I	394	329	354	379	274	282	275	259
II	403	356	463	407	326	244	284	300
III	343	396	374	365	272	269	280	290
IV	422	401	420	396	299	233	264	299
				SUGAR PERCENTAGE				
I	14.48	15.28	14.93	15.68	16.02	16.19	16.19	16.30
II	15.10	14.82	15.10	15.05	15.50	15.85	16.02	15.16
III	15.62	15.05	14.48	15.28	15.22	16.30	15.96	16.59
IV	14.88	14.36	15.16	14.48	16.59	15.79	16.07	15.68

SUMMARY OF RESULTS

	No Minerals	Potash	Super.	Potash, Super.	*Mean*
ROOTS (washed)					
Tons per acre					
Kleinwanzleben . .	12.47	12.70	12.38	12.94	*12.62*
Marsters	11.43	10.83	12.21	12.29	*11.69*
Per cent.					
Kleinwanzleben . .	102.6	104.5	101.8	106.4	*103.8*
Marsters	94.0	89.1	100.4	101.1	*96.2*
TOPS					
Tons per acre					
Kleinwanzleben . .	20.92	19.85	21.58	20.72	*20.76*
Marsters	15.68	13.77	14.77	15.37	*14.90*
Per cent.					
Kleinwanzleben . .	117.3	111.3	121.0	116.2	*116.4*
Marsters	87.9	77.2	82.8	86.2	*83.6*
SUGAR PERCENTAGE					
Tons per acre					
Kleinwanzleben . .	15.02	14.88	14.92	15.12	*14.98*
Marsters	15.83	16.03	16.06	15.93	*15.96*
Per cent.					
Kleinwanzleben . .	97.1	96.1	96.4	97.7	*96.8*
Marsters	102.3	103.6	103.8	103.0	*103.2*

Standard errors of single entries—Roots : 0.426 tons, or 3.64 per cent.
Tops : 0.717 tons, or 4.02 per cent.
Sugar percentage : 0.224 or 1.44 per cent.

MEAN OF BOTH VARIETIES.

	No Super.	Super.	*Mean*
ROOTS (washed) **Tons per acre**			
No Potash	11.95	12.30	*12.12*
Mur. Pot.	11.77	12.61	*12.19*
Mean	*11.86*	*12.45*	*12.16*
Per cent.			
No Potash	98.3	101.1	*99.7*
Mur. Pot.	96.8	103.7	*100.3*
Mean	*97.6*	*102.4*	*100.0*
TOPS **Tons per acre**			
No Potash	18.30	18.17	*18.24*
Mur. Pot.	16.81	18.05	*17.43*
Mean	*17.55*	*18.11*	*17.84*
Per cent.			
No Potash	102.6	101.9	*102.3*
Mur. Pot.	94.2	101.2	*97.7*
Mean	*98.4*	*101.6*	*100.0*
SUGAR PERCENTAGE **Tons per acre**			
No Potash	15.42	15.49	*15.46*
Mur. Pot.	15.46	15.52	*15.49*
Mean	*15.44*	*15.50*	*15.48*
Per cent.			
No Potash	99.6	100.1	*99.8*
Mur. Pot.	99.9	100.2	*100.1*
Mean	*99.8*	*100.2*	*100.0*

Standard error of single entries—Roots : 0.301 tons, or 2.57 per cent.
Tops : 0.507 tons, or 2.84 per cent.
Sugar percentage 0.158 or 1.02 per cent.

CONCLUSIONS

Kleinwanzleben yields significantly higher than Marsters, 0.93 tons or 7.6 per cent. in the case of the roots, and 5.86 tons or 32.8 per cent. in the case of the tops, but this difference is set off by the significantly lower sugar percentage, Kleinwanzleben being 0.98 or 6.4 per cent. less than Marsters.

The roots show a barely significant response to superphosphate, 0.59 tons or 4.8 per cent., the sugar percentage being unaffected (0.06 or 0.4 per cent. increase). Otherwise the mineral manures show no general effects, nor any differential effects on the different varieties.

SUGAR BEET

EFFECT OF SULPHATE OF AMMONIA, MURIATE OF POTASH AND SALT

Messrs. C. S. and G. M. Wilson, Stanway Hall Farm, Colchester, 1932

12 C A 61

0N 2K —	0N 1K —	1N 1K —	— 1N 1K	— 1N 2K	2N 1K —
— 2N 2K	— 2N 0K	1N 0K —	0N 1K —	2N 2K —	— 0N 0K
— 1N 2K	0N 0K —	2N 1K —	0N 2K —	— 2N 0K	— 1N 0K
0N 0K —	0N 2K —	— 2N 2K	— 2N 1K	2N 2K —	— 0N 1K
1N 0K —	— 0N 1K	1N 1K —	1N 0K —	— 0N 0K	1N 1K —
— 2N 1K	— 1N 2K	— 2N 0K	1N 2K —	— 0N 2K	2N 0K —

1 D B 72

In each plot the half receiving no salt is left blank, and the dressing of sulphate of ammonia and muriate of potash applied to the whole plots is indicated by a symbol in the half receiving salt.

SYSTEM OF REPLICATION : 4 randomised blocks, each of 9 plots, split for salt.
AREA OF EACH SUB-PLOT : 1/120th acre.
SOIL : Sandy, on rather solid gravel sub-soil.
VARIETY : Kleinwanzleben E.
TREATMENTS : Sulphate of ammonia (N) at the rate of 0,0.3, and 0.6 cwt. N per acre and muriate of potash (K) at the rate of 0, 0.5 and 1.0 cwt. K_2O per acre. Salt at the rate of 0.85 cwt. per acre. All plots received Superphosphate at the rate of 0.4 cwt. P_2O_5 per acre.
MANURES APPLIED : April 26th.
BEET PLANTED : April 26th.
BEET LIFTED : Nov. 21st.
PREVIOUS CROP : Rye and mustard in turn, ploughed in for green manure.

https://doi.org/10.23637/ERADOC-1-64

Actual weight in lb.

Block.	0N 0K	0N 1K	0N 2K	1N 0K	1N 1K	1N 2K	2N 0K	2N 1K	2N 2K
ROOTS (washed)									
Without Salt									
A ..	81	74	92	95	80	93	101	92	99
B ..	106	85	130	111	111	137	129	98	107
C ..	97	88	78	92	88	98	110	126	88
D ..	71	109	107	83	122	94	111	97	114
With Salt									
A ..	83	84	97	104	79	97	111	98	102
B ..	155	103	120	134	105	152	130	131	127
C ..	92	71	80	99	82	99	106	122	96
D ..	93	100	117	90	135	105	110	98	125
TOPS									
Without Salt									
A ..	95	84	103	116	114	117	123	112	118
B ..	99	83	114	158	137	148	131	126	123
C ..	87	77	85	122	119	120	118	160	123
D ..	64	99	86	107	150	109	141	136	140
With Salt									
A ..	90	99	104	100	115	110	131	126	107
B ..	130	93	99	159	108	179	153	129	139
C ..	85	85	83	136	110	113	113	157	124
D ..	85	95	81	110	146	113	129	131	151
SUGAR PERCENTAGE									
Without Salt									
A ..	16.93	16.84	16.47	16.02	16.99	16.42	16.19	16.99	16.19
B ..	16.42	17.10	16.99	16.19	16.59	16.93	15.62	16.87	16.64
C ..	17.33	17.04	17.38	15.90	15.85	16.13	16.59	16.64	16.59
D ..	17.04	16.87	17.33	16.08	16.07	16.76	15.10	16.53	16.02
With Salt									
A ..	16.99	17.04	16.82	16.76	16.42	16.76	16.42	16.13	16.87
B ..	16.47	17.61	16.76	16.99	17.10	15.90	16.24	16.07	16.53
C ..	17.27	17.04	16.88	16.07	15.62	17.33	16.47	15.62	16.47
D ..	17.12	17.44	17.44	17.16	16.47	15.90	15.62	16.53	15.96

SUMMARY OF RESULTS

		No Potash	Single Potash	Double Potash
	ROOTS (washed) **Tons per acre**			
No Salt	No Sulph. Amm.	4.75	4.77	5.45
	Single Sulph. Amm.	5.10	5.37	5.65
	Double Sulph. Amm.	6.04	5.53	5.46
Salt	No Sulph. Amm.	5.66	4.79	5.54
	Single Sulph. Amm.	5.72	5.37	6.07
	Double Sulph. Amm.	6.12	6.01	6.03
Mean	.. ..	*5.56*	*5.30*	*5.70*
	Per cent.			
No Salt	No Sulph. Amm.	86.0	86.3	98.6
	Single Sulph. Amm.	92.4	97.2	102.3
	Double Sulph. Amm.	109.3	100.1	98.9
Salt	No Sulph. Amm.	102.5	86.8	100.4
	Single Sulph. Amm.	103.5	97.2	109.8
	Double Sulph. Amm.	110.8	108.8	109.1
Mean	.. ..	*100.8*	*96.0*	*103.2*
	TOPS **Tons per acre**			
No Salt	No Sulph. Amm.	4.62	4.59	5.20
	Single Sulph. Amm.	6.74	6.96	6.62
	Double Sulph. Amm.	6.87	7.15	6.75
Salt	No Sulph. Amm.	5.22	4.98	4.92
	Single Sulph. Amm.	6.76	6.41	6.90
	Double Sulph. Amm.	7.04	7.27	6.98
Mean	.. ..	*6.21*	*6.23*	*6.22*
	Per cent.			
No Salt	No Sulph. Amm.	74.3	73.8	83.5
	Single Sulph. Amm.	108.3	111.9	106.3
	Double Sulph. Amm.	110.4	114.9	108.5
Salt	No Sulph. Amm.	84.0	80.1	79.0
	Single Sulph. Amm.	108.7	103.1	110.8
	Double Sulph. Amm.	113.2	116.9	112.2
Mean	.. ..	*99.8*	*100.1*	*100.0*

For standard errors see next page.

