Change and Innovation in NORFOLK FARMING

Professor Sir Joseph Hutchinson and A C Owers





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Portrait drawing of Lord Hastings as a young man

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Seventy Years of Experiment and Advice at the Norfolk Agricultural Station

Michaelmas 1908 to Michaelmas 1978

By
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With a Foreword by

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President of the Norfolk Agricultural Station

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Foreword

by Sir Edmund Bacon, Bart. K.G., K.B.E., T.D., J.P.
President of the Norfolk Agricultural Station

Anyone who has been connected with or benefited from the Norfolk Agricultural Station must be extremely grateful to Sir Joseph Hutchinson for the way in which he has dealt with the history of the Station from the date of its inception at Jex Farm, Little Snoring in 1908 until the present day. This history deals widely and factually with the story of what is in many ways a unique agricultural venture. It has involved much research into Executive Committee minutes, detailed reports of 70 years of experimental work and a host of other documents. It explains how the germ of the idea sprang from the Norfolk Chamber of Agriculture during the acute agricultural depression of the 1880's following Mr. Gladstone's refusal to allow the State in any way to become involved in any form with its alleviation.

Above all, however, it sets out the ways in which the pattern of agriculture has been transformed in Norfolk from the days of the ewe flock with its folded roots and its one year ley to the cash cropping that we know and practice today. The Norfolk four course shift had served the County well for many decades. Its modification was resisted strongly in many quarters by those who genuinely thought that fertility could not be maintained without the golden hoof. The history relates the arrival of the Sugar Beet and the vital part the Station played in its establishment.

Throughout the narrative two things seem to stand out. Firstly the very close connection that has existed between the Station and Cambridge University. In the very beginning it was Professor T. B. Wood on whom the Executive Committee relied so much. He was followed in the 1940's and 50's by the great animal geneticist Sir John Hammond. Today we are fortunate to have as members of the Executive Committee both the author of this history, Drapers' Professor Emeritus, and Dr. Bell formerly Director of the Plant Breeding Institute. The Station owes much to the School of Agriculture for any success it has achieved. Secondly, throughout its seventy years it has been superbly served by its Directors and their staffs. The influence particularly of Dr. Frank Rayns has not been confined to Norfolk farming alone, it has been felt nation wide. We in Norfolk take, I hope, a modest pride in the fact that over the centuries some of our agricultural practices have proved of benefit to others outside the confines of our own County. In the mini agricultural revolution that started in the depression of the 1930's and continued after the end of the World War, the Station, I believe, has played a remarkable part. It would not be unjust to link the name of Frank Rayns with Coke and Townshend as one of the Great Improvers.

Finally, the Station could not have been in the position that it stands today, bearing in mind that it has to rely on profitable farming for a substantial part of it's income, without the support of persons and institutions with kindred interests. These are acknowledged later, but it is appropriate here to record the appreciation of the Committee and Members for the wide ranging support and collaboration that the Station has enjoyed throughout its history.

Introduction

by J. B. Hutchinson

History is a backward look. The immediate looms very large. The recent is rather less prominent. "Before the war" is distant. "Before the first war" is remote. And "Before the turn of the century" is beyond the limit, even of an old man's memory. I have tried to bring this whole period into perspective, so that we may see how yesterday's history influenced what we do today and plan for tomorrow.

I have planned first a narrative, tracing the growth of the Norfolk Agricultural Station from its origins before the turn of the century to the present day; from scattered plots to Jex Farm, Middle Farm, Church and Oak Lodge Farms, and so to Morley Manor; from simple demonstrations to sophisticated trials, statistically designed and computer analysed.

Having so set the stage, I set out to report on the main experimental themes that run through the Station's programme over the years. In this section particularly, I needed help. I was not in this country during the greater part of the period of the Station's history when Rayns was Director and worked on Church Farm. It soon became evident to me that I must seek the collaboration of Rayns' successor as Director, A.C. Owers. I had the time, and the information was within his own experience, and we worked together on that basis. As I was preparing the final draft for discussion with him, I heard of his sudden death. The Station has lost an able experimental scientist who, though he had retired, still had much to give. I have lost a collaborator and a friend.

This apportionment of the subject results in a narrative that covers most of the Station's early activities and little of its recent work, and an account of experimental topics that is heavily weighted with the work of recent years. Neither is balanced by itself, but together they build up a coherent view of the Station's past. Finally I have written an appraisal; a chapter in which I have set out my own assessment of the achievement of the Norfolk Agricultural Station, and of its place in the development of Norfolk farming.

Part 1

Narrative

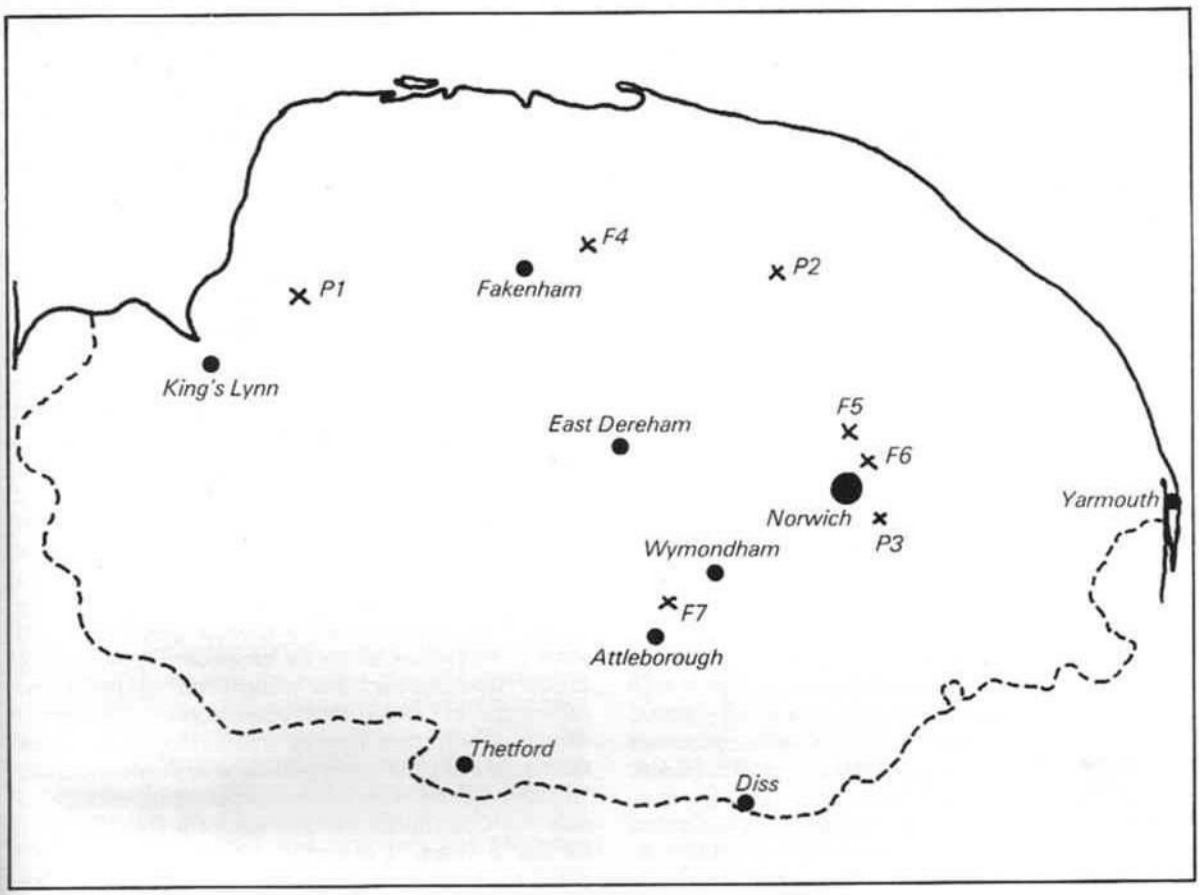
by J. B. Hutchinson

The Beginning

The idea of experimental work for the benefit of Norfolk agriculture was conceived by the Norfolk Chamber of Agriculture and Farmers' Club in the 1880s. It was a time of agricultural depression, and the annual reports record resolutions condemning the systems of local taxation as "unjust and oppressive", protesting against the restrictions imposed on movements of fat stock on account of Foot and Mouth disease while the precautions against introduction of the disease from abroad were inadequate, and arguing that the structure of railway rates was such as to favour imports against home grown farm produce. There had been a Royal Commission on agriculture, and in January 1883 the Chamber passed a resolution approving the recommendations of the Royal Commissioners and respectfully requesting Her Majesty's Government "to legislate on these questions with the least possible delay". Her Majesty's Government showed no sign of responding to this request, and in December 1884 the Chamber returned to the charge with a resolution "That the Norfolk Chamber of Agriculture, believing that the long continued depression in Agriculture affects all other industries, desires that a Committee of the two Houses should enquire into the cause of the distress, and recommend such practical remedies as may be found advisable." This evoked a prompt response. On Mr. Gladstone's instructions a letter was sent a week later in reply. It concluded: "Mr. Gladstone cannot hold out hope that an enquiry into Agricultural distress such as is advocated by the Chamber will commend itself to Her Majesty's present advisers, unless it can be shown that it would not do mischief to the cultivators of the soil by encouraging expectations not likely to be realised."

It was in these circumstances of continuing agricultural depression, and the plainest evidence that the State could not or would not do anything to alleviate it, that the Norfolk Chamber began to consider what they could do to help themselves. In December 1883, following an address by Mr. J. C. Buckmaster, of the Science and Art Department of the Committee of Council on Education, the Council resolved "That in the opinion of this meeting it is most desirable that the opportunities which have been provided by the Government for instruction in Science in the manufacturing towns should be extended to Agricultural Districts, and the School Managers, and others interested in Agriculture, are invited to use their influence in establishing classes for teaching the Science of Agriculture." In October of the following year, two months before the second approach to Whitehall on the agricultural depression, Mr. F. J. Cooke of Flitcham Abbey read a paper on Artificial Manures and Feeding Stuffs, "and he concluded by strongly advocating the establishment of stations throughout the country where Agricultural experiments of a thoroughly practical character could be carefully and accurately carried out."

Mr. Cooke addressed the Annual General Meeting of the Chamber in December 1884. He proposed "the formation of an Experimental Committee, the establishment of Experimental Stations in different parts of the County, the securing of the services of a competent Chemist possessing some knowledge of Agriculture who would determine upon the work to be done, and the appointment of a Farm Bailiff to help to see that such work was



Map 1. Sketch map of Norfolk: sites of early experimental plots and of successive Agricultural Station farms

Experimental Plots
1886 et seq
P.1. Flitcham Abbey (F.T. Cooke)
P.2. Aylsham (B.B. Sapwell)
P.3. Whitlingham (Garrett Taylor)

Station Farms
F4. Jex Farm, Little Snoring
F5. Middle Farm, Newton St. Faith's
F6. Church and Oak Lodge Farms, Sprowston
F7. Manor Farm, Morley

properly carried out." Mr. Cooke made it clear that to establish special Experimental Stations would be very expensive, and proposed that members of the Chamber should be invited to make available "small fields of good and clean cultivation on which the various experiments could be carried out." They would be expected to carry normal cultivation costs, but experimental costs were to be met from a fund raised for the purpose. It is significant that Norfolk men were from the beginning under no illusion as to the expense of an experimental programme. The costly nature of their undertaking was to be emphasised from time to time in the years that followed, but the sponsors of the venture had the satisfaction of knowing that they had entered upon it with full knowledge of what they were about.

A committee of nine members was set up to ascertain what support there would be for the venture. They met on three occasions and reported that promises of support had only reached £150,

"an amount considerably short of what they considered necessary for a satisfactory start." They proposed to continue their efforts, and to hold meetings in the spring of 1885 at which papers on Agricultural Experiments would be read.

In the report of the Council for the following year (1886), negotiations with the Royal Agricultural Society of England (RASE) were recorded. In January Dr. Voelcker, "the well-known Chemist to the Royal Society", gave an address in Norwich. A joint venture with the RASE was proposed; "But a responsible person to superintend the experiments, and possessing certain knowledge was a *sine qua non.*" The matter was referred to the Chamber's Committee, who were given power to act.

The Committee arranged for experiments to be carried out on land made available to them (by members of the Committee) at Whitlingham, Flitcham and Aylsham, and engaged a "competent person" to supervise the work. Attached to the report of the Council are a report on the experiments, a list of subscribers to the experiments fund, and a statement of the accounts of the fund. Thirty-two subscribers put up £208.10.6d. A fee of £30 was paid to the Superintendent (Thos. W. Farrow; the "competent person"). Experimental expenses and other costs amounted to £62.12.2d; £115.18.4d was carried forward.

In the twenty-first annual report of the Council (for the year 1887) there is an account of a discussion on the report of the Experiments Committee on experiments in 1886, and this is followed by a report on the experiments in 1887 and a statement of the accounts of the Agricultural Experiments Fund for 1887. The Superintendent's fee was raised to £50. Experimental and other costs amounted to £64.14.10d. The Council's report concludes: "Thanks to the three gentlemen of the Committee — Messrs. F. J. Cooke, Garrett Taylor, and B. B. Sapwell — on whose farms the agricultural experiments were carried out, the expenses have again been kept down to the minimum, so that they have been able to refrain, up to the present, from asking the various subscribers for the further donations to the funds which they had so liberally promised."

The experimental work of the Norfolk Chamber of Agriculture was carried on until about 1905, and was then continued under the control of the Department of Agriculture in the University of Cambridge. Professor T. B. Wood, of the Department of Agriculture in Cambridge (Drapers' Professor from 1907 to 1929), had taken an active part in these developments from the beginning. The part played by trained scientists, and in particular by those on the Cambridge staff, had steadily increased, and by 1905 the change in control was little more than nominal. However the time was ripe for further change and development, and for the establishment of a more ambitious organisation.

Jex Farm, Little Snoring

In September 1907 Mr. Sancroft Holmes of Gawdy Hall, after discussion with a group of like-minded agriculturists, circulated a letter to landowners and tenant farmers inviting support for a proposal to establish "an Agricultural Bureau and Experimental Farm in Norfolk, the idea being to provide in some central situation a farm of, say, 200 acres, where the best and most practical methods of husbandry could be demonstrated, and where expert and scientific information would be available for all concerned in the cultivation of the land." It was "proposed to run the farm on business principles with a view to making a profit, the experimental plots being on such a moderate scale as to involve little, if any, loss." Nevertheless, the recognition of their predecessors in 1885 that educational and experimental work costs money that is not likely to be recouped out of farming profits, was acknowledged. "If some person can be found generous enough to give the Committee the free use of a suitable farm, for say 5 years, it would greatly simplify matters"; and "It is intended to ask the Education Committee to give an annual subsidy in recognition of the educational advantages which the farm will provide." Mr. Sancroft Holmes concluded that it would be necessary to raise by subscription £1000 and to negotiate a loan of £1500 or £2000, and he invited his correspondents to say whether they approved the scheme, and if so what subscription they would be prepared to make.