SUGAR PERCENTAGE

		No Potash	Single Potash	Double Potash
No Salt	No Sulph. Amm.	16.93	16.96	17.04
	Single Sulph. Amm.	16.05	16.38	16.56
	Double Sulph. Amm.	15.88	16.76	16.36
Salt	No Sulph. Amm.	16.96	17.28	16.98
	Single Sulph. Amm.	16.75	16.40	16.47
	Double Sulph. Amm.	16.19	16.09	16.46
Mean		*16.46*	*16.64*	*16.64*
		Per cent.		
No Salt	No Sulph. Amm.	102.1	102.3	102.8
	Single Sulph. Amm.	96.8	98.7	99.9
	Double Sulph. Amm.	95.7	101.0	98.6
Salt	No Sulph. Amm.	102.3	104.2	102.4
	Single Sulph. Amm.	101.0	98.9	99.3
	Double Sulph. Amm.	97.6	97.0	99.2
Mean		*99.2*	*100.4*	*100.4*

Each yield in the above table is the mean of 4 half plots. The standard errors of the yields of single whole plots (appropriate to comparisons involving potash and nitrogen) and of single half plots (appropriate to the direct effect of salt, and its interactions with potash and nitrogen) are :

Roots (whole plots) :	0.707 tons, or 12.8 per cent.
(half plots) :	0.483 tons, or 8.7 per cent.
Tops (whole plots)	0.824 tons, or 13.2 per cent.
(half plots) :	0.491 tons, or 7.9 per cent.
Sugar percentage (whole plots)	0.352 or 2.12 per cent.
(half plot) :	0.349 or 2.10 per cent.

MEAN OF ALL LEVELS OF POTASH

	ON	1N	2N	*Mean*
ROOTS (washed)				
Tons per acre				
No salt	4.99	5.37	5.68	*5.35*
Salt	5.33	5.72	6.05	*5.70*
Mean	*5.16*	*5.54*	*5.86*	*5.53*
Per cent				
No Salt	90.3	97.3	102.8	*96.8*
Salt	96.6	103.5	109.6	*103.2*
Mean	*93.4*	*100.4*	*106.2*	*100.0*
TOPS				
Tons per acre				
No salt	4.80	6.77	6.92	*6.17*
Salt	5.04	6.69	7.10	*6.27*
Mean	*4.92*	*6.73*	*7.01*	*6.22*
Per cent				
No Salt	77.2	108.8	111.3	*99.1*
Salt	81.0	107.6	114.1	*100.9*
Mean	*79.1*	*108.2*	*112.7*	*100.0*
SUGAR PERCENTAGE (actual)				
No Salt	16.98	16.33	16.33	*16.55*
Salt	17.07	16.54	16.24	*16.62*
Mean	*17.02*	*16.44*	*16.28*	*16.58*
Per cent				
No Salt	102.4	98.5	98.4	*99.8*
Salt	103.0	99.7	97.9	*100.2*
Mean	*102.7*	*99.1*	*98.2*	*100.0*

Standard errors: see first table.

CONCLUSIONS

The small apparent effects of potash, 1.2 per cent. increase per unit application in roots, 0.1 per cent. increase in tops and 0.6 per cent. increase in sugar percentage, are not significant, and there is no indication of interaction with the other nutrients.

The response to sulphate of ammonia is a significant increase in root weight, 6.4 per cent. per unit application, and 16.8 per cent. in top weight, set off by a significant decrease of 2.2 per cent. in the sugar percentage.

The response to salt is a significant increase of 6.4 per cent. in root weight; the increases of 1.8 per cent. in top weight, and of 0.4 per cent. in sugar percentage are not significant.

SUGAR BEET

EFFECT OF INCREASING DRESSINGS OF GROUND CHALK

A. W. Oldershaw, Esq., County Organiser, Tunstall, Suffolk, 1932

	21				25
I	3	1	0	4	2
II	0	2	4	1	3
III	4	3	1	2	0
IV	1	0	2	3	4
V	2	4	3	0	1
	1				5

System of Replication : 5 × 5 Latin square.
Area of Each Plot : 0.0168 acres.
Soil : Acid Sand.
Variety : Kleinwanzleben E.
Treatments : Ground chalk at the rate of 0, 1, 2, 3 and 4 tons per acre.
Manures Applied : January 12th.
Beet Planted : May 12th.
Beet Lifted : November 15th-16th.
Previous Crop : Wheat.

Actual weights in lb.

Row.	0	1	2	3	4
		ROOTS (unwashed)			
I	89	571	710	702	722
II	82	546	668	676	667
III	126	554	575	612	675
IV	53	636	589	573	583
V	52	475	613	586	606
		TOPS *			
I	14	194	229	281	221
II	33	227	218	289	222
III	49	206	183	215	269
IV	16	268	233	214	252
V	24	215	267	272	290
		SUGAR PERCENTAGE			
I	19.27	18.35	18.70	18.58	18.70
II	19.38	18.81	18.92	18.92	18.81
III	18.41	19.15	18.64	18.64	18.92
IV	18.30	18.70	18.92	18.52	18.75
V	18.35	18.58	19.04	18.58	18.75

* Tops weighed on half plots only.

SUMMARY OF RESULTS

	No chalk	1 ton chalk	2 tons chalk	3 tons chalk	4 tons chalk	*Mean*	Standard Error
ROOTS (washed)							
Tons per acre ..	1.82	12.61	14.30	14.27	14.74	*11.55*	0.432
Per cent. ..	15.8	109.2	123.8	123.6	127.6	*100.0*	3.75
TOPS							
Tons per acre ..	1.44	11.79	12.01	13.50	13.32	*10.41*	0.557
Per cent. ..	13.9	113.2	115.3	129.7	127.9	*100.0*	5.35
SUGAR PERCENTAGE							
Actual	18.74	18.72	18.84	18.65	18.79	*18.75*	0.114
Per cent. ..	100.0	99.8	100.5	99.5	100.2	*100.0*	0.61

CONCLUSIONS

A large response to the first dressing of ground chalk ; in the case of the roots there is also a significant response to the second dressing. The sugar percentage does not appear to be affected by chalk.

SUGAR BEET

EFFECT OF MURIATE OF POTASH AND SUPERPHOSPHATE

COMPARISON OF AMMONIUM HUMATE AND SULPHATE OF AMMONIA

A. W. Oldershaw, Esq., County Organiser, Tunstall, Suffolk, 1932 (PS)

	26			50
I	P —	— K	PK —	O —
II	— K	P —	O —	— PK
III	O —	PK —	— P	K —
IV	PK —	O —	K —	— P
	33			57

In each plot the half receiving sulphate of ammonia is left blank, and the dressing of super. and potash applied to the whole plot is indicated by a symbol in the half receiving ammonium humate.

System of Replication : 4 × 4 Latin square, plots split for ammonium humate and sulphate of ammonia.

Area of Each Sub-Plot : .009026 acres.

Soil : Deep sand.

Variety : Kleinwanzleben E.

Treatments : Superphosphate (P) at the rate of 0.5 cwt. P_2O_5 per acre, muriate of potash (K) at the rate of 0.75 cwt. K_2O per acre, ammonium humate at the rate of 0.4 cwt. free N (or 1.12 cwt. total N) per acre and sulphate of ammonia at the rate of 0.4 cwt. total N per acre.

Manures applied : April 19th and 25th.

Beet Planted : May 12th.

Beet Lifted : November 15th.

Previous Crop : Wheat.

Actual weights in lb.

Row.	Ammonium humate.				Sulphate of ammonia.			
	O	K	P	PK	O	K	P	PK
ROOTS (unwashed)								
I	377	417	410	425	357	413	415	402
II	362	397	404	372	368	421	363	378
III	373	357	396	394	387	372	379	398
IV	410	400	410	443	402	406	387	449
TOPS								
I	185	228	252	217	192	209	241	204
II	191	198	192	190	185	216	168	200
III	153	155	201	171	189	175	179	188
IV	207	204	232	207	224	218	194	227
SUGAR PERCENTAGE								
I	19.61	19.32	19.27	19.38	19.38	19.38	19.04	19.84
II	19.38	19.72	18.81	19.49	19.27	19.38	19.27	19.32
III	19.21	19.49	19.32	19.44	19.04	19.84	19.38	19.61
IV	19.32	18.98	19.38	19.61	19.27	19.72	19.61	19.44

https://doi.org/10.23637/ERADOC-1-64

SUMMARY OF RESULTS

	No Minerals	Super.	Mur. Pot.	Super., Mur. Pot.	*Mean*
ROOTS (washed)					
Tons per acre					
Ammonium Humate	16.85	17.94	17.39	18.09	*17.57*
Sulph. Amm.	16.76	17.10	17.85	18.02	*17.43*
Difference A-S	*+0.09*	*+0.84*	*−0.46*	*+0.07*	*+0.14*
Per cent.					
Ammonium Humate	96.3	102.5	99.4	103.4	*100.4*
Sulph. Amm.	95.8	97.7	102.0	102.9	*99.6*
Difference A-S	*+0.5*	*+4.8*	*−2.6*	*+0.5*	*+0.8*
TOPS					
Tons per acre					
Ammonium Humate	9.10	10.84	9.71	9.71	*9.84*
Sulph. Amm.	9.77	9.67	10.11	10.13	*9.92*
Difference A-S	*−0.67*	*+1.17*	*−0.40*	*−0.42*	*−0.08*
Per cent.					
Ammonium Humate	92.1	109.8	98.2	98.2	*99.6*
Sulph. Amm.	98.9	97.9	102.4	102.5	*100.4*
Difference A-S	*−6.8*	*+11.9*	*−4.2*	*−4.3*	*−0.8*
SUGAR PERCENTAGE					
Ammonium Humate	19.38	19.20	19.38	19.48	*19.36*
Sulph. Amm.	19.24	19.32	19.58	19.55	*19.42*
Difference A-S	*+0.14*	*−0.12*	*−0.20*	*−0.07*	*−0.06*
Per cent.					
Ammonium Humate	99.9	99.0	99.9	100.4	*99.8*
Sulph. Amm.	99.2	99.6	101.0	100.8	*100.2*
Difference A-S	*+0.7*	*−0.6*	*−1.1*	*−0.4*	*−0.4*

Standard Errors of differences A-S for separate treatments—	Roots :	0.338 tons or 1.93 per cent.
	Tops :	0.390 tons or 3.95 per cent.
	Sugar percentage :	0.156 or 0.807 per cent.

MEAN OF AMMONIUM HUMATE AND SULPHATE OF AMMOMIA.

	No Super.	Super.	*Mean*
ROOTS (washed)			
Tons per acre			
No Potash	16.81	17.52	*17.16*
Potash	17.62	18.05	*17.84*
Mean	*17.21*	*17.78*	*17.50*
Per cent.			
No Potash	96.0	100.1	*98.0*
Potash	100.7	103.2	*102.0*
Mean	*98.4*	*101.6*	*100.0*
TOPS			
Tons per acre			
No Potash	9.43	10.26	*9.84*
Potash	9.91	9.92	*9.92*
Mean	*9.67*	*10.09*	*9.88*
Per cent.			
No Potash	95.5	103.8	*99.6*
Potash	100.3	100.4	*100.4*
Mean	*97.9*	*102.1*	*100.0*
SUGAR PERCENTAGE			
Tons per acre			
No Potash	19.31	19.26	*19.28*
Potash	19.48	19.52	*19.50*
Mean	*19.40*	*19.39*	*19.39*
Per cent.			
No Potash	99.6	99.3	*99.4*
Potash	100.4	100.7	*100.6*
Mean	*100.0*	*100.0*	*100.0*

Standard Errors of Single Entries. Roots: 0.175 tons, or 1.00 per cent.
Tops: 0.338 tons, or 3.42 per cent.
Sugar percentage: 0.082 or 0.42 per cent.

CONCLUSIONS

For the roots the responses to potash, 0.68 tons or 4.0 per cent., and superphosphate, 0.57 tons or 3.2 per cent., are significant. The potash produces an apparent increase of 0.22 or 1.2 per cent. in the sugar percentage, which, however, is not significant. Superphosphate has shown no effect on the sugar percentage. The increases in the tops with potash and superphosphate are not significant.

There is no significant average difference between ammonium humate and sulphate of ammonia, either for roots, tops, or sugar percentage, though in the case of superphosphate alone the difference is striking.

EXPERIMENTS AT OTHER CENTRES, CARRIED OUT BY THE LOCAL WORKERS ON THE LINES OF THOSE DESCRIBED ON THE PRECEDING PAGES.

Potatoes. County School, Welshpool, Montgomeryshire, 1932.

4×4 Latin Square : Plots 1/160th acre.
Soil : Medium loam (Wenlock shale).
Variety : Great Scot.
Treatments : Slag (Citric solubility 96.5%), rock phosphate and superphosphate at the rate of 1 cwt. P_2O_5 per acre, applied to previous crop.
Basal manuring : Sulphate of potash and sulphate of ammonia each at the rate of 3 cwt. per acre.
Potatoes planted : May 1st. Lifted : Sept. 26th.
Previous crop : Swedes.

	Yield. tons per acre.	Yield. per cent.
No phosphate ..	10.43	96.6
Slag	12.02	111.4
Rock phosphate	10.09	93.5
Superphosphate	10.62	98.5
Mean	*10.79*	*100.0*
Standard Error	0.285	2.64

CONCLUSIONS

The residual effect of basic slag is significant, but rock phosphate and superphosphate do not appear to produce any such effect.

Potatoes. J. E. Arden, Esq., Owmby Cliff, Lincolnshire, 1932.

J. A. McVicar, Esq., County Organiser.

4×4 Latin square : Plots 1/80th acre.
Soil : Limestone. Variety : King Edward.
Basal manuring : 4 cwt. sulphate of ammonia, and 2 cwt. superphosphate per acre.
Potatoes planted : Mar. 24th. Lifted : Oct. 11th.
Previous crop : Seeds.

Sulphate of potash cwt. per acre.	Yield. tons per acre.	Yield. per cent.
None	3.79	69.6
1 cwt.	5.61	102.8
2 cwt.	6.38	117.1
3 cwt.	6.03	110.5
Mean	*5.45*	*100.0*
Standard Error	0.183	3.35

CONCLUSIONS

Definitely significant response to the single dressing of potash, and a further significant response to the double dressing.

Potatoes. J. B. Everatt, Esq., Garthorpe, Lincs., 1932.

J. A. McVicar, Esq., County Organiser.

4×4 Latin square : Plots 1/80th acre.
Soil : Warp. Variety : King Edward.
Basal manuring : Superphosphate and sulphate of ammonia each at the rate of 4 cwt. per acre.
Potatoes planted : Mar. 30th-31st. Lifted : Sept. 29th.
Previous crop : Seeds.

Sulphate of potash cwt. per acre.	Yield. tons per acre.	Yield. per cent.
None	10.84	101.4
1 cwt.	10.64	99.6
2 cwt.	10.94	102.3
3 cwt.	10.33	96.6
Mean	*10.69*	*100.0*
Standard Error	0.103	0.96

CONCLUSIONS

The lower yield of the plots receiving the highest dressing of potash is statistically significant, but the reality of this effect is doubtful as the estimate of error seems abnormally small.

Potatoes. H. W. Gardner, Esq., Hertfordshire Farm Institute, 1932. Farm Department.

5 × 5 Latin square : Plots 1/50th acre.
Soil : Gravelly loam. Variety : King Edward.
Treatments : No artificials, 2⅓ cwt. and 4⅔ cwt. No. 2 concentrated complete fertiliser (I.C.I.) per acre, 4 cwt. and 8 cwt. own mixture per acre.
Analysis of concentrated complete fertiliser, 10.4 per cent. N, 10.4 per cent. P_2O_5, 20.8 per cent. K_2O. Analysis of own mixture, 6.1 per cent. N, 6.2 per cent. P_2O_5, 12.4 per cent. K_2O, in the form of sulphate of ammonia, super., and muriate of potash.
Basal manuring : Dung.
Potatoes planted : April 16th. Lifted : Sept. 28th.
Previous crop : Lucerne.