Having had a favourable response to the letter, a small committee met under Mr. F. Sancroft Holmes (Chairman), and J. B. Forrester (Hon. Secretary),* at the Norwich Shire Hall on January 30th 1908. At Mr. Sancroft Holmes' request, Professor T. B. Wood of Cambridge set out a proposal for the establishment of a demonstration farm. He argued that a farm "concerned in putting into actual practice on

* J. B. Forrester; Land and Estate Agent of 32 Prince of Wales Road, Norwich, became Hon. Secretary of the Norfolk Chamber of Agriculture in 1881 and held the post for forty years.

the farming scale the latest discoveries of the Experimental Stations", could be run at very little expense, and might well pay its way. The farm should be under the management of a "thoroughly practical farmer with a good all-round grounding in the science bearing on Agriculture." The committee gave general approval to Professor Wood's scheme, adding to it in discussion the hope that the local experiments that were then going on would be continued, and the opinion that the single expert at the farm would need the help of the staff at Cambridge if he was to meet the wide-ranging needs of Norfolk farmers. Bearing in mind the choice of Morley when it became necessary to move from Sprowston, it is of interest that Professor Wood suggested that the neighbourhood of Wymondham would be a suitable place for the farm.

After discussion at a further meeting, a Scheme for the Establishment of an Agricultural Station in Norfolk, based on Professor Wood's proposals, was printed and circulated. In this it was proposed that:

The farm should be a demonstration farm rather than an experimental station. Capital to the extent of £10 to £12 per acre for equipment and stock plus say £200 for demonstration extras (threshing machine and weighbridge) would be raised by voluntary subscription. (£350 had already been promised). An income of £300 outside the farming enterprise would be required for the Manager's salary (£200 per year) and expenses. The Manager should be a farmer with a good grounding in general science. It was hoped that the County Council would make a grant of £300 per annum.

The farm was to be undertaken for a limited period of 8 years, and would not be continued thereafter unless it had been successful. Local experiments should be continued, the Manager assisting in supervision.

The farm should be under the control of a committee. Norfolk farmers and others interested could visit the farm.

The scheme was discussed at a public meeting held at the Agricultural Hall, Norwich, on March 21st 1908. Mr. Sancroft Holmes (in the Chair) set out the objectives of the enterprise. He emphasised the intention to demonstrate what had been proved by experiment, rather than to add another to the experimental stations already in existence. For this reason the Norfolk station would be dependent on the agricultural experts in Cambridge for new information, and in no way in competition with the Cambridge School. He hoped to raise £1500 capital for the project, and to enlist support in some measure from the local authority. He pointed out that Cambridge had the benefit of a farm at Impington, rent free for nine years, but it is recorded that his hope "that someone who had a farm would give it to the purposes of this scheme for the next eight years" was greeted with laughter. Professor Wood followed, and expanded the technical side of the scheme.

On the motion of Mr. E. G. Cubitt, seconded by Mr. H. Overman, it was agreed, "That this meeting, approving the scheme for the foundation of an agricultural station for the county of Norfolk, resolves that the gentlemen, whose names are appended to the report be, and are hereby appointed a committee with power to add to their number, and that the committee be requested to open a subscription list for the purpose of raising the required funds, and to take such other steps as will be necessary to give effect to the scheme." The names were: Messrs. J. Sancroft Holmes, E. G. Cubitt, Eustace Gurney, F. H. Millington, H. Overman, B. B. Sapwell, Garrett Taylor, J. M. Wood, T. B. Wood and J. B. Forrester. The form of the motion is characteristic of an attitude of mind that has much to do with the subsequent success of the Station. Approval of the Scheme was recorded but the core of the motion was the appointment of the Committee, and the mandate to raise the money and to take all other necessary steps to set the project up.

This characteristic of accepting responsibility for getting something done was in evidence again at the first meeting of the Committee. Lord Hastings, who was present at the inaugural meeting, and who spoke in favour of the scheme, was elected a member of the Committee. The Chairman, Mr. Sancroft Holmes, informed the Committee that Lord Hastings had invited him, Professor Wood, and Mr Henry Overman to meet him at Jex Farm, Little Snoring, on the Melton Constable estate. They had inspected the farm, which comprised about 130 acres arable and pasture, and concluded that it would meet their requirements. He continued that Lord Hastings had most generously offered the farm to the Committee, rent free, for eight years. Lord Hastings then joined the meeting.

By July 1908 the Committee had raised £1,325. They received a contribution of 50 guineas from H.M. the King, but they failed in their application for support from the Norfolk County Council. They agreed that to put the station on a permanent

financial basis they would need annual subscriptions to the amount of £200 to £300, and they proposed to make an appeal for this sum. Management of the station should then be by a Committee of 26, made up of 12 representing the subscribers, 12 representing the Norfolk Chamber of Agriculture, and two representing the Cambridge University Department of Agriculture. The Committee also appointed seven of their number to form an Executive Committee. The Executive Committee was authorised to take all necessary steps for taking over the Little Snoring Farm.

The expenses of entry to Jex Farm (at Michaelmas 1908) and the funds from which they were met were set out in a balance sheet adopted by the Executive Committee at their meeting at the farm at Little Snoring on December 3rd 1908.

The balance sheet read as follows:

Receipts

Donations received up to December 2, 1908	£1165	2	0
Balance from Norfolk Agric. Expts. Fund	16	6	1
Payment in lieu of annual subscription	25	0	0
Annual subscriptions	9	2	0
Overdraft at Bank	191	3	2
	1406	13	3

Payments

Valuer's award to J. J. Sayce				£298	16	5
Purchase of livestock						
5 horses	190	10	0			
20 bullocks	340	0	0			
60 ewes	192	0	0	722	10	0
Implements & harness				253	5	9
Fees, & miscellaneous expenses				28	10	9
Fire & workmens' insurance				3	0	0
On account to Mr. Perowne for farm expenses				100	0	0
Balance with Hon. Sec.					10	4
				1406	13	3

Pigs, turkeys, geese, fowls and ducks, and a stack of straw, were still to be purchased.

The day to day management of the farm was carried out by two members of the Executive Committee, Messrs. B. C. Perowne (the Chairman) and Henry Overman. In March 1909 Mr. Musgrave Mordaunt was appointed Superintendent to work under their direction.

The first Annual Meeting of the subscribers was held at the Agricultural Hall, Norwich, on March 13th, 1909. The annual report and balance sheet were presented. The year had been devoted primarily to getting the farm in good order, and the experimental programme had been small. The land was uneven, with many wet patches, and a survey by R. H. Rastall from Cambridge revealed the need for comprehensive drainage if good cropping conditions and satisfactory uniformity for experimental purposes were to be established. On the accounts, the Honorary Secretary reported "a balance to the good of £29. 5. 2d." Professor Wood proposed a programme of work for the coming year and this was in fact to be the first experimental programme on the Little Snoring Farm.

The quarterly meeting of the Executive Committee held in Norwich on July 2nd 1910 was an historic occasion in three respects. It was the first meeting at which the chair was taken by Lord Hastings, who, although on that occasion acting in the absence of Messrs. Perowne and Sancroft Holmes, was later to hold the office of Chairman for forty-four years. At that meeting arrangements were made for the first "Annual visit of subscribers and others to the Farm", and further, Professor Wood proposed, and it was agreed, that an application should be made for a grant from the Development Fund.

The annual visit took place on August 10th 1910 (this is the first annual visit to which there is any reference in the Minutes, but Mr. Sancroft Holmes in his speech on that occasion referred to a visit by a smaller party the year before), and a large party was conducted round the experimental plots by Professor Wood, and provided with refreshments by Mr. Sancroft Holmes. In his speech of thanks to Professor Wood, Mr. Sancroft Holmes referred to the need for a more adequate income if the farm was to make its full contribution to Norfolk agriculture. Management depended heavily on oversight by Mr. Perowne and Mr. Overman, and the subscription income from which to pay for anything beyond the commercial enterprises of the farm, was only £100 per annum.

Application was made to the Board of Agriculture and the Treasury for a grant from the Development

Fund on the grounds that "The income at present available will not admit of more than £100 a year for the salary of a Manager and as the ultimate success of such a venture must largely depend on the energy and capacity of its Manager, the Committee urgently require an Annual Grant of £200 a year to enable them to secure the services of a really first-rate man and to further extend the operation of the Station." They asked further for a capital sum of £500 to complete the equipment of the Station.

Lord Hastings was appointed Chairman of the Executive Committee at the third Annual General Meeting of Subscribers (AGM) in January 1912. The farm had made a loss, and the inability to combine experimentation and profit-making was again emphasised. Negotiations for a grant from the Development Fund continued, but showed no sign of an early conclusion. With the assistance of a grant from the local branch of the RASE a threshing machine had been purchased, and the Station's ability to provide pure seed of cereals had thereby been increased. Purification and multiplication of malting barley seed was one of the Station's earliest successes. In a time when pure seed is taken for granted it is worth remembering that it was the work of the Norfolk Agricultural Station begun in 1908 at Jex Farm that first made pure stocks of cereals available to English farmers.

In November 1912 the Board of Agriculture sent Mr. Stewart to discuss the application for a grant from the Development Fund. He inspected the farm with Professor Wood and stated to the Executive Committee the terms under which grants from the Development Fund might be given to the Station. In particular, he asked for some guarantee that the tenure of the farm would continue beyond the four years remaining of the period for which Lord Hastings had made it available. Supervision by the Board of Agriculture, representation on the Executive Committee, and the support of the local Authority would also be required. The Committee discussed Mr. Stewart's views, and were evidently not prepared to commit themselves to Little Snoring as a suitable long term centre for agricultural studies in Norfolk. It was then agreed to ask for a capital sum of £300 from the Development Fund, to be expended on items of equipment that would remain the property of the Board of Agriculture, and that would be removed by the Board if the occupation of the Little Snoring Farm were terminated.

The negotiations with Mr. Stewart of the Board of Agriculture were reported to the Fourth AGM in January 1913. The report continued: "Since this meetting, Mr. A. D. Hall FRS, one of the Development Commissioners, has also visited the Station with Professor Wood, but the result of this, if any, has not yet transpired. In spite of the long delayed decision the Committee still live in hope that at some future time they may yet receive some assistance from a fund which was apparently instituted for such a purpose." At the meeting also, the results of growing a five acre field of sugar beet were reported.

When the Little Snoring Farm was first taken, the Committee had hoped to obtain two additional fields amounting to 22 acres. This did not then prove possible but in October 1913 Lord Hastings' agent wrote to the Committee saying that two fields, 25 acres in extent, would fall vacant, and offering them to the Committee at a rent of 18/- per acre. After discussion, Professor Wood and Mr. H. Overman were asked to put the Committee's views to Lord Hastings personally. The meeting took place in Professor Wood's rooms in Cambridge, and was followed by a letter from Lord Hastings to Mr. Overman. There were doubts in Lord Hastings' mind as to the wisdom of taking on more land at that time. He wrote, "When you and I met Professor Wood in his rooms at Cambridge, I said that it would be my intention to offer the Farm to the Committee after their present lease expires, at a moderate rent; but the whole position of Farm Schools and agricultural education generally is in such an uncertain state at the present time that it is at least possible that some substitute more popular with the majority will be found for the Snoring Farm before its existing lease comes to an end." Lord Hastings concluded that "it will be safer for the Committee to consider this question of Gidney's two fields in the light of their present lease only." The Committee considered the offer, and decided to accept it, subject to negotiation on the rent. This was finally agreed at 12/- per acre. At the same meeting as the rent of 12/- per acre was agreed, the price at which Archer seed barley was to be sold was set at £1 per coomb.

In February 1915, it was reported that the outcome of negotiations with the Development Commissioners had been successful, and also that "the balance sheet showed a surplus on the year's working, due to the fact of only a nominal rent being paid, to the receipt of a maintenance grant of £100 from the Development Commissioners, and to the generous support of the friends of the station." "The balance sheet showed a surplus of £103. 1. 5d on



Plate I. *Inspection at Jex Farm, 1912*

Cutting lent by W. D. Everington.
Reproduced by courtesy of the Norwich Mercury.

the year's working, which reduced the total loss on the six years to £92. 13. 5d." The only references at the meeting to the impact of the first World War (then in progress for six months) were the exhortation by the Chairman that "farmers must support (the Station) as well as they could in these bad times", and the report by Professor Wood that palm kernel cake had become available at £5.6.0d per ton against £9 for linseed cake because "This year it could not get into Germany, and was on the English market at a cheap rate."

The eight year lease of the Little Snoring Farm was due to expire at Michaelmas 1916, and in August 1915 the Committee agreed to consult Lord Hastings on the future of the undertaking. Lord Hastings replied that, reviewing the work of the past 7 years, he thought that the Station had proved its worth, though "It is a thousand pities that farmers will not make any attempt to get full value out of an instructive station such as this, and apparently it makes little difference if it is in their midst or difficult of access." He went on to offer to let the farm to the Committee on an annual tenancy at 10/- per acre. He believed that the full rent of similar farms at that time was 15/- per acre, and said he was prepared to regard 5/- per acre as his subscription towards the annual maintenance. The Committee accepted his offer, and thanked him for his generosity.

At the 1916 AGM, the Executive Committee reported the new agreement and reviewed the financial and administrative results of seven years' working as follows: ". . . it was finally decided to continue the Station on a yearly tenancy, commenc-

ing from Michaelmas 1916, at an annual rent of 10/- an acre. This rent was considered to be two-thirds of the annual value of the farm, and the Committee recognised that the remaining third was a direct contribution by Lord Hastings to the support of the Station, for which they most heartily thanked him. After valuation of the stock and crops on the farm at Michaelmas 1915, it appeared that there was a small surplus on the seven years' working of the farm, there being a considerable surplus on the year 1914–15, due to war-time prices, which had more than wiped out previous deficiencies. However, this result had been attained by assistance from outside sources, notably from Lord Hastings, from generous help by donors and subscribers, and from the Government Development Fund. The Committee wished to impress upon all interested in the Station the impossibility of such an undertaking being self-supporting. Hence, if the good work is still to be carried on, it must be with help from outside."

The diverse effects of the war were noted in the Minutes of meetings during 1916–1918. In October 1916 Mr. Dawson, the farm superintendent, was instructed to undertake the duties of milk recorder in addition to his duties on the farm. In August 1917 the Hon. Secretary reported that the Station had £1000 on deposit and £473.17.10d to their credit in the current account at the Bank — a very substantial change for the better in the Station's fortunes. In August 1918 the salary of the farm steward (then Mr. Cook) was raised from £100 to £150 per annum, "in consideration of his efficient services."