	Yield. tons per acre.	Yield. per cent.
No artificials	11.94	95.9
Single No. 2. C.C.F. ..	12.69	101.8
Double No. 2. C.C.F. ..	12.44	99.9
Single own mixture ..	12.64	101.4
Double own mixture ..	12.58	101.0
Mean	*12.46*	*100.0*
Standard Error	0.205	1.64

CONCLUSIONS

Significant response to the single dressing of artificials, but no further response to the double dressing. No significant difference between the two mixtures.

Potatoes. H. W. Gardner, Esq., Hertfordshire Farm Institute, 1932. Farm Department.

5 × 5 Latin square : Plots 1/50th acre.
Soil : Gravelly loam. Variety : King Edward.
Treatments : No artificials, 6 cwt. and 12 cwt. own mixture, 8 cwt. organic manure balanced with superphosphate and potash, 6 cwt. concentrated complete fertiliser No. 2. Composition of own mixture : 5 parts sulphate of ammonia, 9 parts superphosphate, 4 parts muriate of potash and 2 parts steamed bone flour. Analysis of own mixture : 5 per cent. N., 6 per cent. soluble phosphoric acid, 3 per cent. insoluble phosphoric acid and 10 per cent. potash. Analysis of concentrated complete fertiliser, 10.4 per cent. N., 10.4 per cent. P_2O_5, 20.8 per cent. K_2O.
Potatoes planted : April 7th. Lifted : Oct. 6th.
Previous crop : Oats.

	Yield. tons per acre.	Yield. per cent.
No artificials ..	10.26	80.0
Single own mixture ..	12.96	101.2
Double own mixture ..	13.33	104.1
Organic manure	13.88	108.3
Concentrated fertiliser No. 2	13.63	106.4
Mean	*12.81*	*100.0*
Standard Error	0.185	1.44

CONCLUSIONS

A significant response to all artificials. The further response to the double dressings of own mixture is not significant. The organic fertiliser is significantly superior to both dressings of own mixture, and the concentrated fertiliser No. 2, to the single dressing. There is no signicant difference between the organic manure and fertiliser No. 2.

Potatoes. Fakenham School, Norfolk, 1932.

4 × 4 Latin square : Plots 1/302nd. acre.
Soil : Sandy loam. Variety : King Edward.
Treatments : Sulphate of potash at the rate of 1.0 cwt. K_2O per acre, superphosphate at the rate of 0.6 cwt. P_2O_5 per acre.
Potatoes planted : May 18th. Lifted : Sept. 30th.
Previous crop : Waste grassland.

CONCLUSIONS

The response to potash is barely significant. No apparent response to superphosphate.

	Yield. tons per acre.	Yield. per cent.
No potash or superphosphate	3.30	98.2
Sulph. of potash	3.57	106.3
Superphosphate	2.76	82.2
Potash and superphosphate	3.81	113.3
Mean	*3.36*	*100.0*
Standard Error	0.271	8.06

Potatoes. Norton New Council School, Doncaster, 1932.

4 × 4 Latin square : Plots 1/306th acre.
Soil : Medium loam. Variety : Majestic.
Treatments : Sulphate of potash at the rate of 1.5 cwt. K_2O per acre before planting (Feb. 16th), at planting (April 18th), and top dressed (June 23rd).
Basal manuring : 3 cwt. sulphate of ammonia, and 4 cwt. superphosphate per acre.
Potatoes planted : April 18th. Lifted : Aug. 26th-Sept. 15th.
Previous crop : Old grass.

CONCLUSIONS

Definitely significant response to potash. No significant differences between the different modes of dressing. The standard error is abnormally high.

	Yield. tons per acre.	Yield. per cent.
No potash . .	6.54	70.1
Potash before planting . .	9.87	105.9
Potash at planting	11.39	122.2
Potash top dressed	9.49	101.8
Mean . .	*9.32*	*100.0*
Standard Error	0.758	8.13

Potatoes. H. Stewart Sandeman, Esq., The Lawes, Kingennie, Angus, 1932.

4 randomised blocks of 8 plots each. Ordinary cultivations (harrowed twice May 11th and 21st, twice grubbed May 21st and June 25th, once hoed June 28th, and earthed up July 6th) and extra cultivations (as ordinary cultivation plus harrowed and earthed up May 24th, grubbing and subsoiling June 8th).

Plots 1/40th acre. Soil: Medium loam. Variety: Kerr's Pink. Basal manuring: 16 tons of dung, 3 cwt. superphosphate, 1½ cwt. bone flour, 2 cwt. sulphate of potash per acre.

Potatoes planted : April 18th. Lifted : Sept. 29th. Previous crop : Spring oats.

	Tons per acre.					Per cent.				
	Sulphate of ammonia				*Mean*	Sulphate of ammonia				*Mean*
	None	1 cwt.	2 cwt.	3 cwt.		None	1 cwt.	2 cwt.	3 cwt.	
Ordinary cultivations	13.93	14.14	14.18	14.55	*14.20*	98.6	100.1	100.3	102.9	*100.5*
Extra cultivations . .	13.24	13.76	14.62	14.64	*14.06*	93.6	97.4	103.4	103.6	*99.5*
Mean	*13.58*	*13.95*	*14.40*	*14.60*	*14.13*	*96.1*	*98.7*	*101.9*	*103.3*	*100.0*

Standard Error of single entry: 0.254 tons or 1.80 per cent.

CONCLUSIONS

Significant response to sulphate of ammonia, with no significant difference from proportionality in response to increasing dressings, though nearly the full effect is reached at the second dressing.

There appears to be no difference between the two types of cultivation when averaged over all levels of sulphate of ammonia, but there is some indication that the heavier cultivation becomes relatively more effective with increasing dressings of sulphate of ammonia. This difference does not, however, quite reach the 5 per cent. level of significance.

Potatoes. F. Richardson, Esq., Sansom Wood Farm, Calverton, Notts., 1932.

K. R. Davis, Esq., County Organiser.

4 × 4 Latin square : Plots 1/40th acre.
Soil : Very light sand, bunter sandstone.
Variety : King Edward.
Treatments : Mineral mixture (2.12 cwt. sulphate of ammonia, 3.98 cwt. 16 per cent. superphosphate and 3.28 cwt. 30 per cent. potash salt per acre), I.C.I. concentrated fertiliser No. 1 (12½ per cent. N., 12½ per cent. P_2O_5, 15 per cent. K_2O), and 10 cwt. H.O.P. No. 9 fish manure.
Basal manuring : 12 loads dung per acre.
Potatoes planted : April 28th. Lifted : Oct. 12th.
Previous crop : Ley grazed and sheep fed.

	tons per acre. Yield.	per cent. Yield.
No artificials	4.42	81.8
Mineral mixture	5.75	106.4
I.C.I. fertiliser No. 1 ..	5.40	99.9
H.O.P. No. 9 fish manure	6.04	111.7
Mean	*5.40*	*100.0*
Standard Error	0.229	4.24

CONCLUSIONS

Significant response to fertilisers. No significant differences between the different mixtures.

Potatoes. J. Heyes, Esq., Bickerstaffe, Ormskirk, 1932.

Lancashire County Council.

4 × 4 Latin Square : Plots 1/57th acre.
Soil : Moss. Variety : Majestic.
Basal manuring : 10-15 tons farmyard manure, 1 cwt. sulphate of ammonia, 2 cwt. sulphate of potash, 10 cwt. ground limestone.
Potatoes planted : April 26th. Lifted, Sept. 15th.
Previous crop : Oats.

Super. cwt. per acre.	Yield. tons per acre.	Yield per cent.
None	10.82	99.7
2 cwt.	10.76	99.2
4 cwt.	11.01	101.5
8 cwt.	10.82	99.7
Mean	*10.85*	*100.0*
Standard Error	0.265	2.44

CONCLUSIONS

No significant effects.

Potatoes. Sailors' Orphan Homes School, Hull, 1932.

4 × 4 Latin square : Plots 1/217th acre.
Soil : Heavy alluvium. Variety : Great Scot.
Treatments : Sulphate of ammonia at the rate of 0.223 cwt. and 0.6 cwt. N per acre, ammonia humate and sulphate of ammonia and humic acid at the rate of 0.6 cwt. total N (0.223 cwt. ammonia N.) per acre.
Potatoes planted : April 14th. Lifted : Sept. 20th and 21st.
Previous crop : Mixed vegetables.

	Yield. tons per acre.	Yield. per cent.
Reduced sulph. amm. ..	11.08	100.8
Full sulph. amm.	11.24	102.3
Ammonium humate ..	10.90	99.2
Sulph. amm. and humic acid	10.75	97.8
Mean	*10.99*	*100.0*
Standard Error	0.456	4.15

CONCLUSIONS

No significant effects.

Potatoes. Grammar School, Burford, Oxon, 1932.

4×4 Latin square : Plots 1/100th acre.
Soil : Brashy loam. Variety : King George.
Treatments : Sulphate of ammonia at the rate of 0.223 cwt. and 0.6 cwt. N. per acre, sulphate of ammonia and humic acid at the rate of 0.6 cwt. total N. (0.223 cwt. ammonia N.) and ammonium humate at the rate of 0.6 cwt. total N. (0.223 cwt. ammonia N.).
Basal manuring : 4 cwt. superphosphate and 3 cwt. sulphate of potash per acre.
Potatoes planted : May 5th. Lifted : Oct. 5th.

	Yield. tons per acre.	Yield. per cent.
Reduced sulph. amm. ..	7.61	94.3
Full sulph. amm.	8.47	105.0
Ammonium humate ..	7.70	95.4
Sulph. amm. and humic acid	8.49	105.2
Mean ..	*8.07*	*100.0*
Standard Error	0.592	7.33

CONCLUSIONS

No significant effects.

Potatoes. County School, Tonbridge, 1932.

4×4 Latin square : Plots 0.0037 acres.
Soil : Clay. Variety : Great Scot.
Treatments : Sulphate of ammonia at the rate of 0.223 cwt. and 0.6 cwt. N. per acre, sulphate of ammonia and humic acid at the rate of 0.6 cwt. total N. (0.223 cwt. ammonia N.), and ammonium humate at the rate of 0.6 cwt. total N. (0.223 cwt. ammonia N.).
Basal manuring : Superphosphate at the rate of 4 cwt. per acre, sulphate of potash at the rate of 3 cwt. per acre.
Potatoes planted : April 26th. Lifted : Sept. 23rd-30th.
Previous crop : Turnips.

	Yield. tons per acre.	Yield. per cent.
Reduced sulph. amm. ..	10.04	100.4
Full sulph. amm.	9.76	97.6
Ammonium humate ..	10.23	102.3
Sulph. amm. and humic acid	9.96	99.6
Mean	*10.00*	*100.0*
Standard Error	0.379	3.79

CONCLUSIONS

The differences between treatments are not significant.

Potatoes. County School, Godalming, Surrey, 1932.

4×4 Latin square. Plots 1/290th acre.
Soil : Sandy. Variety : Arran Chief.
Treatments : Sulphate of ammonia at the rate of 0.223 cwt. and 0.6 cwt. N. per acre, ammonium humate at 0.6 cwt. total N. (0.223 cwt. ammonia N.), sulphate of ammonia and humic acid together providing 0.6 cwt. total N. (0.223 cwt. ammonia N.).
Basal manuring : 3 cwt. sulphate of potash and 4 cwt. superphosphate per acre.
Potatoes planted : April 30th. Lifted : Sept. 17th.
Previous crop : Turnips.

	Yield. tons per acre.	Yield. per cent.
Reduced sulph. amm. ..	10.11	101.0
Full sulph. amm.	10.17	101.6
Amm. humate ..	10.63	106.2
Sulph. amm. and humic acid ..	9.13	91.2
Mean	*10.01*	*100.0*
Standard Error	0.324	3.23

CONCLUSIONS

The differences between treatments are not significant.

Sugar Beet. Mr. W. G. Muir, Cheapside, St. Albans, 1932.
H. W. Gardner, Esq., Hertfordshire Farm Institute.

4×4 Latin square: Plots 1/112th acre.

Soil: Light loamy gravel. Variety: Klein.E.

Treatments: Slag and superphosphate at the rate of 7 cwt. per acre. Chalk at the rate of 3 tons per acre.

Basal manuring: 2 cwt. sulphate of ammonia; 4 cwt. potash salt.

Beet planted: April 29th. Lifted: Oct. 14th.

Previous crop: Winter oats.

	ROOTS (washed)		TOPS	
	tons per acre.	per cent.	tons per acre.	per cent.
No phosphate ..	5.25	76.5	6.34	80.0
Slag	6.58	95.9	7.53	94.9
Superphosphate	6.68	97.3	7.67	96.7
Super. and Chalk	8.94	130.3	10.19	128.4
Mean	*6.86*	*100.0*	*7.93*	*100.0*
Standard Error	0.571	8.33	0.614	7.74

CONCLUSIONS

The increase due to the phosphatic dressings is just significant in the case of the roots, but not significant for the tops. There is no significant difference between slag and superphosphate. The plots receiving chalk in addition to superphosphate give a significantly greater yield than those with superphosphate alone.

Sugar Beet. Mr. W. G. Muir, Cheapside, St. Albans, 1932.
H. W. Gardner, Esq., Hertfordshire Farm Institute.

4 randomised blocks of 9 plots each. Plots 1/56th acre. Soil: Light loamy gravel.

Treatments: Sulphate of ammonia, 0, 1½ and 3 cwt. per acre, muriate of potash 0, 1 and 2 cwt. per acre.

Basal manuring: 4 cwt. superphosphate per acre.

Variety: Kleinwanzleben E. Beet sown: April 29th. Beet lifted: Oct. 17th-18th.

Previous crop: Oats.

	Tons per acre.					Per cent.				
	No Sulph. Amm.	Single Sulph. Amm.	D'ble Sulph. Amm.	*Mean*	Standard Error.	No Sulph. Amm.	Single Sulph. Amm.	D'ble Sulph. Amm.	*Mean*	Standard Error.
ROOTS (washed)										
No muriate of potash	6.34	6.00	6.02	*6.12*	0.307	86.5	82.0	82.3	*83.6*	4.20
Single muriate of potash	7.45	7.36	8.15	*7.65*		101.8	100.6	111.4	*104.6*	
Double muriate of potash	7.57	7.90	9.06	*8.18*		103.5	108.0	123.8	*111.8*	
Mean	*7.12*	*7.09*	*7.75*	*7.31*	*0.177*	*97.3*	*96.9*	*105.8*	*100.0*	*2.42*
TOPS										
No muriate of potash	5.54	5.88	6.23	*5.89*	0.317	91.0	96.6	102.4	*96.7*	5.20
Single muriate of potash	5.62	6.11	6.77	*6.17*		92.4	100.3	111.2	*101.3*	
Double muriate of potash	5.54	5.78	7.33	*6.21*		90.9	94.8	120.4	*102.0*	
Mean	*5.56*	*5.92*	*6.78*	*6.09*	*0.183*	*91.4*	*97.2*	*111.3*	*100.0*	*3.00*
SUGAR PERCENTAGE										
No muriate of potash	18.13	17.87	18.12	*18.04*	0.166	99.0	97.6	99.0	*98.5*	0.910
Single muriate of potash	18.52	18.26	18.45	*18.41*		101.2	99.7	100.8	*100.6*	
Double muriate of potash	18.38	18.68	18.32	*18.46*		100.4	102.0	100.1	*100.8*	
Mean	*18.34*	*18.27*	*18.30*	*18.30*	*0.096*	*100.2*	*99.8*	*100.0*	*100.0*	*0.525*

CONCLUSIONS

The response to sulphate of ammonia is significant both in the roots (0.32 tons or 4.2 per cent. per unit application) and tops (0.61 tons or 10.0 per cent.), with no appreciable reduction in sugar percentage. The smaller response to the first than to the second dressing of sulphate of ammonia, though striking, is not significant.

The response of the roots to muriate of potash, 1.53 tons or 21.0 per cent. to the first dressing and 0.53 tons or 7.2 per cent to the second dressing, is significant, with a significant difference between the responses to the two dressings. Muriate of potash also increases the sugar percentage 0.37 or 2.1 per cent for the first dressing and 0.05 or 0.2 per cent. for the second ; the first increase is significant. The response of the tops to potash is not significant.

In the case of the roots the response to potash is significantly greater in the present of sulphate of ammonia and equally the response to sulphate of ammonia is significantly greater in the presence of potash.

Sugar Beet. County Farm Institute, Moulton, Northampton, 1932.

4 × 4 Latin square. Plots, 0.01870 acres. Soil : Sandy loam derived from Northampton sand.
Variety : Kleinwanzleben E.
Nature of fertiliser mixture used : 5 cwt. sulphate of ammonia, 5 cwt. superphosphate, 2½ cwt. steamed bone flour and 7½ cwt. 30 per cent. potash salt.
Basal manuring : 12 tons farmyard manure.
Beet planted : May 21st. Beet lifted : Nov. 24th-26th. Previous crop : Sugar Beet.

Fertiliser Cwt. per acre	ROOTS (washed)		TOPS		SUGAR PERCENTAGE	
	tons per acre.	per cent.	tons per acre.	per cent.	actual.	per cent.
None ..	9.53	89.7	11.80	83.6	17.27	101.7
5 cwt.	10.84	102.1	13.65	96.7	17.16	101.0
10 cwt.	11.14	104.9	15.25	108.1	16.90	99.5
15 cwt.	10.97	103.3	15.75	111.6	16.61	97.8
Mean ..	*10.62*	*100.0*	*14.11*	*100.0*	*16.98*	*100.0*
Standard Error	0.318	3.0	0.577	4.09	0.206	1.21

CONCLUSIONS

Significant response to fertiliser both by roots and tops. The roots show little additional response to the higher dressings, whereas the tops show a significant additional response to the double dressing. There is a significant depression of sugar percentage with increasing amounts of fertiliser.