The annual inspections became a feature of the Committee's activities. Mr. Sancroft Holmes, "the Founder and first President of the Station", had made it his custom to provide refreshments on these occasions. On August 18th 1916 "A party of members, headed by the President (Mr Sancroft Holmes) arrived at the farm early in the afternoon and having, as usual, taken something to eat and drink at the President's invitation, made a round of the fields under the guidance of Professor T. B. Wood." This proved to be Mr. Holmes' last inspection, though he continued to take an active interest in the Station until shortly before his death in 1920.

The future of the occupancy of the Little Snoring Farm continued to exercise the Committee and in March 1920 they decided to give it up at Michaelmas, even though at that time no more suitably situated farm was in prospect.

The first reference to the National Institute of Agricultural Botany (NIAB) appeared in August 1920, when Professor T. B. Wood made a statement to the Committee on a Seed Growing Station and referred to the newly founded Institute. The Norfolk Agricultural Station developed a close working relation with the NIAB that continues to this day, and now includes secondment of two NIAB staff members to the Station for variety testing work on a wide range of arable crops.

Middle Farm, Newton St. Faith's

The year 1921 was an interlude in the history of the Station. The Little Snoring Farm had been given up and the accounts were made up and presented at the Executive Committee meeting in June 1921. They are important as showing the impact of wartime circumstances on farm finances. The total assets of the Station when the Committee entered Jex Farm amounted to £1,183. 19. 4d. In November 1921 there was a credit at the Bank of £3,500 in a deposit account and £789. 13. 8d in the current account. The whole of this improvement in fortune had come about since the outbreak of war, the accounts adopted at the Sixth Annual General Meeting held in February 1915 having shown a debit balance on the six year's working up to the beginning of the war of £92.13.5d.

At this time there was a renewal of interest in agricultural education, and the Executive Committee considered at two meetings in June 1921 a report by the Norfolk County Council's Advisory Committee on Agricultural Education. This included a proposal to absorb the Norfolk Agricultural Station into the County's system of agricultural education. The Committee resolved to maintain the independence of the Station, but asked Lord Hastings to convey this decision to the Advisory Committee, and to inform them that "if the Norfolk County Council appointed a County Organiser who was *persona grata* to the Station Committee, the latter would be happy to co-opt him as a member of their Committee but could accept no further representation." It was also left to Lord Hastings to enquire whether the Advisory Committee could make an offer of a 200 acre farm at Tunstead for the consideration of the Station Committee.

The idea of a farm at Tunstead came to nothing, but in September 1921 it was reported that Mr. Spurrell was willing to let to the Committee Middle Farm, Newton St. Faith's, about 160 acres at a rent of 40/- an acre. On a favourable report of an inspection by Messrs. H. Overman and J. T. Thistleton-

Smith, the Committee took the farm. Time being short, it was agreed to take over the stock and implements at valuation. Mr. Merrick Harvey was appointed Superintendent on a salary of £150 per annum.

Mr. Stanley Stimpson of Bixley was invited to join the Executive Committee, and to "give an eye to the management of the farm." Mr. Stimpson was associated with the Station from then until his death in 1976. He signed the Memorandum and Articles of Association (see below), and he was still a member of the Executive Committee when he died.

The Committee debated various proposals for the direction of the farm, consideration being given to association with:

1. the National Institute of Agricultural Botany;
2. the Ministry of Agriculture;
3. the Cambridge University Department of Agriculture;
4. the Royal Agricultural Society of England.

They decided "to carry out an extended scheme of work at the Station in conjunction with and with financial help from the Ministry of Agriculture and the RASE and it was left to Lord Hastings to negotiate with the Ministry of Agriculture and Mr. Henry Overman undertook to do so with the RASE." The RASE undertook to make an annual contribution to the Station's funds of £500 in support of a programme of research and seed production of malting barleys.

The Norfolk County Council had decided — by a large majority — against appointing an Agricultural Organiser, in spite of pressure to do so from the Ministry of Agriculture and Fisheries, and this was adduced as an argument for Treasury support for the Norfolk Agricultural Station. Negotiations with the Treasury took some time, but in November 1922 the Treasury agreed to pay up to £800 from the fund set up under the Corn Production Acts (Repeal) Acts 1921, for one year, to cover the salary and expenses of a Scientific Director.

In view of these arrangements with the RASE and the Ministry of Agriculture and Fisheries, the Executive Committee was enlarged by co-optation of four further members, two to represent each body. The post of Scientific Director was advertised, for one year in the first instance, at a starting salary of £600 a year plus travelling and incidental expenses. Mr. Clement Heigham was appointed. Heigham took a house at 71 Thorpe Road, Norwich and offered to rent one room to the Committee as an office. This was accepted and an allowance made to him of £50 a year, he providing "Fire, light and attendance."

In March 1923 the Committee received, and with regret accepted, the resignation of Mr. J. B. Forrester, who had been their Hon. Secretary from the beginning. Heigham was appointed Secretary in his place. A year later, on receiving an application for membership, the Committee elected Mr. Forrester an Honorary Life Member "in view of the great services rendered by Mr. Forrester to the Station from its earliest inception."

Dissatisfaction with Middle Farm appeared increasingly in the Minutes of the Executive Committee. The well which was the water supply was unsatisfactory from the beginning, and an analysis of the well water was sent to the landlord before the farm was occupied, but there appears to have been no action on it. The farm premises also appear to have been out of repair, and inadequate for the Committee's needs.

The appointment of a Scientific Director led to an increase in the Station's activities, and the Committee decided to hire rooms in Bridewell Alley for an office, and a half stand in the Corn Hall, Norwich, for extension work. Further evidence of the growing strength of the Station is the signing of the Station's Memorandum and Articles of Association at the Executive Committee meeting on August 11th 1923. Membership of the Station, open to landowners, farmers, and others with farming interests, was established by the Articles of Association, and has been the instrument whereby, over the years, Norfolk farming has concerned itself with, and has benefited from, the work of the Station (see p.61).

Annual inspections, which had been a feature of the years before the 1914–18 war had lapsed during the war and the interlude thereafter when the Station had no farm. The first inspection of the inter-war period was held at Middle Farm in August 1923. It is of particular interest in that Beaven's half drill strip method of sowing a variety trial was demonstrated for the first time on the Station's land, the forerunner of successive improvements in experimental technique that have been adopted with profit to the Station and its members.

The provision of pure seed, particularly of malting barley, continued to be an important interest of the station, and one supported by the RASE. In November 1923 plans were made to let contracts for growing up to 50 acres of barley for seed in addition to that produced on the Station's farm. At this time also it was decided that experimental work on sugar

beet would be desirable, and a sub-committee was set up to consider the matter further, and report.

The first Annual General Meeting of the Norfolk Agricultural Station under the new Memorandum and Articles of Association was held at the Royal Hotel, Norwich on December 8th 1923. A loss of £943 on the year's working was reported but this was considerably less than the loss of £1,448 on the previous year. A large experimental programme had been undertaken, and carried through successfully despite the farm labourers' strike of March and April 1923. Advice had been given on a wide range of subjects, and the Director foresaw "a very great development in this advisory work which is a new undertaking as far as the Station is concerned." This last referred to discussions between the Executive Committee and the Agricultural Education Sub-Committee of the County Council, which resulted in the Committee accepting an annual grant of £500 in return for extending their activities to include demonstrations in different centres, advice on farms and at markets and other gatherings of farmers, and publication of the results of experiments and demonstrations.

The office in No. 11 Bridewell Alley was used for the meeting of the Executive Committee on February 9th 1924. On this occasion the Secretary/Director was instructed to "inspect Sir E. Gurney's lands and buildings at Sprowston and to report as to their suitability for an experimental farm if it should be decided to terminate the tenancy at St. Faith's."*

The difficult financial position of the Station — indeed of all farmers in those years of depression — is indicated by the Minute authorising the Director to seek a loan from the Bank to buy the bullocks required to consume the root crop. However, a forecast of things to come appears in the Minute giving approval to plans for sugar beet experiments.

Evidence of changing times appeared in the Minutes of the April meeting in 1924. The Director was "instructed to proceed with the suggested sale of the manager's pony, cart and harness and to arrange to replace them with a motor van at a price of about £50." At this meeting there was a full discussion of the possibility of moving the Station from Newton St. Faith's to Sprowston. It was noted that the landlord was not willing to sell Middle Farm, and it was agreed that a change was desirable, and that no farm more than five miles from Norwich could be considered suitable. The Secretary was instructed to call a Special Meeting of the Committee to be held at Church Farm, Sprowston on April 19th. At a meeting on May 10th 1924 it was agreed that an offer should be made to Sir Eustace Gurney to lease Church Farm, Sprowston from Michaelmas at a rent of 30/- per acre. No offer was made for the Dairy Farm, which Sir Eustace Gurney had also made available.

A request from the Ministry of Agriculture to set aside an area for experimental plots as part of a scheme centred on the NIAB was considered favourably, but the Committee were not disposed to accept an upper limit of £15 per acre to cover work done. They preferred to charge according to actual expenses. Further, they did not think it necessary to appoint a special officer to have charge of the plots. They considered this work should be a part of the duties of an Assistant to the Director. They went on to agree the terms of an advertisement for a man to fill this post, and offered a salary of £350 per annum plus expenses. "Applicants must possess a modern scientific training in agriculture with a University Degree or Diploma, a sound practical knowledge of mixed farming, organising ability and a facility for lecturing." Following interviews in June, Mr. S. T. Johnson was appointed Assistant Director. At that time also, H. B. Cowell was appointed crop recording officer at a salary of £200 per annum. This was paid through the Station by the Ministry of Agriculture as part of a grant covering field trials started in that year for the NIAB. The Annual Report for 1923–24 reads that "his appointment takes the form of a Prize Studentship open to graduates of the School of Agriculture of Cambridge University, and tenable for not more than two years." These appointments marked the beginning of the expansion of staff to meet the demands of a growing programme of experimentation and advisory work.

Church Farm, Sprowston

The August 1924 meeting of the Committee was largely concerned with arrangements for the move to Sprowston. It was agreed to give notice to the landlord of Middle Farm, to quit at Michaelmas 1925, thereby arranging for one year's overlap with Church Farm, Sprowston. It was not financially possible to run the two farms on the Station's resources, and it was agreed to seek accommodation from the Bank up to £2000 for the overlap

* In the Minute Book is a note on a small slip of paper that was passed to the Chairman on this occasion. It reads: "I could probably offer you some suitable land at Sprowston. E. Gurney."

period.

In September 1924 the Director, Mr. Heigham, submitted his resignation, to take effect from Janurary 1 1925. The Committee accepted his resignation and minuted their great regret at losing his services, and their congratulations "on his important appointment at Rothamsted." Arrangements were made forthwith to advertise the vacancy. Mr. F. Rayns, then on the staff of the Midland Agricultural and Dairy College, was appointed and took up his duties on January 1st 1925.* Rayns immediately found himself involved in proposals for the expansion of the Station's activities. Discussions were in progress with the Norfolk County Council and its Agricultural Education Sub-Committee with a view to expanding the Station's advisory work to cover all agricultural interests in the County.

Finance was a continuing anxiety. In December 1925 the Committee was concerned at the loss of capital that had occurred over the past four years' working. The Director presented a statement showing that in May 1926 they might practically clear the overdraft, but it would then only be possible to meet the running expenses of the following five months by means of the acreage grant from the Crop Variety Testing Scheme and the research grant of £500, provided the latter was renewed by the RASE. The Director was instructed to apply to the Ministry of Agriculture and Fisheries for an interest free loan of £1000 to replenish the depleted capital (estimated to have declined from £4,000 to £1,620. 11. 1d), for an increase in the Development Commission grant for the salary and expenses of the Director from £800 to £1,000 p.a., and for an annual grant of £500 for research and experimental work. The Committee also applied for a 75% grant on the estimated cost of £2,500 of building houses for the Director and his assistant.

The experimental programme was actively developed at the same time as the Station's advisory work increased. An indication of the impact of the changes taking place was given by the Committee's decision in 1926 to allow Sprowston to be farmed on a 5-course, instead of 4-course shift. The decision was not taken without dissent. Sir Eustace Gurney, who was the landlord as well as a Committee member, requested that it be minuted that he had voted against the change.

Livestock work included beef fattening trials at Sprowston, financed by the RASE, and sheep feeding trials initiated by Professor T. B. Wood on his farm at Saxlingham. Interest in sugar beet was increasing and in November 1926 it was decided to clamp five tons of beet "with a view to estimating the loss if any in weight and % sugar." In March 1927 the Director reported that twelve varieties of sugar beet would be tested in a replicated trial in the coming season. This was the first report in the minutes of a replicated trial, and indicated the Station's continuing interest in experimental design, first displayed in the adoption of the Beavan half drill strip layout for variety comparisons.

Sugar beet demonstration work was now becoming important, and the Station undertook to arrange and supervise 40 demonstrations in Norfolk under a Ministry of Agriculture scheme. A Recorder of Field Experiments was appointed, and the opportunity was taken of selecting from the remaining candidates a man to serve as Sugar Beet Demonstration Officer. It is of interest to note that the advertisement for the Recorder post included the statement that "Statistical knowledge will be considered a special qualification."

The practical interest of the Chairman in the experimental programme was illustrated by his intervention in a debate on plant spacing in farm crops, which was to be an interest of the Station over many years. Work on the irregular distribution of seed by commercial drills was written up as 'A Census of an Acre of Barley" and offered for publication in the RASE Journal. The evidence of irregularity in seed distribution was disputed by a member of the RASE Research Committee. Lord Hastings, who was a member of the Research Committee, undertook to reply at the next meeting. In the event, the evidence was fully supported by experiments carried out by Mr. (later Sir) Frank Engledow, and the conclusions were accepted by the Research Committee.

The Station was undertaking substantial educational commitments, and it became necessary for the Committee to review very carefully all demands on staff time. It declined such extras as the management on behalf of the County of the Ministry Blacksmith Demonstration Vans, but gave the director leave to accept the nomination of the County Council to serve on the Faculty Board of Agriculture of Cambridge University.

* Rayns said that Professor T. B. Wood, his old Professor, told him to apply. Wood said it would be a suitable job for him for two or three years. He held it for 35.

The Committee had only partial success in their financial negotiations with the Ministry. No capital grant was forthcoming and the most that they were able to get as a contribution to staff housing was a second mortgage of £900, the first mortgage of £1,500 having been negotiated with a building society. The houses were occupied in the spring of 1927. Tenancy agreements were made which enabled the Station to pay off capital and interest completely over a term of thirty years. The Committee had also been allowed to use £250 of the Development Fund grant to put up an office building at Sprowston. The use of the Bridewell Alley office was then reduced to consultations on Saturdays and Executive Committee meetings.

In October 1927 the overdraft stood at £280. 0. 5d, and an upper limit of £1,000 was negotiated with the Bank. By the December meeting the overdraft had risen to £1,036. 7. 4d. Nevertheless at the fifth AGM held in January 1928, the Chairman "drew attention to the creditable result of the farming year" and "referred to the Balance Sheet which he considered to be very satisfactory." Grants received during the year amounted to £3,200.

Trials were in progress on the use of sugar beet pulp as a livestock feed, and in November it was agreed to collaborate with the former Director, Heigham, who by then had become Professor of Agriculture at Newcastle, in parallel trials at Cockle Park. Work undertaken with support from the RASE included (beside beet pulp trials) barley manurial trials, seed drill performance, and baby beef trials. Work on bolting in sugar beet, of interest to the RASE but not supported by them, was also in progress.

In March 1929 the Director reported on nitrogenous manuring trials on grassland, laid down at the request of the Ministry and of the County Council. The analytical work required for the evaluation of the treatment effects had made it necessary to acquire apparatus, and to bring a gas supply to the field laboratory. This marked "a further step in the Station's evolution for it is the beginning of a small chemical laboratory."

In January and February 1930 discussions took place on the responsibility of the Station for agricultural education in Norfolk. At a conference it was agreed that "all future agricultural education activity in the county should be carried out by the station", and a sub-committee was appointed to produce a scheme. However, at the first meeting of the sub-committee a letter from the Ministry was read saying that "the Ministry could not view with favour" an extension of the Station's commitment to agricultural education.

In February 1930 Johnson, the Asistant Director, resigned on appointment to a post at Seale Hayne Agricultural College, Devon. The Director went to see John Mann. Mann studied Chemistry at Cambridge, but gave up a career in chemistry to manage his uncle's farm at Bridgham. He had by then inherited the farm and got it into order. He found a manager for his farm and agreed to join Rayns at Sprowston as Assistant Director. Rayns then went to his Chairman, Lord Hastings, and persuaded him to endorse what he had done. Mann's appointment as Assistant Director of the Station, and also as Assistant Director of Agricultural Education, ranked with that of Rayns as Director in its significance for the advance of Norfolk farming. He proved an admirable counterpart to Rayns, and the partnership that developed between them was a dominant influence on the agriculture, not only of Norfolk, but of the whole of England, until their retirement.

At the seventh AGM held in January 1930, a small loss on the year's working was reported, but the Chairman remarked on the extra staff required for experimental purposes and on the work for agricultural education in the County, and concluded that the Station was giving good service both to the public bodies which supported the Station financially in return for experimental work carried out, and to the ratepayers on whose behalf the agricultural education work was conducted.

Further development in the relations between the Station and the County was agreed at the Committee meeting in March 1930. Under a scheme devised by Lord Hastings and agreed by a Sub-Committee set up by a Conference on Agricultural Education in Norfolk, the County Council would appoint the advisory and clerical staff of the Directorate of Agricultural Education, and these staff members would be controlled by the Agricultural Education Committee. The Director of the Station would be appointed Director of Agricultural Eucation, and in that capacity would serve part time, and be paid part salary under the Agricultural Education Committee. The Assistant Director and the Advisory Officer were to be paid entirely by the County Council. Office accommodation for the education work was to be provided by the County Council on or near the Station, and every effort was to be made to maintain close co-operation between the farming and educational branches of the enterprise. To this



Plate II. *Inspection at Church Farm, Sprowston, 29 July 1931*

Reproduced by courtesy of the Norwich Mercury.

end also it was proposed that there should be reciprocal representation on the Committee of the Station and the Agricultural Education Committee. The agreement was ratified between the Station and the County Council Agricultural Education Committee to take effect from April 1st 1930.

It says much for Rayns' leadership and for the quality of the two staffs that they worked harmoniously together. The Station staff assisted with numerous trials in the County and the day classes held at Norwich, King's Lynn, Fakenham and Diss, while the Assistant Director devoted much of his time to Station affairs and the Advisory Officer helped to bring the Station into close contact with farmers. This close association of advisory work with a demonstration farm was what was needed to give farmers confidence in the advice given, and it had a powerful impact on farming thought and practice. Moreover, with all the trials on the Station and in the County, help and encouragement were freely given by members of the staff of the Cambridge School of Agriculture.

The new pattern of integrated experimental and advisory work was expounded by the Director in July 1930, in a memorandum on Station policy (see pp. 36, 37). Development of the advisory work to match the experimental programme became a major matter of policy in the years that followed, and this

in turn influenced the experimental programme, the better to serve farming interests. At this time also the Committee agreed to publish a Guide to Field Trials and County Experiments, and provision to meet the costs was included in the County estimates.

The problems of the period were serious. Grants had been reduced and the Committee had to resolve to reduce salaries. Losses on the years 1931 and 1932 were reported, but the Chairman felt that they "could congratulate themselves that the loss was small." At the 9th AGM in January 1932 it was agreed to sell three horses, dismiss one team man, and buy a tractor. Nineteen thirty-three was a better year, and at the 11th AGM the Chairman reported a sound financial position.

Norfolk farmers needed an imaginative and wide-ranging experimental programme at this time at least as much as at any time in the Station's history, and in this they were well served. Crops new to Norfolk farming were studied. Brussels sprouts were tried over many years but never became very important. Potatoes, on the other hand, did. Field scale production at Sprowston began with five acres in 1933. Both canning peas and blue peas were grown on a field scale. Interest in fertilisers was increasing and the experimental programme for 1933 included fertiliser trials with barley, and experimental work on winter wheat, including trials of the Hornsby "Leake Precision" drill, and wheat spacing trials. The Leake Precision drill was developed in response to the demonstration at Sprowston and Cambridge that the drills then in use gave a very irregular distribution of seed in the row (see p. 18).

The Committee discussed the suggestion that in view of the increasing interest in the improvement of dairy cattle in Norfolk, the Station should undertake work on dairying. While agreeing in principle, the Committee noted that it would be necessary to acquire extra land and to erect suitable buildings. The Director was asked to make enquiries about adjacent land.

Recognition of the potential of the sugar beet crop led to its inclusion in the commercial cropping of the farm, and to an enlarged experimental programme, both on the crop itself and on the related problems of disposal of its by-products. In 1931, it was agreed to enter into contracts for growing sugar beet with the factories at Bury St. Edmunds and Cantley. Arrangements were made with Cambridge agricultural economists to undertake costings on the commercial growing of sugar beet both on the Station and on farms of Lord Hastings and other members of the Committee. Analytical work on the produce of trials was made possible by the English Beet Sugar Corporation, which equipped a small laboratory.

Attached to the Minutes of December 12th 1934 was a proposal to be put to the RASE for "An investigation into the cumulative effects on a light arable soil, of various methods of disposal of beet tops and straw." This was the beginning of the important long term "straw disposal" work.

Rayns visited sugar beet growing areas in Europe and brought back a wide range of horse drawn cultivation and harvesting equipment. A big demonstration was held at Sprowston in 1937. This was the precurser of the long series of National Sugar Beet Demonstrations that still continue, and also led to the development by a British manufacturer of one of the standard sugar beet harvesters.

The impact of the Sprowston work on sugar beet was widely felt. The establishment of the crop in the Norfolk farming system, and husbandry improvement to increase its profitability, called for flexibility and foresight in planning the experimental programme. For example, at the 12th AGM in February 1935, reference was made, on the one hand, to the importance of the beet crop in providing employment for farm labour, and on the other to experiments in mechanisation that, in the event, were to lead to very great savings in labour use. Both Committee and staff at Sprowston were well equipped to hold a balance in this kind of work between current needs and future prospects. Reporting on the work to the 13th AGM in January 1936, the Chairman said that "the success of the sugar beet crop in Norfolk was largely due to the dissemination of information from Sprowston. This was based on the results of experiments carried out under the direction of Mr. Rayns who had gained an international reputation as an expert on the crop. The Chairman expressed pleasure in the recognition of Mr. Rayns' work by the recent award to him of the O.B.E."

Ninteen thirty-six was an important year for Station policy. At this time Lord Hastings drew attention to probable changes in the County Council's Agricultural Education activities. He foresaw the possibility of these changes affecting the Station's position, and possibly limiting its freedom of action. The Committee was unanimous that the Station's independence must be preserved.

They welcomed an invitation from the British Sugar Beet Seed Producers Asssociation to undertake the inspection of seed fields for a fee of £500, as it would broaden the grant base of the Station's finances.

Later in the year the Committee considered proposals from the County Council to unify Horticultural Education and Agricultural Education, and to give Rayns charge of the whole organisation. A letter in support from the Ministry was also considered. It was decided to negotiate a new agreement with the County Council to replace that of December 15th 1930, and it was felt desirable to erect permanent offices at Church Farm, Sprowston.

At the end of 1936 the first suggestion that the Station should purchase Church Farm, Sprowston was recorded. The agent to the Gurney Trustees wrote to the Chairman stating "his willingness to advise the Trustees to accept £65 per acre for purchase of the experimental farm." The Committee decided not to pursue the matter, as "the offer was beyond any sum which the Station could raise."

At the 15th AGM in January 1938, the Chairman drew attention to the state of the farm. Sprowston is not naturally productive land, but Lord Hastings said that "Taken on the evidence he thought the Sprowston Farm was one of the most productive farms in all England." The success of high farming at Sprowston was also indicated by a Minute of the Committee recording that "The Director . . . pointed out the difficulties of now growing Little Joss, due to improved soil condition." The demonstration of the merits of Little Joss in the winter wheat trials at Jex Farm had been one of the Station's early achievements, and the variety maintained its position until the improvement of husbandry standards and of fertility levels at Sprowston rendered it obsolete. The achievement by Rayns and his staff of high productivity on land of only moderate natural fertility was to be of enormous value to Britain in the war years that followed.

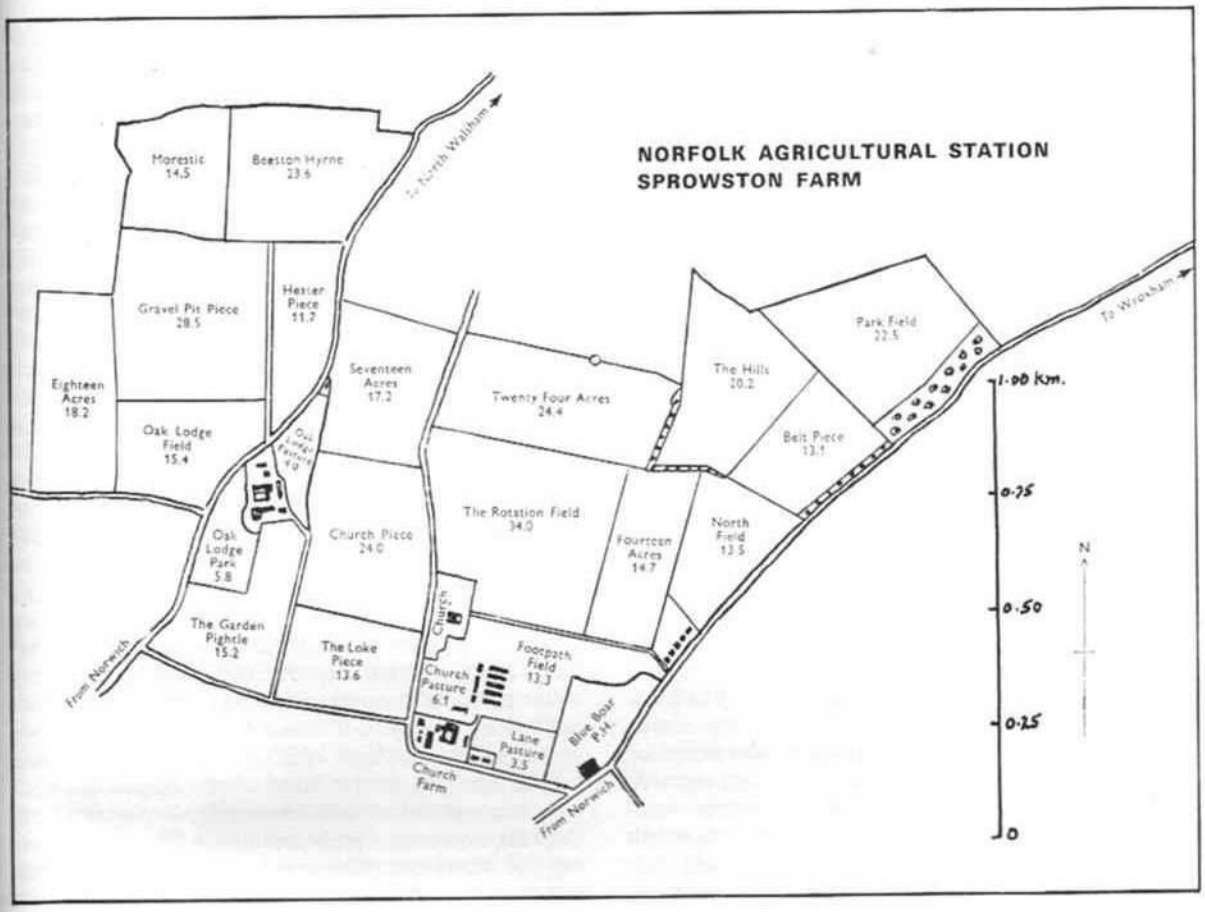
Lord Hastings went on to refer to staff changes, and to the fact that both Norfolk and other English counties had come to look to Sprowston for the recruitment of their senior officers. This was a testimony, both to the quality of the men recruited to the Sprowston staff (mostly from the Cambridge School of Agriculture), and to the leadership and team work characteristic of the Station. The Chairman went on to say that for the standing of the Station in British agriculture and in particular for its pre-eminence in sugar beet work, "a debt of gratitude was due to Mr. Rayns."

The outbreak of war in 1939 brought further responsibilities to the Station. In 1940 the Committee considered cutting down the experimental programme in view of the commitments of the staff to work for the War Agricultural Executive Committee. This was done, but long term trials such as the straw disposal trial were maintained, and enough of S. Culpin's time was reserved to look after them.

In October 1941 the Committee agreed to take the tenancy of Oak Lodge Farm from the Gurney Trustees. At this time also they took over and farmed several other parcels of land of various sizes, as a war measure. There were increasing references also to wartime farming expedients. They found soda treated straw poor stuff for feeding stock, and objected strongly to publicity in favour of it on the strength of trials conducted in other places. Demonstrations were arranged of wartime cattle feeding systems, and trials were undertaken on the feeding of detoxicated castor bean meal. War time needs, and the availability of supplies from the USA are indicated by the decision in 1941 to order a 6′–7′ cut combine harvester, at an estimated cost of £350. The machine was received a year later.

There is an interesting adjustment in the Station records at this time. The AGM held on January 25th 1941 was the 18th since the Station's incorporation (see p.16). The following AGM held on January 24th 1942 was recorded as the 33rd since the Station's foundation. (For the first AGM see p.12). By the 33rd AGM the effects of the war on the Station finances were becoming evident. Despite the costs of taking over substantial additional acreage, a surplus of £2,000 had been realised. The Chairman pointed out that with the additional acreage it would be possible to relieve the pressure of experimental work on Church Farm. It was agreed that it would be "an excellent proposition" to purchase Church and Oak Lodge Farms from the Gurney Trustees, and the Director was instructed to approach the Agent, but it was found that the Trustees were not at that time willing to sell.