Sugar Beet. R. Goodhand, Esq., Redbourne, Kirton-Lindsey, Lincs., 1932. J. A. McVicar, Esq., County Organiser.

5 × 5 Latin square. Plots, 1/50th acre. Soil : Light limestone loam, 8 ins. to 10 ins. deep.
Variety : Kleinwanzleben E.
Analysis of Fertiliser : Sulphate of ammonia providing ammonium nitrogen 3.60 per cent, nitrate of soda providing nitric nitrogen 2.71 per cent, superphosphate providing soluble phosphoric acid 5.15 per cent, steamed bone flour providing insoluble phosphoric acid 1.38 per cent and muriate of potash providing potash 11.25 per cent.
Basal manuring : 7 cwt. fish salt.
Beet planted : April 25th. Beet lifted : Oct. 19th. Previous crop : Oats.

Fertiliser cwt. per acre.	ROOTS (washed)		TOPS		SUGAR PERCENTAGE	
	tons per acre.	per cent.	tons per acre.	per cent.	actual.	per cent.
None ..	13.61	92.8	9.81	75.1	18.27	100.5
4 cwt.	14.64	99.9	11.93	91.3	18.68	102.8
8 cwt.	14.74	100.5	13.54	103.7	18.14	99.8
12 cwt.	15.28	104.3	14.36	109.9	18.19	100.1
16 cwt.	15.02	102.5	15.66	119.9	17.59	96.8
Mean ..	*14.66*	*100.0*	*13.06*	*100.0*	*18.18*	*100.0*
Standard Error	0.242	1.65	0.418	3.20	0.263	1.44

CONCLUSIONS

The roots show a significant response to the single dressing of fertiliser, but no further significant response to the higher dressings. The tops show a significant response to all dressings, there being no significant departure from proportionality. The decrease in sugar percentage is not significant, the error being large.

Sugar Beet. J. C. Mann, Esq., Bridgham, Norfolk, 1932.

4 randomised blocks of 8 plots each. Plots 1/100th acre. Soil : Light blowing sand of Glacial origin, sand and gravel subsoil. Varieties : Marsters and Kleinwanzleben E. Treatments : Sulphate of ammonia at the rate of 0.6 cwt. N per acre, sulphate of potash at the rate of 0.75 cwt. K_2O per acre. Basal manuring : Superphosphate at the rate of 0.5 cwt. P_2O_5 per acre. Beet planted : April 29th. Beet lifted : Nov. 8th-9th. Previous crop : Swedes and Kale folded by sheep.

	Tons per acre.					Per cent.				
	No Arti-ficials.	Sulph. Amm.	Sulph. Pot.	Sulph. Amm., S. Pot.	*Mean.*	No Arti-ficials.	Sulph. Amm.	Sulph. Pot.	Sulph. Amm., S. Pot	*Mean.*
ROOTS (washed)										
Marsters	14.00	13.90	13.54	14.10	*13.89*	96.5	95.9	93.4	97.2	*95.7*
Klein E.	14.50	15.33	15.12	15.52	*15.12*	100.0	105.7	104.3	107.0	*104.3*
TOPS										
Marsters	10.03	12.64	10.74	11.99	*11.35*	77.3	97.4	82.8	92.4	*87.5*
Klein E.	11.98	16.20	13.43	16.78	*14.60*	92.3	124.9	103.5	129.4	*112.5*
SUGAR PERCENTAGE										
Marsters	18.90	18.64	19.24	18.94	*18.93*	102.6	101.2	104.4	102.8	*102.8*
Klein E.	18.30	17.53	18.06	17.75	*17.91*	99.3	95.2	98.0	96.4	*97.2*

Standard errors of single entries : Roots, 0.323 tons or 2.23 per cent.
Tops, 0.707 tons or 5.45 per cent.
Sugar Percentage, 0.135 or 0.731 per cent.

MEAN OF BOTH VARIETIES.

	Tons per acre			Per cent.		
	No Nitrogen.	Sulph. of Amm.	*Mean.*	No Nitrogen.	Sulph. of Amm.	*Mean.*
ROOTS (washed)						
No Sulph. Pot.	14.25	14.61	*14.43*	98.3	100.8	*99.6*
Sulph. Pot.	14.33	14.81	*14.57*	98.8	102.1	*100.4*
Mean	*14.29*	*14.71*	*14.50*	*98.6*	*101.4*	*100.0*
TOPS						
No Sulph. Pot.	11.01	14.42	*12.72*	84.8	111.1	*98.0*
Sulph. Pot.	12.09	14.39	*13.24*	93.2	110.9	*102.0*
Mean	*11.55*	*14.40*	*12.98*	*89.0*	*111.0*	*100.0*
SUGAR PERCENTAGE						
No Sulph. Pot.	18.60	18.08	*18.34*	101.0	98.2	*99.6*
Sulph. Pot.	18.65	18.34	*18.50*	101.2	99.6	*100.4*
Mean	*18.62*	*18.21*	*18.42*	*101.1*	*98.9*	*100.0*

Standard Errors of single entries : Roots, 0.228 tons or 1.58 per cent.
Tops, 0.500 tons or 3.86 per cent.
Sugar Percentage, 0.0952 or 0.517 per cent.

CONCLUSIONS

The yield of roots for Kleinwanzleben is 1.23 tons or 8.6 per cent. greater than for Marsters, the yield of tops 3.25 tons or 25.0 per cent. greater, but the sugar percentage 1.02 or 5.6 per cent. less, all these differences being significant.

The response to nitrogen in the case of the roots, 0.42 tons or 2.9 per cent., is not significant, and there is a significant depression in sugar percentage of 0.41 or 2.2 per cent. The tops show a significantly higher yield, 2.86 tons or 22.0 per cent., with nitrogen.

Potash shows no apparent effects.

https://doi.org/10.23637/ERADOC-1-64

Sugar Beet. W. A. Muddell, Thoroton, Notts., 1932.
K. R. Davis, Esq., County Organiser.

5×5 Latin Square with plots split for nitro-chalk and sulphate of ammonia.
Sub-plots 1/80th acre. Soil : Medium heavy loam on Keuper Marl.
Variety : Kuhn.
Treatments : High soluble slag (citric solubility 96.5 per cent.), low soluble slag (citric solubility 23.0 per cent.), superphosphate and mineral phosphate providing 1.0 cwt. P_2O_5 per acre.
Basal manuring : 15 loads of dung in autumn, 1931.
Beet sown : May 9th. Beet lifted : Oct. 19-21st. Previous crop : Winter oats (with dung).

	No Manure.	Low Soluble Slag.	High Soluble Slag.	Super-phosphate.	Mineral Phos-phate.	*Mean.*	Standard Error.
ROOTS (washed) Tons per acre							
Sulphate of Ammonia ..	9.58	9.71	9.31	9.13	9.39	*9.42*	
Nitro-Chalk	9.02	9.32	9.33	9.03	9.46	*9.23*	
Mean	*9.30*	*9.52*	*9.32*	*9.08*	*9.43*	*9.33*	*0.400*
Difference S—N	*+0.56*	*+0.39*	*−0.02*	*+0.10*	*−0.07*	*+0.19*	*0.612*
Per cent.							
Sulphate of Ammonia ..	102.7	104.2	99.8	97.8	100.6	*101.0*	
Nitro-Chalk	96.6	99.9	100.0	96.9	101.4	*99.0*	
Mean	*99.7*	*102.0*	*99.9*	*97.4*	*101.0*	*100.0*	*4.28*
Difference S—N	*+6.1*	*+4.3*	*−0.2*	*+0.9*	*−0.8*	*+2.0*	*6.56*
TOPS Tons per acre							
Sulphate of Ammonia ..	6.72	6.71	6.19	6.55	6.81	*6.60*	
Nitro-Chalk	7.17	6.44	6.18	6.23	6.50	*6.50*	
Mean	*6.95*	*6.57*	*6.19*	*6.39*	*6.66*	*6.55*	*0.340*
Difference S—N	*−0.45*	*+0.27*	*+0.01*	*+0.32*	*+0.31*	*+0.10*	*0.454*
Per cent.							
Sulphate of Ammonia ..	102.6	102.4	94.5	100.0	104.0	*100.7*	
Nitro-Chalk	109.5	98.2	94.4	95.1	99.2	*99.3*	
Mean	*106.0*	*100.3*	*94.5*	*97.5*	*101.6*	*100.0*	*5.20*
Difference S—N	*−6.9*	*+4.2*	*+0.1*	*+4.9*	*+4.8*	*+1.4*	*6.94*
SUGAR PERCENTAGE Actual							
Mean of Sulphate of Ammonia and Nitro-Chalk ..	*19.09*	*18.70*	*19.15*	*19.25*	*19.24*	*19.09*	*0.184*
Per cent.							
Mean of Sulphate of Ammonia and Nitro-Chalk ..	*100.0*	*98.0*	*100.3*	*100.9*	*100.8*	*100.0*	*0.965*

CONCLUSIONS

No significant effects.

https://doi.org/10.23637/ERADOC-1-64

Sugar Beet. South-Eastern Agricultural College, Wye, Kent, 1932.