By the end of 1942 the rundown of the Station's experimental programme had reached the point where only the long term straw disposal trials, the Crop Variety tests and the Sugar Beet experiments remained. It was agreed that every effort should be made to recruit another staff member, so as to maintain the Station's position. At the 34th AGM in January 1943 the Chairman reported that the



Map 2. Church and Oak Lodge Farms

Station had made a large profit, as a result of high prices and the effect on crop yields of good farming over the years. It would be in a strong position at the end of the war, but grant support would still be necessary.

In 1943 there was further discussion of livestock policy. It had earlier been decided that the Station could not embark on a dairy enterprise, at least during the war, but on the Director's suggestion it was agreed to purchase some dairy heifers, to be sold later in calf. The heifers when brought should be inseminated by AI from Cambridge. A discussion ensued on the desirability of establishing an AI centre at Sprowston, and a sub-committee was appointed to study the possibilities and financial implications.*

Sprowston in Post-War Agricultural Development

In 1943 the Minister of Agriculture announced his intention to set up after the war a National Agricultural Advisory Service (NAAS). This was evidently likely to affect the Station's position, and at the 35th AGM in January 1944 the Chairman "drew attention to the dangerous situation which had arisen following the announcement of the Govenment's decision that the Agricultural Advisory Services should now be divorced from County Council control and transferred to the Ministry of Agriculture." He went on to say that the Executive Committee had long felt that the purchase of the Farm was an "essential prerequisite to the fullest

* Some Committee members were against the project on principle.

development of the Station's usefulness." He made the suggestion that an endowment of not less than £25,000 was necessary to assure continuity of scientific direction, but added that it was not then the right time to invite members to subscribe.

During 1944 the Executive Committee discussed Station policy, considering the choices open to them of co-operation with the Agricultural Research Council (ARC), or with the Agricultural Improvement Council (AIC), or of retaining independence. In the Director's opinion, "The future financial position of the Station would be the overriding factor no matter which course it was decided to follow. Since the Executive Committee had decided against the present practicability of an Endownment Fund it seemed difficult to see how the Station could continue independently to fulfil its present function in view of the possible development of government experimental stations on a regional basis throughout the country. The Station was already filling the gap between research and the practical farmer; its work was based more upon example than upon investigation and quite clearly if it was to co-operate in the national development that seemed to be ahead it could do so most appropriately with the Agricultural Improvement Council." The Committee was unanimous that the present degree of independence should be maintained, though it was appreciated that the Station already received grants from national funds. It was agreed that an approach should be made to the Chairman of the AIC.

In August 1944 Rayns produced a memorandum on the future development of the Station which forecast closely the pattern that the Experimental Husbandry Farms were to follow. In October Lord Hastings, Jas. Alston and F. Rayns met Sir Donald Fergusson (Chairman, AIC) and Mr. C. Nathan (Ministry of Agriculture, Education Department) and put forward their views. There seemed to be general agreement that the Station could fit satisfactorily into the system being planned. This was reported to the Committee. At the same time, the Committee received a request that Rayns should transfer to the Ministry. Rayns did not wish to do so, and it was agreed that he should be seconded part-time. Negotiations with the Ministry over the relation of the Station to the new Experimental Husbandry Farms (EHFs) began in 1945 and continued for a decade. They were important, since the independence of the Station was at stake, and it will be convenient to record them here before reporting on the experimental policy of the Station over the same period.

They began in 1945 with a visit to the Station by Drs Salisbury, Slater and Fryer, representing a committee on the setting up of the EHFs. It was reported that they were very impressed. No progress was made until 1948, but in that year there were active discussions between the Ministry and the Station on the relation of the Station to the Ministry's new undertakings in the Advisory Service and the EHFs. The Chairman wrote to the Ministry setting out the Committee's views on how the Station could best fit into the EHF system. The Station was financially strong, but it would need grant support and secondments from the Advisory Service. It must remain independent and must appoint — with close consultation — its own senior staff. Discussion continued throughout the year, and in January 1949 the Chairman reported to the 40th AGM that negotiations "seemed to be reaching a conclusion" but the Committee would have to be reconstituted.

The Chairman proved to have been unduly optimistic. After another meeting, the Ministry produced in November 1949 an *aide memoire* on the future of the Station that was acceptable, subject to further consideration on one or two points, but even this was not the end of the matter. At the 41st AGM in 1950 the Chairman gave a further account of the state of the negotiations. It was suggested that a holding company would hold the Station's assets and employ the Director, receiving 3% interest on the assets, rents of the houses, and half the profit on the farm. There would be a farming company which would set up a management committee consisting of six appointed by the Station members, six by the Ministry of Agriculture, two by the University of Cambirdge, two by the Norfolk County Council and two by the RASE. In February 1950 it was reported that these arrangements had been agreed with the Treasury, and documents could be prepared. However, it was not until July 1951 that the papers were received. An agreement was then approved between the Norfolk Agricultural Station and the Norfolk Experimental Farm, and a copy was sent to the Ministry

Only in 1954 were the long negotiations brought to a conclusion. The Committee decided not to proceed with the complicated agreement with the Ministry, to abandon the proposal to form a Holding Company and an Operating Company, and to ask Mr. Bartlett of the Ministry to draft a simple agreement covering the main points of collaboration between them. This agreement was finally recorded

in December 1955.

The establishment of the EHFs and the NAAS also affected the staffing of the Station over this period. In 1945 Rayns resigned the post of Director of Agricultural Education under the Norfolk County Council. This involved a drop in salary, part of which the Station made up. In 1946 Mann resigned as Assistant Director on appointment as County Officer for Norfolk. S. Culpin became Assistant Director, but applications were pending from him and from the Field Supervisor, P. N. Harvey, to go into the Advisory Service, which they both did in due course. Indeed by 1952, when the EHFs were fully established, three of their Directors, one Senior Assistant, and one Assistant to the Ministry's Director of EHFs had previously been members of the Station's staff.

Returning now to the development of the Station's programme, 1945 was a year of change, with the ending of the war and planning for the future. At the AGM in February the Station's capital assets were valued at £19,522. The Development Fund grant was likely to be £830, and the Treasury was said to be setting limits on what the Station could do with its own funds. The Station's enterprises were reviewed. Poultry and pigs, that had suffered repeatedly from disease, were given up and the equipment sold. At the suggestion of Professor G. E. Blackman, sunflowers and silage maize were tried. The first crop of sunflowers was harvested and sold, but as the Director could not get another contract, the crop was not grown again. Silage maize does not seem to have fitted into Sprowston farming. Pea haulm silage, a by-product of the successful vining pea crop, did prove valuable over a long period. At that time no support was forthcoming for studies of control of virus yellows in sugar beet, though the disease was bad that year. The Station undertook work on the disease at its own expense.

In September 1946 the buildings sub-committee produced a schedule of recommendations for the development of the buildings at Oak Lodge. They proposed: (a) a Drier Shed, (b) a Covered Bullock Yard to house 100 beast and to be economical in labour, (c) Implement Store and Workshop, (d) Tractor, Trailer, and Combine Shed, (e) "Welfare Centre", (f) Farm Office. Drainage and concrete roads and standing areas were also considered. Church Farm buildings were not to be developed, as a road straightening project might go right through them. The Gurney Trustees were not prepared to carry out the suggestions made to them on buildings, but agreed to put the Oak Lodge buildings into tenantable repair, and to build an implement shed. They also indicated that they were prepared to sell Church and Oak Lodge Farms and invited the Committee to make an offer.

Nineteen forty-seven was a year of severe drought, rising wages, and a loss of over £3,000 on the running of the Farm. Nevertheless, at the AGM in January 1948, the Chairman was able to report that the Station's capital assets stood at £20,859. In 1949, besides maintaining the usual means of publicity for the Station's work ("Rotation Experiments on Straw Disposal" was published in the RASE Journal), the Station broke new ground with three broadcasts on the Sprowston work, on the Midland Region of the BBC.

A most important event was the purchase from the Gurney Trustees in 1950 of the farms on which the Station was situated. The previous year had been good, yielding a satisfactory profit, and the Station's assets stood at £30,000. The Gurney Trustees wished to sell. After negotiation the Committee agreed to buy 320 acres of Church and Oak Lodge farms for £21,295, the purchase to be completed by Michaelmas 1950. A debenture issue of £15,000 was floated among members of the Station, and the balance was met from Station reserves. The Gurney Trustees first offered to sell the two farms in 1936. They had asked £65 per acre and the Committee had decided "the offer was beyond any sum which the Station could raise" (p. 22). In 1950 the price agreed was about the same (about £67 per acre), and the Station raised the money without any difficulty.

American Conditional Aid was available in those years, and the Ministry proposed, and the Committee agreed, that a turkey demonstration unit should be set up at Sprowston with Aid funds. The unit was officially opened on September 8th 1954 by Mr. Nugent of the American Embassy. It was run with a manager seconded by the Ministry, and with Aid funds, until June 1956. Thereafter the Ministry handed it over to the Station for experimental work, but were unable to second a manager, and had no experimental programme to propose. After carrying out successfully a contract for the evaluation of the effects on healthy birds of drugs used in disease control in turkeys, the unit was closed down in 1965.

At the 45th AGM the members and staff of the Station made a presentation to Lord Hastings "in

recognition of his Chairmanship of the Executive Committee for 41 years (1912–1953)." In the same year they were able to congratulate Rayns on the award of the C.B.E. in the Coronation Honours.

Sugar beet work was increasing in importance and in its impact on Norfolk farming. By 1953 papers were available on mechanical thinning and on chemical weed control in the crop. Cereal work was also advancing, particularly with the range of new varieties emerging from the breeding stations in Britain and on the Continent that had expanded their activities in the post-war period. Proctor barley was picked out at Sprowston in its early trials, and Sprowston made a substantial contribution to its multiplication and distribution in its early years. It was perhaps partly as a result of this experience that the Station agreed with the NIAB and the Plant Breeding Institute to undertake early trials of breeding material, particularly of cereals.

Nineteen fifty-four and 1955 were good years, yielding surpluses on the farm account of £3,600 and £6,900. The scientific assets of the Station were notably increased by the presentation in 1955 by Mr. S. G. Gurney of weather records kept by Sir Eustace Gurney of Sprowston Hall from 1909 to 1920. In 1958 these were augmented by the gift, by Mr. Basil Cozens-Hardy, of a book containing meterological records kept at Oak Lodge from 1872 to 1957.

Lord Hastings and the development of Sprowston

The first Minute of the Committee meeting in January 1956 reported the death on January 18th of Lord Hastings, and recorded his great contribution to the establishment of the Station as one with a reputation both nationally and internationally. It is appropriate at this point to reflect on the development of the Station, dominated as it was by Lord Hastings from its foundation to the day of his death. Perusing the Minute Books the singleness of purpose and the capability of Lord Hastings make a lasting impression. They show up, on the one hand, in the offer of Jex Farm as the first farm the Station occupied, and on the other in the advice given in the later years of the Station's tenancy, that this was not a suitable farm for permanent occupation for experiment and demonstration. They are to be observed repeatedly in his accounts of the events of the years at successive AGMs. And their impact on the Station's fortunes are manifest in the growth of the Station's resources, fluctuating according to the fortunes of war and peace, and the demands made by the country on its agriculture, but always showing a degree of stability that owed a great deal to the character of the Chairman. With a deep sense of the debt that Norfolk agriculture, and the Norfolk Agricultural Station, owed to Lord Hastings, the Committee considered ways in which the debt should be acknowledged. They asked Mr. R. W. Ketton-Cremer to write a memoir of him, and they established a Lord Hastings Memorial Lecture, to be given from time to time by eminent agriculturists. Sir John Hammond was invited to give the first lecture.

The establishment and growth of the Station, with which Lord Hastings was so deeply concerned, was a means to an end; and the end — the improvement of Norfolk farming — was always clearly in his mind. Indeed, it must be remembered that the founder members when they agreed with Lord Hastings to accept his offer of Jex Farm rent free for eight years, did so with the explicit understanding between them that if the enterprise did not serve this purpose, they would close it down at the end of the period. Recorded in the Minutes is the evidence of steadily increasing effectiveness in discharging this duty. In the early years, the application of science to agriculture was in its infancy. The image of the scientist in agriculture that was in the minds of the founders of the Station was a chemist like Voelcker of the RASE and Woburn. There was no concept of husbandry as a scientific discipline, and it should never be forgotten that the emergence of husbandry as the driving force in agricultural improvement was in very large measure the result of the partnership between Lord Hastings and his Committee on the one hand, and Rayns as Director, and his staff at Sprowston on the other. The early work of the Station was simple. Comparison and demonstration of varieties was backed up by multiplication and distribution of pure stocks of seed. In these days of rigorous national — and indeed international — control of seed supplies, it is hard to realise that at the beginning of this century it was almost impossible to obtain pure seed of a barley variety except through the Norfolk Agricultural Station.

Jex Farm was run by a manager working under the direction of two members of the Committee. It was only after the first World War that a Government grant was obtained to make possible the appointment of a Scientific Director. Heigham, the first Director, ran the St. Faith's Farm, and saw the Station through that difficult and rather un-

satisfactory period. He developed the experimental programme and began the adoption of the new generation of statistical techniques by introducing in 1923 the Beavan half drill strip technique of variety comparison. His major contribution, however, was in the development of the Station's advisory work, at which he was good. During his tenure the first grant from the County Council Agricultural Education Sub-Committee was negotiated, to enable the Station to extend its advisory work. Heigham resigned following his appointment to Rothamsted, just as the move to Sprowston was completed. So he handed over the new farm to the new Director, with a busy extension programme in being, and a substantial experimental programme to be developed. Heigham had put the Station on the agricultural map of Norfolk. He had a clear idea both of what he had achieved and of what was next to be done. Rayns recalled his parting advice: "I've done the talking, it's up to you to deliver the goods."

So Rayns, while maintaining and expanding the advisory work, set about developing the experimental programme to a new order of magnitude. It is a measure of Heigham's success that it was recognised that the Station had grown beyond the compass of one man's activities. Johnson's appointment as Assistant Director was the beginning of the development of a scientific and advisory staff. Cowell was appointed as a student assistant, and as the years went on the Director and Assistant Director were supported by two, three and then five or six scientific assistants. It was with this growing team that trials and demonstrations were developed at Sprowston, and advisory work was conducted in the County of Norfolk. It has been — and still is — one of the weaknesses of British agricultural research that it tends to be conducted in a world of its own, with but tenuous links with those who make their living by farming. The Norfolk Agricultural Station was set, deliberately and firmly, in the no-man's-land between science and practice. Rayns has recalled how this was brought home to him in the early years. He received an invitation — it must have seemed little less than a command — to advise T. B. Wood, his old Professor, on his farming at Saxlingham. After he had walked round and given such advice as he could, T. B. Wood remarked, "This is what you learnt in my lectures?" "Yes, sir." "Well it sounds different when you have to set it against your own cheque book." It was the achievement of Rayns and his staff that the advice they gave in the county of Norfolk was set— and set successfully — against the Station's cheque book at Church Farm, Sprowston.