5 × 5 Latin square, with plots sub-divided into four for potash, superphosphate, neither or both.
Sub-plots : 1/200th acre. Soil : Silty loam. Variety : Kleinwanzleben E.
Treatments : Nitrate of soda, sulphate of ammonia and ammonium humate (0.148 cwt. ammonium N) at the rate of 0.4 cwt. N per acre, sulphate of ammonia at the rate of 0.148 cwt. N per acre.
Sub-plot treatments : Superphosphate at the rate of 0.5 cwt. P_2O_5 per acre, and muriate of potash at the rate of 0.75 cwt. K_2O per acre.
Beet planted : May 17th. Beet lifted : Oct. 6th. Previous crop : Wheat.

	No Nitrogen.	Reduced dressing Sulph. Amm.	Full dressing Sulph. Amm.	Full dressing Nitrate of Soda.	Ammon. Humate	*Mean*
ROOTS (washed) Tons per acre						
No minerals	12.23	13.08	14.00	13.57	12.91	*13.15*
Muriate of potash ..	11.74	12.08	13.27	14.55	12.81	*12.90*
Superphosphate ..	12.23	12.73	14.07	13.65	12.77	*13.09*
Mur. Pot. and Super. ..	11.94	12.73	14.07	14.19	12.69	*13.12*
Mean	*12.04*	*12.66*	*13.85*	*13.99*	*12.79*	*13.07*
Per cent.						
No minerals	93.6	100.0	107.1	103.8	98.8	*100.7*
Muriate of potash ..	89.9	92.5	101.6	111.4	98.0	*98.7*
Superphosphate ..	93.6	97.4	107.7	104.5	97.7	*100.2*
Mur. Pot. and Super...	91.4	97.4	107.7	108.6	97.2	*100.4*
Mean	*92.1*	*96.8*	*106.0*	*107.1*	*97.9*	*100.0*
TOPS Tons per acre						
No minerals	7.98	8.00	10.16	9.89	8.62	*8.93*
Muriate of Potash ..	7.21	7.78	8.93	10.91	8.39	*8.65*
Superphosphate ..	7.37	8.59	8.84	10.12	8.36	*8.66*
Mur. Pot. and Super...	7.82	8.68	10.50	10.59	8.30	*9.18*
Mean	*7.60*	*8.26*	*9.61*	*10.38*	*8.42*	*8.85*
Per cent.						
No minerals	90.2	90.4	114.8	111.7	97.4	*100.9*
Muriate of potash ..	81.5	87.9	100.8	123.2	94.8	*97.7*
Superphosphate ..	83.3	97.0	99.8	114.4	94.4	*97.8*
Mur. Pot. and Super.	88.3	98.0	118.6	119.6	93.8	*103.7*
Mean	*85.8*	*93.3*	*108.5*	*117.2*	*95.1*	*100.0*
SUGAR PERCENTAGE						
Mean of all sub-treatments	*17.63*	*17.31*	*17.42*	*17.64*	*17.55*	*17.51*
Per cent						
Mean of all sub-treatments	*100.7*	*98.9*	*99.5*	*100.7*	*100.2*	*100.0*

Each single entry in the above table (except sugar percentage) is the mean of 5 sub-plots.

The standard errors of the yields of single whole plots (appropriate to direct comparisons of nitrogenous dressings) and of single quarter plots (appropriate to comparisons involving potash, superphosphate and their interactions with nitrogen) are :

Roots : Whole plots : 0.393 tons or 3.01 per cent. Tops : Whole plots : 0.754 tons or 8.52 per cent.
Sub-plots : 1.13 tons or 8.68 per cent. Sub-plots : 1.08 tons or 12.20 per cent.
Sugar Percentage : Whole plots : 0.273 or 1.56 per cent.

CONCLUSIONS

A significant response to nitrogen, both by the roots and tops, this response being proportional to the amount of free nitrogen. No significant differences between the reduced dressing of sulphate of ammonia and the ammonium humate, nor between the full dressings of sulphate of ammonia and nitrate of soda. No significant effects of potash or superphosphate.

Mangolds. Oakerthorpe, 1932.

G. Limb, Esq., Derbyshire Education Committee.

4 × 4 Latin square. Plots split for dung at the rate of 15 tons per acre. Plots 1/160th acre. Soil : Medium loam—coal measures. Variety : Masterpiece.

Treatments : Sulphate of ammonia at the rate of 6 cwt. per acre and potash salt at the rate of 12 cwt. per acre. Basal manuring : 8 cwt. superphosphate per acre.

Mangolds sown : May 12th. Lifted : Oct. 17th. Previous crop : Oats.

		No Sulph. amm.	Sulph. amm.	*Mean*
ROOTS				
Tons per acre				
Without dung	No potash salt ..	15.54	24.43	*19.98*
	Potash salt ..	18.86	33.45	*26.16*
Mean		*17.20*	*28.94*	*23.07*
With dung	No potash salt ..	25.84	31.48	*28.66*
	Potash salt ..	30.77	36.70	*33.74*
Mean		*28.30*	*34.09*	*31.20*
Per cent.				
Without dung	No potash salt ..	57.3	90.0	*73.6*
	Potash salt ..	69.5	123.3	*96.4*
Mean		*63.4*	*106.6*	*85.0*
With dung	No potash salt ..	95.2	116.0	*105.6*
	Potash salt ..	113.4	135.2	*124.3*
Mean		*104.3*	*125.6*	*115.0*
TOPS				
Tons per acre				
Without dung	No potash salt ..	3.98	5.43	*4.70*
	Potash salt ..	5.21	7.57	*6.39*
Mean		*4.60*	*6.50*	*5.54*
With dung	No potash salt ..	5.59	7.05	*6.32*
	Potash salt ..	6.98	8.91	*7.94*
Mean		*6.28*	*7.98*	*7.13*
Per cent.				
Without dung	No potash salt ..	62.8	85.6	*74.2*
	Potash salt ..	82.2	119.3	*100.8*
Mean		*72.5*	*102.6*	*87.5*
With dung	No potash salt ..	88.1	111.2	*99.6*
	Potash salt ..	110.1	140.5	*125.3*
Mean		*99.1*	*125.8*	*112.4*

Each single entry in the above table is the mean of 4 sub-plots.

The standard errors of the yields of single whole plots (appropriate to direct comparisons of nitrogen and potash) and of single half plots (appropriate to comparisons involving dung and its interactions with nitrogen and potash) are :

Roots : Single whole plots, 0.704 tons or 2.6 per cent.
Single half plots, 1.38 tons or 5.1 per cent.
Tops : Single whole plots, 0.165 tons or 2.6 per cent.
Single half plots, 0.369 tons or 5.8 per cent.

https://doi.org/10.23637/ERADOC-1-64

CONCLUSIONS

The roots show significant responses to sulphate of ammonia, potash salt, and dung, the response to sulphate of ammonia being significantly less in the presence of dung, and significantly greater in the presence of potash. This last effect only occurs in the absence of dung. The effects on the tops are similar, with the exception that dung produces no significant changes in the responses to the artificials.

Mangolds. South-Eastern Agricultural College, Wye, Kent, 1932

5 × 5 Latin square. Plots, 1/50th acre.
Soil : Silty loam. Variety : Golden Tankard.
Treatments : No nitrogen, sulphate of ammonia at the rate of 0.148 cwt. and 0.4 cwt. N. per acre, ammonium humate and humic acid at the rate of 0.4 cwt. total N. (0.148 cwt. ammonia N.).
Basal manuring : 12 tons farmyard manure, 4 cwt. superphosphate, and 2 cwt. muriate of potash
Mangolds sown : April 30th. Lifted : Oct. 11th.
Previous crop : Wheat.

	Yield. tons per acre.	Yield. per cent.
No nitrogen	13.68	79.5
Reduced sulph. amm.	17.32	100.6
Full sulph. amm. . .	20.87	121.3
Ammonium humate	18.59	108.0
Humic acid . .	15.58	90.5
Mean	*17.21*	*100.0*
Standard error . .	0.485	2.82

CONCLUSIONS

Significant differences between all treatments except the reduced dressing of sulphate ammonia and ammonium humate.

Mangolds. County School, Welshpool, Montgomeryshire, 1932.

3 randomised blocks of 4 plots each. Plots, 1/200th acre. Soil : Medium loam (Wenlock Shale).

Treatments : Sulphate of ammonia at the rate of 0.22 cwt. and 0.6 cwt. N. per acre, ammonium humate at the rate of 0.6 cwt. total N. (0.22 cwt. ammonia N.), sulphate of ammonia and humic acid at the rate of 0.6 cwt. total N. (0.22 cwt. ammonia N.).

Previous crop : Potatoes.

	ROOTS		TOPS	
	tons per acre.	per cent.	tons per acre.	per cent.
Reduced sulph. amm.	12.86	94.9	5.65	104.7
Full sulph. amm. . .	15.60	115.1	6.19	114.6
Ammonium humate	13.54	99.9	5.24	97.0
S/amm. & humic acid	12.20	90.1	4.52	83.7
Mean	*13.55*	*100.0*	*5.40*	*100.0*
Standard Error . .	0.584	4.31	0.191	3.54

CONCLUSIONS

Significantly greater response to the full dressing of sulphate of ammonia than to the other treatments, and in the case of the tops only a significantly lower response to the humic acid combination than to all other treatments.

Meadow hay. 2nd Season. Lady Manner's School, Bakewell, 1932.

5 × 5 Latin square. Plots: 1/198th acre.
Soil : Limestone.
Treatments : Rock phosphate, low soluble slag (citric solubility 23.0 per cent), high soluble slag (citric solubility 96.5 per cent.), and superphosphate all providing 1 cwt. P_2O_5 per acre.
Hay cut : July 5th.

	Yield, dry matter. cwt. per acre.	Yield, per cent.
No phosphate	29.4	92.7
Rock Phosphate	30.5	96.3
Low soluble slag	30.0	94.7
High soluble slag	36.9	116.4
Superphosphate	31.6	99.8
Mean	*31.7*	*100.0*
Standard Error	1.76	5.54

CONCLUSIONS

The response to treatments is not significant.

Meadow hay. 2nd Season. Lady Manner's School, Bakewell, 1932.

3 randomised blocks of 8 plots each. Plots : 1/161th acre. Soil : Limestone.
Treatments : 2 cwt. nitrate of soda , 3 cwt. superphosphate, and 2 cwt. kainit per acre.
Hay cut : June 21st.

		Cwt. per acre.			Per cent.		
		No nitrate of soda.	Nitrate of soda.	*Mean*	No nitrate of soda.	Nitrate of soda.	*Mean*
No Kainit	No super. ..	47.1	60.4	*53.8*	86.2	110.5	*98.4*
	Super. ..	42.0	61.4	*51.7*	77.0	112.5	*94.8*
	Mean ..	*44.6*	*60.9*	*52.8*	*81.6*	*111.5*	*96.6*
Kainit.	No super. ..	39.4	64.3	*51.8*	72.1	117.7	*94.9*
	Super. ..	45.9	76.5	*61.2*	84.0	140.1	*112.0*
	Mean ..	*42.6*	*70.4*	*56.5*	*78.0*	*128.9*	*103.4*
Mean of Kainit and No Kainit ..		*43.6*	*65.6*	*54.6*	*79.8*	*120.2*	*100.0*

Standard error of single entry: 3.76 cwt. or 6.89 per cent.

CONCLUSIONS

Definitely significant response to nitrogen. The average responses to phosphate and kainit are not significant, but the response to nitrogen in the presence of kainit is significantly higher than in the absence of kainit. The response to superphosphate in the presence of kainit is barely significant.

Meadow hay. Lady Manner's School, Bakewell, 1932

3 randomised blocks of 9 plots each.
Plots, 1/216th acre.
Treatments : 8 tons compost, 2 cwt. nitrate of soda, 3 cwt. superphosphate and 2 cwt. kainit per acre.
Hay cut : June 28th.

CONCLUSIONS

The effect of manures is definitely significant. The difference between artificials and compost does not reach the 5 per cent. level of significance.

	Yield, cwt. per acre.	Yield, per cent.
None	33.0	75.3
Nit. Soda, Super, kainit	51.7	117.9
Compost	46.8	106.8
Mean	*43.8*	*100.0*
Standard Error ..	1.94	4.42

Meadow hay. Haileybury College Farm, 1932.
H. W. Gardner, Esq., Hertfordshire Farm Institute.

5×5 Latin square. Plots 1/50th acre.
Treatments : Top dressings of nitro-chalk, sulphate of ammonia, cyanamide and nitrate of soda equivalent to 1½ cwt. per acre of sulphate of ammonia.
Hay cut : June 25th.

CONCLUSIONS

Definitely significant response to nitrogen. No significant differences between the different kinds of nitrogen.

	Yield, cwt. per acre.	Yield, per cent.
None	38.8	83.7
Cyanamide	43.6	94.1
Nitro-chalk	49.3	106.5
Sulphate of ammonia	52.0	112.4
Nitrate of Soda ..	47.8	103.2
Mean	*46.3*	*100.0*
Standard Error ..	2.15	4.65

Kale. Midland Agricultural College, Loughborough, 1932.

4 randomised blocks of 6 plots each. Plots 1/50th acre. Soil : Light loam.
Variety : Marrow stemmed.
Treatments : Nitro-chalk at the rate of 0, 2 and 4 cwt. per acre, applied as top-dressing. Kale thinned (12 ins.) and unthinned (4 ins.).
Basal manuring : 12 tons farmyard manure, 8 cwt. slag. and 1 cwt. muriate of potash per acre.
Kale planted : April 12th. Cut : Mid-end Sept. Previous crop : Spring Oats.

	Tons per acre (fresh material)				**Per Cent**			
	No Nitro-chalk.	Single Nitro-chalk.	Double Nitro-chalk.	*Mean*	No Nitro-chalk.	Single Nitro-chalk.	Double Nitro-chalk.	*Mean*
Not thinned ..	23.44	25.00	27.03	*25.16*	95.3	101.7	110.0	*102.3*
Thinned ..	22.19	23.75	26.09	*24.01*	90.2	96.6	106.1	*97.6*
Mean	*22.81*	*24.38*	*26.56*	*24.58*	*92.8*	*99.2*	*108.0*	*100.0*

Standard error of single entry: 0.809 tons or 3.29 per cent.

CONCLUSIONS

Nitro-chalk produces a significant response, there being no significant deviation from proportionality in response to single and double dressings.

The lower yield of the thinned, as compared with the unthinned plots, is not significant.

Tomatoes. Hertfordshire Farm Institute, 1932, Horticultural Dept.

8 randomised blocks of 4 plots each.
Plots 0.00386 acres. Plants per plot 129, plants weighed 86 (guard rows discarded).
Variety : E.S.I.
Treatments applied in 11 top dressings.
Top dressings providing N at the rate of 4.2 cwt., sol. P_2O_5 at the rate of 5.8 cwt., insol. P_2O_5 at the rate of 2.2 cwt., and K_2O at the rate of 8.0 cwt. per acre.
Basal manuring : 20 tons dung, ½ ton sulphate of potash, ½ ton lime, 2½ cwt. super., and 2½ cwt. steamed bone flour per acre.

	Yield. tons per acre.	Yield. per cent.
Dried blood	54.93	99.8
Hoofs and horns	55.07	100.0
Sulphate of ammonia	54.14	98.3
Fish meal	56.12	101.9
Mean	*55.06*	*100.0*
Standard Error	0.879	1.60

CONCLUSIONS

No significant differences between the various kinds of nitrogenous fertiliser.

Apples. G. Ogilvie, Esq. Cox's, Harpenden, Herts, 1932.

Experiment on the effect of manuring on the production of shoots from root stocks.

8 × 8 Latin square. 3 root stocks per plot. Soil : Clay with flints. Variety : E. Malling No. IX.
Treatments : Sulphate of ammonia and sulphate of potash at the rate of 3 cwt. per acre and superphosphate at the rate of 4 cwt. per acre, applied June 15th.

Pence per root stock.	No treatment.	Sul. Amm.	Super.	Sul. Pot.	S/Am. Super.	S/Am. S/Pot.	Super. S/Pot.	S/Am. Super. S/Pot.	*Mean.*	Stand. Error.
Total value of shoots	14.42	13.67	16.38	14.17	13.92	15.62	14.58	14.42	*14.65*	1.04
Value of roots to shoots	0.79	0.67	1.33	1.21	0.75	1.04	0.92	0.71	*0.92*	0.133

CONCLUSIONS

There is no indication that manuring affects the value of the shoots, except in so far as this is dependent on their roots, but the variability is so great that only large effects would be detectable.

The value of the roots to the shoots is significantly decreased by the application of nitrogen. Phosphate and potash produce no general effects but are significantly less favourable together than when applied separately.

Lawes Agricultural Trust

(*JANUARY—DECEMBER, 1932.*)

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https://doi.org/10.23637/ERADOC-1-64