Throughout the 1930s the Station, with support from the County, carried on an extensive advisory service with limited staff. A column appeared in the Eastern Daily Press every week. Like so many of the Station's initiatives this has continued without interruption to the present day, first by the Station alone, then in collaboration with NAAS, and now with ADAS. For many years the Station took stands in the Corn Halls in Norwich, Diss and King's Lynn. That they were popular and well used is endorsed by Mann's memory of an afternoon in the Norwich Corn Hall when he and Rayns kept a record of the enquiries they dealt with. They gave advice on 77 diverse problems. "Husbandry" was published, a quarterly journal that covered most aspects of Norfolk farming. The "Milkers Mardle" led the campaign for better milk production methods, and in particular for clean milk. Stockmen's clubs were organised. A poultry adviser and other staff were appointed. Rayns was for a time Director of Agricultural Education for the County of Norfolk.

Rayns and Mann headed a team that dominated agricultural development in Norfolk in the 1930s, during the second World War, and through the post-war reorganisation of agricultural advisory work. The years between the wars saw the emancipation of Norfolk farming from rigid adherence to the four course rotation, folded sheep and yarded bullocks. Sprowston pioneered the sugar beet crop, and it was on information and experience gained there that it emerged from the doubtful realms of experimental plots to become a key crop in the restoration of farming fortunes. Dairying, never before an important component of Norfolk farming, also developed extensively. The Station had not the resources to set up a dairy enterprise though the Committee considered the possibility more than once. But advice was given on the farms and at the "Milker's Mardle".

As important as the introduction of new enterprises was the discarding of the old that were no longer remunerative. Getting rid of folded sheep on the Sprowston farm was a slow and cautious exercise, and it took years of experiment and demonstration to satisfy the conservative among the Station's members that yields of cash crops on Norfolk light land could be maintained without the root break fed to folded sheep.

This slow but well documented and convincing liberation of the farming system from the traditional

practices of an earlier age yielded an unexpectedly rich return during the war years. The system had become flexible. The proportion of the cropping that was sold off the farm for cash had already risen to an extent that was beyond the terms of tenancy agreements before the first World War. The need to alter the system in the direction of the intensification of cereal production, of potatoes and of sugar beet was therefore already acceptable to progressive farmers. The sheep gave place to sugar beet and the bullock yards remained empty, in the confidence that yields could be maintained, and any sacrifices made could be recouped when war-time needs were in the past.

Rayns, as Executive Officer of the War Agricultural Executive Committee, with Mann as his deputy, organised Sprowston and the County Executive work as a single enterprise. This was evidently to the satisfaction of Lord Hastings and the Committee and it must have been with a sense of shock and of disappointment that they heard the Minister's announcement that he planned after the war to take the advisory work away from the counties and to establish a national service. Coupled with this was the proposal to set up a series of EHFs over the country. Though it was clear that these were to be modelled on the Norfolk Agricultural Station — and in that sense it was a recognition of the success with which the Sprowston staff had matched their advice against their cheque book — it was by no means certain that the new Government farms would leave a place for their independent predecessor.

The long and complex negotiations with the Ministry are recorded earlier. They ended simply and satisfactorily with an endorsement of the *status quo.* On the record it all looks like an illustration of the truth of a remark by Lord Hastings quoted by Ketton-Cremer, "The man who invented ink, gentlemen, should have been drowned in it — drowned in it." But there was more to it than this. This happy outcome was possible because of the personal decisions of two people. In 1944 Rayns declined an invitation to transfer to the Ministry of Agriculture, where he would have had the responsibility of developing the EHFs, and in 1945 he resigned his post of Director of Agricultural Education for Norfolk, which he had held concurrently with the Directorship of the Norfolk Agricultural Station. Then in 1946 Mann resigned as Asssistant Director to become County Officer for Norfolk in the new National Agricultural Advisory Service. Thus Sprowston retained Rayns, and the Norfolk advisory work was still run by Mann, and the partnership that had been so fruitful remained undissolved. With men of their stature in the County, an elaborate agreement with Whitehall was superfluous.

In the war years farming was profitable and experimental costs necessarily much reduced. So the Station emerged in a good financial position. The place of Sprowston as an independent Station alongside the EHFs being satisfactorily established, the Ministry augmented the staff by secondment, and the Committee was able to build up the experimental programme to meet the emerging needs of the post war period. The Norfolk Agricultural Station was among the first to base a beef enterprise on surplus bull calves from milk producers, and to demonstrate the exploitation of arable by products in beef feeding. Moreover at a time when open yards were common, they built covered yards at Oak Lodge, both to save labour and improve working conditions, and to ensure that the elements of fertility were not leached from the manure. The cropping system was intensified by the introduction of vining peas. The potato and beet crops were improved by the application of the results of their own experiments, and cereals were intensified by better fertiliser practice, by improved varieties, and by increasing the proportion of cereals in the rotation. Mechanisation had been adopted cautiously but steadily over the years.

This was Sprowston at the time of Lord Hastings' death: the leading translator of agricultural science into farming practice. It was directed by Rayns, influential, respected, and listened to in the County of his adoption, and speaking with authority in the counsels of the Ministry of Agriculture in Whitehall. His authority lay not only in his great personal qualities, but also in the support of an outstanding staff. Agricultural experimentation may have been devised elsewhere, but it was applied on the farm at Sprowston by men of sound training, good judgement, and dedication to agricultural improvement.

Sir Edmund Bacon and the Move to Morley

Sir Edmund Bacon was elected Chairman on Lord Hastings' death in 1956. He first became a member of the Station in 1930, and soon after joined the Committee as a representative of the Ministry of Agriculture. He was to guide the Station through a period of change as demanding of a Chairman's wisdom and skill as any that Lord Hastings had

experienced. The early years of his tenure, however, were years of prosperity and of continued success in experimentation and advice.

Oak Lodge house and the associated farm buildings and paddock were purchased from the Cozens-Hardy family in 1958. The purchase made possible the provision of a committee room on the Station's own premises, just at the time when the Norwich Museums gave notice that they required for themselves the room in Bridewell Alley where the Committee had met — free of charge — for 28 years.

The Oak Lodge purchase made possible the provision of good covered yard and individual feeding accommodation for the beef enterprise. The new facilities attracted the attention of research organisations and beef experiments were undertaken at the request, and at the expense, of outside bodies. This aspect of the Station's work was stimulated and guided by Sir John Hammond. Sir John joined the Committee in 1938, and served on it until his death. He led the way in the exploitation of the beef potential of the Friesian breed, and was largely responsible for the introduction of the Charolais. On his retirement he was made an Honorary Life Member and asked to continue on the Committee. He died in August 1964. Wood and Hammond were two distinguished Cambridge men who forged the link between the practical husbandry of the Station and the agricultural science of the University.

Cereal variety work was of great importance. There are records of the heavy demand for seed of Proctor barley, and of the first distribution of Capelle wheat. Potato work included contracts for the supply of ware to the crisping firms. Sugar beet, in which the Station had been so deeply involved, raised new problems and offered new opportunities. With the heavy and continuing drain of labour from the land, together with the need to absorb the increasing cost of the labour that remained, the emphasis in experimental work shifted to mechanisation, both in spring and at harvest, and chemical weed control, as means of reducing costs on what had always been a labour intensive crop.

These were years which yielded substantial profits on the farm account, and the Station's financial position was strong. There were, however, two clouds that increasingly darkened the horizon. The first was the impending retirement of Frank Rayns, Director of Station throughout the Sprowston period. The second was the steady growth of the City of Norwich in the direction of the Sprowston farms.

Rayns retired on October 31st 1960. The final Minute of the meeting held on October 26th 1960 read as follows:

Minute 16. Retirement of Mr. F. Rayns: *The Chairman said that he felt members of the Executive Committee would like the last Minute of the meeting to record their really deep regret that this would be the last meeting at which the Director Mr. F. Rayns would be present as Director of the Station and to express the committee's unbounded admiration of the way in which he had carried out the work at Sprowston over the past 35 years. The Chairman, on behalf of the Committee, wished Mr. Rayns a long and happy retirement.*

The 52nd AGM was held on October 29th 1960. Rayns' retirement at the end of the month and the appointment of A.C. Owers to succeed him, were reported. A presentation followed, and Sir Edmund Bacon said that in his 35 years the Station's balance sheet had increased from £2,500 to £80,000, and the farm had only made a loss on annual working on six occasions. To produce such figures while doing experimental and demonstration work was a remarkable achievement; "it is also a remarkable tribute to the Director that so many young men have been trained in agricultural science and research at Sprowston. At the moment six out of eleven of the Ministry's EHFs were directed by men who had been trained at Sprowston; in addition a number of County Agricultural Advisory Officers were Sprowston trained, including the Norfolk County Agricultural Officer, Mr. J. C. Mann."

Rayns replied, emphasising the contribution of Lord Hastings, ably followed by Sir Edmund Bacon, the "first class" Station Executive Committee, and the enormous value of the Station's independence. He had come knowing little of Norfolk and its farming, and not expecting to stay more than a few years. He had come to know and understand Norfolk farmers and their farms, and he had stayed, and he could now say, "I have become one of you, I have become a Norfolk farmer myself, and I can think of nothing better." Rayns was made an Honorary Life Member of the Station, and in the following year gave the Third Lord Hastings Memorial Lecture. His "Revolution in Arable Farming"* is his own

* Rayns, F., (1961) A Revolution in Arable Farming. *The Third Lord Hastings Memorial Lecture. Norfolk Agricultural Station.*

authoritative account of the redesign of Norfolk farming, in which he himself played so large a part. In June 1961 Cambridge, his old University, conferred on Rayns the degree of Doctor of Science, *honoris causa*, and in presenting him for the degree the Orator remarked that it was appropriate that the University which had produced a Turnip Townshend should in due course have also produced a Sugar Beet Rayns.

The Committee appointed A. C. Owers as Director on November 1st 1960. Owers first joined the scientific staff of the Station in 1935. During the war he worked with the Norfolk War Agricultural Committee. Then, after a period at Wye College he became Assistant Director at Sprowston from 1949 to 1951. He went to Terrington EHF as Director, and from there returned to Sprowston. At the same time P. N. Harvey resigned to become Director of Gleadthorpe EHF. He was succeeded as Assistant Director by B. M. Scott.

The next two years were uneventful. The new Director, Sprowston trained and an experienced and dedicated experimental husbandryman, took over the programme easily, and soon put his own stamp upon it. However, in 1963 the second cloud on the horizon became heavy. Planning proposals submitted to the Norwich City Council included more than two thirds of the farm and both sets of buildings within the projected boundary of the enlarged city. Strong representations were made to the Boundary Commission, and the appeal was upheld to the extent that only 36 acres of the farm were left within the revised boundary. While it seemed likely that resistance could be sustained at the planning level, urban encroachment on the ground was real and menacing. With the built-up area just across the road, urban birds, dogs, and human trespassers posed a hazard to which an experimental farm was particularly vulnerable. From then on, whether consciously or not, Committee members kept an eye open for a suitable farm beyond the range of urban development.

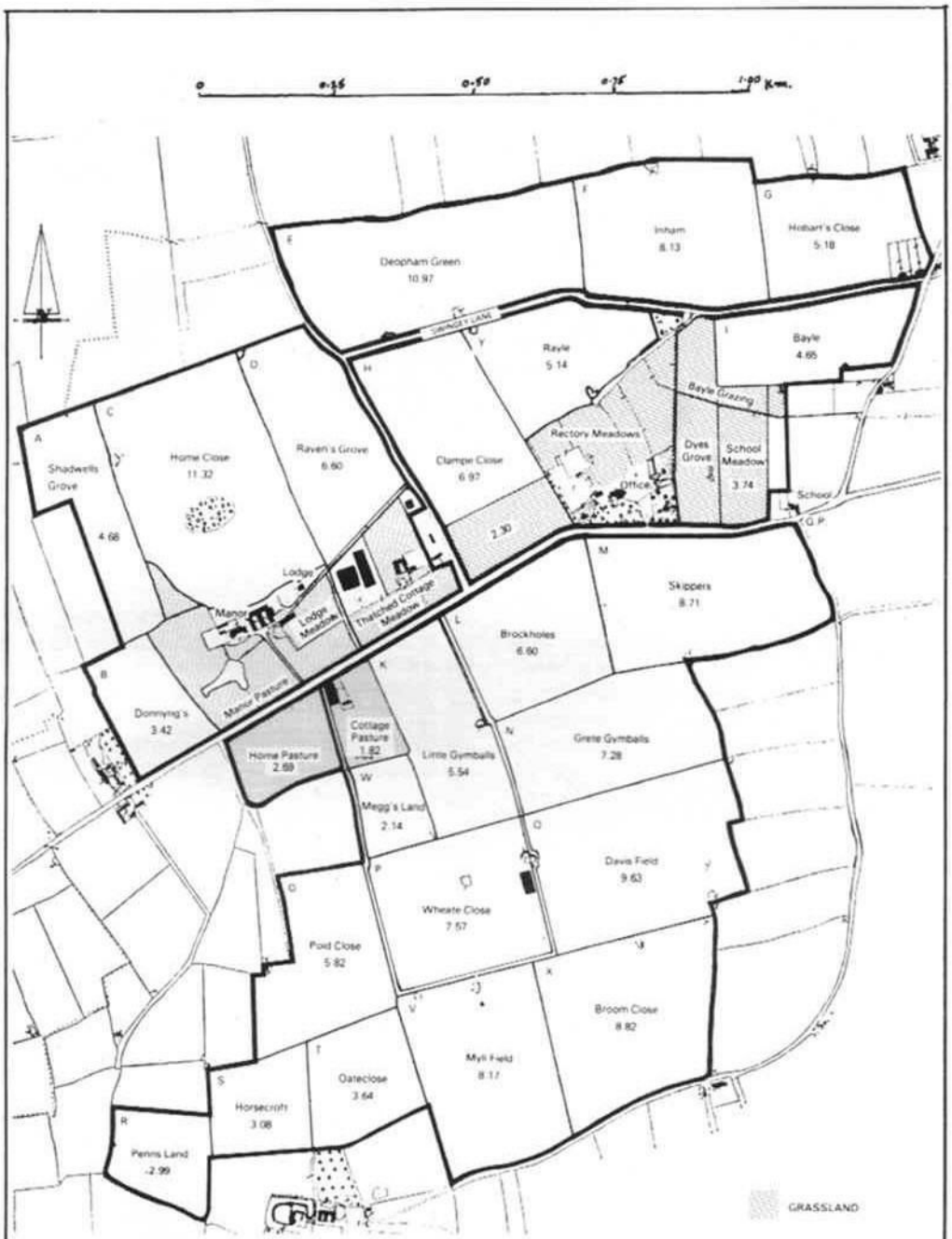
In 1964 and 1965 the debentures outstanding from the issue made to finance the purchase of the Sprowston farms, were redeemed. The Memorandum and Articles of Association of the Station were revised, and the revised document, accepted by the relevant Government Departments, was agreed at an Extraordinary General Meeting held on November 14th 1964. So, when Morley Manor and its farm came onto the market, the Station's financial and administrative situation was clear. The property was bought at auction and the purchase was completed in the first half of 1965. Shortly after, the old Morley rectory, with some of its paddocks, came onto the market, and was bought for conversion into offices and laboratories.

It was the Committee's intention to farm Morley on a simple system to bring the land into a suitable state for experimental work, and then to transfer the programme from Sprowston, and sell the Sprowston land. Development at Morley proved to be a slower and more expensive process than had been anticipated. The farm had been run as a dairy farm, with a large grass acreage, small fields, and a drainage system that was inadequate for intensive arable cropping. Hedge removal, ditching, draining and field-road making were first undertaken. Conversion from one type of farming to another is not something that can be done in a season, and expensive development work, which only yields a return over time, made the first few years at Morley difficult.

It had been anticipated that the Sprowston land could be sold fairly quickly for urban development, thereby paying for Morley and providing an endowment fund to support the experimental programme. In fact, though the development value of the land was substantial, it took considerable time to realise. Large interest charges were incurred in consequence on the Bank loan for the purchase of Morley, and the erection of new buildings for produce storage and for beef fattening was postponed until sales of Sprowston land made the necessary finance available. It was in this period of financial strain that the quality of Sir Edmund Bacon's leadership became fully apparent. Neither the cost of the loan for the purchase of Morley nor the planning problems in the disposal of Sprowston deterred him from his goal of using the development value of the Sprowston land to establish an endowment for the Station's work.

Meanwhile, the experimental programme was developed progressively at Morley. Experimental work was maintained at Sprowston for two reasons: first, an overlap of several seasons was advantageous, so long as suitable land was still in hand at Sprowston, and secondly it was desirable to continue the beef work in the Oak Lodge yards until the new yards were built at Morley. At Morley, emphasis shifted towards the husbandry problems of unstable sandy loam or sandy clay loam soils, and the cropping problems of farms where the alternatives to cereals are limited.

The Bank overdraft was cleared during the year



Map 3. Morley Manor Farm



Plate III. *Inspection at Morley Manor, 21 July 1979*

1. *A. O. Prynne (NIAB)*
2. *J. N. Holmes*
3. *R. W. Hill*
4. *Dr G. D. H. Bell*
5. *W. R. Kidner*
6. *J. C. Mann*
7. *Lord Townshend (Chairman)*
8. *S. P. McClean (Director)*
9. *J. J. A. Kendall*
10. *Prof. Sir J. Hutchinson*
11. *D. A. Sutton (Farm Manager)*
12. *A. N. G. Duckworth-Chad*
13. *C. V. Dodd*
14. *E. R. Bullen*
15. *A. J. Brookes*
16. *J. R. Noble*
17. *James Alston*
18. *M. Nuttall (NAS)*
19. *G. M. Palmer (ADAS seconded)*
20. *W. E. Bray (NAS)*

1972–73, and with the completion of field improvements and the new buildings ready, it was possible to see more clearly the pattern of the Station's finances for the future. The Ministry seconds two staff members to the Station. Variety testing work for the NIAB and the sugar beet programme for the Sugar Beet Research and Education Committee (SBREC) are paid for by these bodies. The Potato Marketing Board contributes towards the cost of potato experiments. Certain other experiments are grant aided by other bodies, to a lesser degree. Beyond these contributions — and in the year 1976–77 they amounted to more than £40,000 — the Station's own resources must meet experimental costs. The amount that can be contributed from Station profits is limited, and is liable to large fluctuation according to season. Even with an endowment from the proceeds of the sale of the Sprowston land, therefore, the future is uncertain. Nevertheless, it must be remembered that throughout the history of the Station the future has been uncertain. Those who founded it were well aware of the difficulty of financing experimental work out of farm profits, and the Committee throughout its history has had to seek outside support. This has been forthcoming because of the success of the Station in discharging its primary duties, which were to serve the needs of Norfolk farmers and to pioneer progressive changes in the farming system.

Success in fostering change is always difficult to achieve. When times are good there is little inducement to change. When times are hard, none dare take the risk of experiment. In farming, these impediments to innovation are reinforced by the wide dispersion of the farming profession, which makes communication difficult. The achievements of the Norfolk Agricultural Station are therefore remarkable. They stemmed in large measure from the membership scheme, and from the men the

members appointed to the Executive Committee. The members were kept informed of the work of the Station by the circulation of reports, by open days, and by informal visits and telephone consultations.

The Executive Committee has always been in close touch with the work of the Station. As a Committee member of long standing has recorded, "During all the years of the Station it has been guided by an Executive Committee of men with a wide range of knowledge and experience, amongst whom are Norfolk landowners, progressive farmers who knew all the problems of the land, and a long succession of men of scientific knowledge and national repute. The monthly meetings of the executive are unusual since they could well be described as a discussion group. These discussions lead to decisions, to decisive decisions." Such a Committee is on the one hand a stimulus to an able Director and a good staff, and on the other, the most important link in the chain of communication between the Station and the farmers it serves. The members, the Executive Committee, the Chairman, and the Director and staff have over the years achieved an integration that is rare in the administration and application of research.

Sir Edmund Bacon retired from the Chairmanship at the 66th AGM in 1973, and was succeeded by The Marquess Townshend of Raynham. One of the first acts of the Committee under the new Chairman was to revive the office of President, in abeyance since the death of the first President, Mr. Sancroft Holmes. They then invited Sir Edmund to become President, in recognition of his distinguished services to the Station during the 14 years of his Chairmanship.

Under the new Chairman the Committee had to prepare for the retirement of the Director. A. C. Owers retired in May 1978 after 18 years. He carried a large experimental programme with great ability. He conducted the move from Sprowston to Morley without allowing the experimental work to falter, and he transformed Morley Manor into a well equipped experimental farm. He assessed sensitively the differences in soil conditions between Sprowston and Morley, and progressively moulded the programme to meet the new needs and opportunities.

The selection of a man to fill a post calling for individual and personal commitment is never easy. In this instance it was made more difficult because of the current trend in Universities and Research Institutes away from the wider interests of agriculture and towards specialist studies in agricultural science and agricultural economics. The post was widely advertised and in the event the Committee was fortunate in attracting the interest of a Sprowston trained man. S. P. McClean, who served at Sprowston from 1953 to 1957, was appointed Director, and took up his duties in May 1978.



Mr. J. Sancroft Holmes
Chairman of the AGM 1908–1915
President 1916–1920



Lord Hastings
Chairman 1912–1956



Sir Edmund Bacon
Chairman 1956–1973
President from 1973
(Reproduced by courtesy of the Eastern Daily Press)

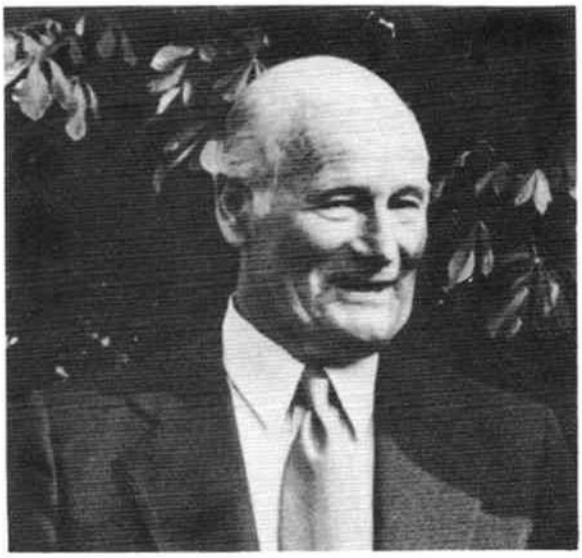


Lord Townshend of Raynham
Chairman from 1973

Plate IV. *Presidents of the Station and Chairmen of the Executive Committee, Norfolk Agricultural Station*



F. Rayns, CBE, MA, ScD
(Hons. Causa)
Director 1925–1960.
(Reproduced by courtesy of the Eastern Daily Press).



A. C. Owers, MA
Director 1960–1978
(Reproduced by courtesy of the Eastern Daily Press)



S. P. McClean BSc
Director from 1978
(Reproduced by courtesy of the Mansfield Chronicle Advertiser).

Plate V. *Directors of the Norfolk Agricultural Station*

Part 2

The Experimental and Advisory Programmes

by J. B. Hutchinson and A. C. Owers

Objectives

Michaelmas 1908 was a landmark in the agricultural history of England. Entry into Jex Farm by the Norfolk Agricultural Station marked the beginning of an enterprise that has become a model for the testing of new information and its dissemination among the farming community. The intimate understanding, and the confidence, between landowners and farmers on the one hand and their staff of experimental and advisory officers on the other, has been outstanding. In the beginning they were faced with a farming system that had outlived its time, and with economic circumstances that made it virtually impossible for even the most imaginative individual in the industry to take the risk of innovation. Only by working together was it possible to try out and to demonstrate alternatives to the existing system.

The function of the Norfolk Agricultural Station, as laid down by Prof. T. B. Wood and the Norfolk landowners and farmers with whom he worked to set it up, was to make available to Norfolk farmers by demonstration and advice the results of scientific experiments carried out in Universities and on research stations. Their own experimental programme grew bigger than they foresaw. In the early years advisory and demonstration work lagged behind, partly because Norfolk County Council were not at that time willing to make their contribution. The success of the experimental programme, and in later years, the ready cooperation of the County Council's Agricultural Education Committee made it possible to establish a proper balance between experiment and advice, and indeed under the stress of war, to move almost the whole staff over to advisory work.

The role of the Station Committee, and the powerful influence of Lord Hastings and Sir Edmund Bacon as Chairman, have been recorded earlier. The experimental and advisory programme was dominated by Rayns, who was Director for almost the whole of the Sprowston period. He was not alone. He was supported by an outstanding staff, and it is to his credit that he recruited and trained men of such quality. The leadership was his, and the imagination and judgement with which he and his staff identified farming needs and planned the experimental and advisory programmes to meet them stemmed from that leadership. His thinking permeated Norfolk farming. Indeed, what went on at Sprowston between the wars became one of the most important influences on University and College teaching of agriculture throughout the country.

Rayns set out the principles on which the Station's work was based in a memorandum to the Committee dated July 1930. It read as follows:

"Director's Memo to the Executive Committee held on the 13th September, 1930

In the past the Sprowston field work has been largely concerned with detailed experiments. The farm has been an experimental farm in every respect and its use as a demonstration farm has been confined to such lessons in good husbandry as its general management may have displayed. Experimental plots, necessarily detailed and sometimes repeated in a bewildering manner, are not always clear and convincing as ***demonstration*** *areas. Since, too, the Station has become definitely associated with the County Council in the Agricultural Education of the County, it is desirable from that point of view to ensure that the maximum educational value is obtained from the work at Sprowston. While it would be fatal, in the interest of the*

Station, to interfere in any retrogressive manner with either the calibre or scope of the experiments it does seem desirable to attempt to co-ordinate them more intimately with the agricultural education of the County. Moreover, it is equally, if not more important to make certain that agricultural advisers, in their respective districts utilise the Station for the purpose for which it was established, viz., to investigate the problems of Norfolk farmers on a Norfolk farm specially equipped for the purpose.

To accomplish this co-ordination the following procedure is suggested:

(a) to continue to utilise the Sprowston farm for carefully conducted investigations, maintaining as before the closest possible co-operation with other Institutions, such as the National Institute of Agricultural Botany, and the Rothamsted Experimental Station;

(b) to demonstrate at Sprowston on a field scale by means of large plots the results of the smaller but detailed experimental plots;

(c) to repeat these demonstrations on farms in East and West Norfolk, the respective advisers being responsible for the layout and demonstration of the plots;

(d) to receive from time to time from district advisers notice of problems that, in their judgement, are important in their districts, and which might be investigated in detail at Sprowston.

In this way not only would the field problems of Norfolk Farmers be certain to receive attention, but the results consequent to all investigations at Sprowston would be demonstrated and disseminated in a popular form."

Thus Rayns set out the objectives of the Norfolk Agricultural Station. Not all that he proposed was brought about in the way that he expected. The demand for land for the experimental programme made it difficult to find space for field scale demonstrations, and it did not prove possible to repeat demonstrations on farms throughout the County. His memorandum is recorded here because it sets out clearly the aims of the Station as an intermediary between practical farming and the research appropriate to Universities and Research Institutes. That this role was not carried out in the way he proposed is an indication of the difficulties of the enterprise. These difficulties faced the Committee and the Director throughout the history of the Station, and they have been overcome in different ways at different times.

Rayns and Mann held the balance between experiment and advice in their own characteristic way. Mann, with his experience as a Norfolk farmer and his chemist's training, supplemented the information gained on the Sprowston farm. He made it his business to acquire an extensive and intimate knowledge of the whole diversity of Norfolk soils. He carried out small plot experiments informally and identified the major nutrient deficiencies and the areas in which they occurred.

With this armoury of forward-looking experimentation at Sprowston and detailed knowledge of farming conditions in the County, Rayns and Mann led Norfolk farming on the road to recovery from the depression. Recovery involved more than the acceptance and application of a range of new technologies emerging from an experimental programme. It encompassed a revolution in farming attitudes, the realisation of new possibilities, and the creation of a new farming system. In duscussing the Station's programme, therefore, it must be borne in mind that it was a means to an end and not an end in itself. The end in view was the improvement of husbandry on Norfolk farms. This is less easily described than the experiments themselves, but the fact that the improvement of husbandry has never been lost to sight has been the Norfolk Agricultural Station's greatest strength. Husbandry studies in this context are those investigations that relate to all crops, and to the effectiveness of the system as a whole. These are discussed in the next chapter. Studies relating to particular crops and to livestock then follow.

The Improvement of Husbandry.

Husbandry is a matter not of experimental plots, but of the farm and its cropping system. The term is an old one, common in the earliest agricultural writings in the English language. More recently the "New Husbandry" has come into use as a general term for the revolutionary agricultural system advocated by the Norfolk Improvers and widely adopted in the 18th and early 19th centuries. The Norfolk four course rotation is the best known component of the New Husbandry, but the system devised by men such as Jethro Tull, "Turnip" Townshend, and Coke of Holkham was of greater significance than its components (cf. van Bath, 1963; Hutchinson, 1972)*.

The Station's contribution to husbandry began with simple improvements at Jex Farm. The purification of malting barley varieties and the marketing of

* van Bath, B. H. S., (1963) The Agrarian History of Western Europe, A.D. 500–1850, Edward Arnold.

Hutchinson, Sir Joseph, (1972) Farming and Food Supply. CUP.

pure seed were among the earliest of the Station's activities. Also at Jex Farm, specialist advice was sought from the Cambridge School of Agriculture on drainage needs. At Sprowston, Rayns when he was first appointed began a study of the distribution of plants in a field of barley. Rayns at Sprowston and Engledow at Cambridge demonstrated the very irregular distribution of seed in the row by commercial seed drills. Their "Census of an acre" work on cereals led to the production of the Hornsby "Leake Precision" drill that was tried out at Sprowston in 1933. Later, "Census of an acre" work on sugar beet served as a stimulus to manufacturers undertaking design work and trials that led to the production of modern precision drills. For 20 years from about 1932, spacing drills by numerous manufacturers were tested as they became available.

Over the years, husbandry improvement has been dominated by four major topics: plant breeding; improving fertiliser practice; the introduction of power and the implements that power made possible; and the advent of agro-chemicals for the control of weeds, pests and diseases. The Station's interest in plant breeding is limited to the NIAB variety testing. Considering fertiliser practice first, there has been an enormous change from the situation on Jex Farm to that at Morley. At Jex Farm a very modest fertility level was maintained by the use of farmyard manure (FYM), and fertilisers hardly had a place. At Morley a high fertility level has been established and is maintained by well controlled and liberal fertiliser application, and FYM is a useful but minor contributor to productivity.

In the classical New Husbandry, the maintenance of fertility depended on the return of FYM to the land, and two of the four crops in the rotation were grown to be fed to stock for the production of meat and dairy produce for sale, and FYM for return to the land. Hence replacement of fodder roots for stock feed by sugar beet for sale had enormous repercussions on the balance of the farming system. Extensive studies were undertaken of the place of FYM in the system, and of means of maintaining fertility if livestock were reduced to match the loss of stock feed. Moreover, by-products of the cropping system — straw from the cereal crops and tops from sugar beet — had to be disposed of in other ways, and if possible used to contribute to soil fertility without turning them into FYM.

During the 1930's the value of these by-products of the beet crop was studied extensively. In the traditional Norfolk four course rotation the root break, fed off to sheep, had been regarded as essential for the generation of soil fertility for the subsequent cereal crop. A major question to be answered if sugar beet was to be introduced was whether the tops would provide adequate feed for the maintenance of the sheep flock, or alternatively, whether fertility could be maintained if sheep were given up in favour of beet. "Sheeping trials" were carried on for 20 years (1931–1951), to compare various means of disposing of beet tops — feeding to sheep, carting off, or ploughing in — and it was shown that, given the recommended fertiliser practice on the beet, fertility could be maintained either by feeding off the tops to sheep, or by ploughing in the tops. Carting off resulted in a fall of fertility, which could however be made good by an increased rate of fertiliser application.

Having determined a fertiliser level that would make good the loss of fertility following the removal of the tops, it became possible to evaluate the tops for feeding to yarded stock. This was done along with the evaluation of wet and dry beet pulp, which is a factory by-product. Beet pulp became an accepted feeding stuff. Beet tops carted off for feeding did not come into general use at that time, since it was cheaper then to use imported feeding stuffs.

In the course of the decade these results were passed on to Norfolk farmers by the Sugar Beet Demonstration Officer, and had a profound effect on farming practice. Some farmers, who saw a prospect of making money out of their sheep, fed the tops in a traditional manner. Most, however, regarded sheep as yielding little profit and demanding much labour and attention, and they were ready to dispose of them as soon as convincing evidence was available that fertility could be maintained without them. Thus the folded flock, for more than a century a characteristic feature of the Norfolk landscape, diminished rapidly and became almost a rarity. There was also the problem of the disposal of straw in the cereal breaks if it were no longer to be trodden into FYM in cattle yards in the traditional manner. It was clear that short term experiments, measuring responses over one or two crops, or even a single rotation, would not provide sufficient evidence to justify a radical departure from the established pattern of crops and livestock of Norfolk agriculture. Long term straw disposal trials were therefore laid down, with the intention of determining the immediate effects of various ways of dispos-

Table 1

Mean yields and responses to straw disposal treatments
(tonnes per hectare: cereals at 85% dry matter)

Crop and Effect	Rotation			
	1	2	3	mean
Potatoes (over 32mm diameter)				
Direct				
Yield when straw removed	32.8	25.4	31.4	29.7
Response to:				
Straw ploughed in	2.02	2.28	1.75	2.05
FYM	2.30	5.42	7.00	4.94
Wheat				
1st residual				
Yield when straw removed	3.98	3.70	4.29	3.99
Response to:				
Straw ploughed in	0.075	0.136	0.188	0.138
FYM	0.226	0.251	0.452	0.314
Spring Oats				
2nd residual				
Yield when straw removed	3.35	2.54	3.83	3.22
Response to:				
Straw ploughed in	−0.063	0.000	0.063	0.000
FYM	0.075	0.063	0.390	0.163
Sugar				
Direct				
Yield when straw removed	5.94	6.44	6.68	6.36
Response to:				
Straw ploughed in	0.000	0.102	0.314	0.138
FYM	0.113	0.640	0.815	0.527
Wheat				
1st residual				
Yield when straw removed	3.80	3.54	4.11	3.82
Response to:				
Straw ploughed in	0.075	0.088	0.201	0.125
FYM	0.138	0.238	0.452	0.289
Spring Oats				
2nd residual				
Yield when straw removed	3.48	2.50	3.80	3.25
Response to:				
Straw ploughed in	0.038	0.000	0.038	0.025
FYM	0.063	0.063	0.301	0.114

ing of straw, and of finding out whether any of the treatments under consideration gave rise to a long term trend in yield response. Experiments on straw disposal were carried on over three complete rotations, and the results were written up by Rayns and Culpin (1948).* The basic comparisons were between:

straw made into manure;
straw ploughed in (with sulphate of ammonia to make good the absorption of nitrogen in the decay of the straw);
beet tops and hay sheeped off;
beet tops ploughed in;

together with combinations of these treatments.

In terms of yield over the rotation, FYM was uniformly good. Beet tops either sheeped off or ploughed in were as effective as FYM on the crop immediately following, but did not have such a long term effect as FYM. Straw ploughed in (with sulphate of ammonia) was beneficial. It was not as effective as FYM on sugar beet, but combined with beet tops sheeped off, it equalled FYM for barley and wheat.

A finding of great interest in the trial was that the cumulative effect of FYM over successive rotations was substantial. Some cumulative effect was recorded from ploughing in straw, but the effect of FYM was greater and more consistent. Moreover, it was clear that the trend towards higher yields from plots given FYM was likely to continue.

Further work was planned in a trial that ran from 1949 to 1969, on a six course rotation of potatoes, wheat, oats, sugar beet, wheat, oats. The main treatments were:

all straw removed;
straw produced by cereals ploughed in (with sulphate of ammonia) for sugar beet and potatoes;
straw removed and FYM applied to sugar beet and potatoes.

Basic fertiliser dressings were given, appropriate to the various crops in the rotation. Two levels of each of the three main nutrients, N, P, and K, were applied, but yield differences between the levels were quite small. Yields in response to the three treatments are given for the three successive rotations in Table 1.

* Rayns, F., and Culpin, S., (1948) Rotation experiments with Straw Disposal at the Norfolk Agricultural Station. Jnl. Roy. Agric. Soc., *109*, 128.

The direct effect of FYM on both potatoes and sugar beet was substantial and increased progressively over the three rotations. The direct effect of straw (plus sulphate of ammonia) ploughed in was considerable, and increased over the three rotations on sugar beet, but did not increase on potatoes. Residual effects on the following wheat crop were greater for FYM than for straw ploughed in, but in both treatments and following both potatoes and sugar beet, the residual effects increased progressively over the three rotations. Second residuals (on spring oats) were small, but in the FYM treatment increased in the third rotation after both potatoes and sugar beet. Increments as percentages of the yield when straw was removed are given in Table 2. Expressed as percentages of the control, the progressive increase in response to organic manuring is clearly brought out. Even the second residuals (on spring oats) showed a substantial effect in the FYM treatment. It should be noted that more has been returned in both treatments than just the residuals of the straw. Sulphate of ammonia was added to the straw ploughed in, and in making the FYM, concentrates were fed that added some residual fertility to the decaying straw. Nevertheless, no comparable cumulative effect was recorded from the higher of the two NPK treatments, and the results may be accepted as evidence of the value of organic manure in the determination of soil fertility.

These data must be considered in conjunction with those from trials of methods of disposing of sugar beet tops. The old sheeping trial, which completed four rotations in 1952, gave consistent results. On plots that had received no FYM for 20 years, but had had sugar beet tops either sheeped off or ploughed in, yields had been maintained. Where the tops were carted off, appropriate fertiliser dressings were sufficient to prevent any yield decline. Thus it was shown that fertility could be maintained by husbandry methods other than the traditional ones of manure from folded sheep or from cattle yards.

These findings gave a new flexibility to Norfolk farming. Since it was shown that a satisfactory level of yield could be maintained without FYM, those farmers for whom livestock were inconvenient or unprofitable could confidently dispense with them. On the other hand, where stock could usefully be retained, the FYM they produced contributed to fertility, and in particular to the yield of high input – high output crops such as sugar beet and potatoes.

Table 2

Increments following straw ploughed in and FYM, as percent of the yield when straw was removed

Crop and Effect	Rotation			
	1	2	3	Mean
Potatoes (over 32mm. diameter)				
Direct				
Response to:				
Straw ploughed in	6.2	9.0	5.0	6.9
FYM	7.0	21.5	22.3	16.6
Wheat				
1st residual				
Response to:				
Straw ploughed in	1.9	3.7	4.4	3.5
FYM	5.7	6.8	10.5	7.9
Spring oats				
2nd residual				
Response to:				
Straw ploughed in	−1.9	0.0	1.6	0.0
FYM	2.3	2.5	10.2	5.1
Sugar				
Direct				
Response to:				
Straw ploughed in	0.0	1.6	4.7	2.2
FYM	1.9	10.0	12.2	8.3
Wheat				
1st residual				
Response to:				
Straw ploughed in	2.0	2.5	4.9	3.3
FYM	3.6	6.7	11.0	7.6
Spring oats				
2nd residual				
Response to:				
Straw ploughed in	1.1	0.0	1.0	0.1
FYM	1.8	2.5	7.9	3.5

This justified the retention at Sprowston and Morley, and on Norfolk farms in like circumstances, of a livestock enterprise that used straw, and converted into meat such by-products as beet tops, pea haulm, and chat potatoes, leaving FYM as a contribution to the productivity of high value crops.

Advances in fertiliser practice have come from study and demonstration on a field scale as well as by fertiliser trials. The latter were partly to assess differences in varietal response and partly, in cereal trials, to determine proneness to lodging. Advisory work was important, as for example on the use of limited and rationed supplies during the war. Demonstration was effective. Norfolk farmers watched Station practice, made their own assessments and adjusted their practice accordingly. The extent of the changes brought about may be illustrated with data from the sugar beet crop. It was

always manured, but fertiliser dressings have grown from nil on the first crop at Jex Farm in 1912 to the very generous dressings now given. Indeed, current practice is to give extra nitrogen to increase top growth and thereby the forage yield for silage. Data are set out in Table 3.

The move from Sprowston to Morley brought a change of interest in soil fertility and structure. Fertiliser practice changed from applications designed for particular crops to treatments planned over the rotation as a whole. Further, a number of fields at Morley were relatively low in magnesium content and these received special attention for sugar beet, peas and potatoes.

Under the present cropping policy generous applications of both phosphate and potash are given for sugar beet and potatoes with little or none for the following cereal crops. The cereals then receive nitrogen only, as required. Sugar beet receives dressings of magnesium and sodium as well. That fertiliser practice is still subject to re-examination and change is shown in the Annual Report for 1977–78. In the long term fertiliser experiment, "Although some plots had not had phosphate or potash for five years, there is still no statistically significant response to either element when applied annually or on a three year rotational basis." Looking at the matter historically, it is apparent that modern intensive fertiliser practice was built up progressively to exploit the response of soils brought to low nutrient levels by long continued farming. This phase is over, and adequate levels of phosphate and potash have now been established. On these fertility levels, the prospect of using a more economical fertiliser regime can be explored. Only with nitrogen, which is rapidly lost from the soil, will it be necessary to continue the use of such liberal applications.

On the light soils of the Sprowston farm, it was not difficult to establish and maintain good seed beds, and satisfactory soil conditions throughout the cropping season. The move to Morley changed the situation in two respects. First, the soil is liable to consolidate into a rather impermeable, compact state if worked under unfavourable conditions. Secondly, the introduction of sugar beet and potatoes into Morley farming, together with the trend towards heavier tractors and machinery, has made consolidation worse, especially during root crop harvesting. In the sense that it is particularly susceptible to damage, and must be worked in good weather conditions if the damage is to be repaired, the Morley soil can be described as unstable. Much of Norfolk is endowed with soils of this character, and it is valuable for the farming of the County to have an experimental programme on the management of sensitive soils with modern heavy equipment.

Experimental work on tillage has therefore been expanded. Everything points to the desirability of reducing the number of passes in seed bed preparation — reduction of compaction, conservation of moisture, economy of labour and saving in cultivation costs. Considerable savings in sugar beet cultivations became possible as a result of spring mechanisation trials begun at Sprowston and continued at Morley. Minimum cultivation techniques that had been worked out on cereals elsewhere were not directly applicable on the Morley farm, where both sugar beet and potatoes are included in the rotation. The possibility of devising a minimum cultivation system, and even a direct drilling system, for use with rotations which include sugar beet, is under study.

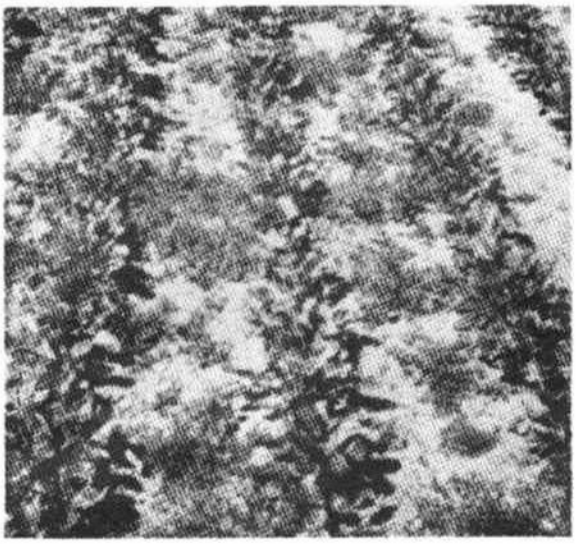
The new systems now being worked out are made possible by the application of modern power to farming. The Station has kept abreast of these

Table 3

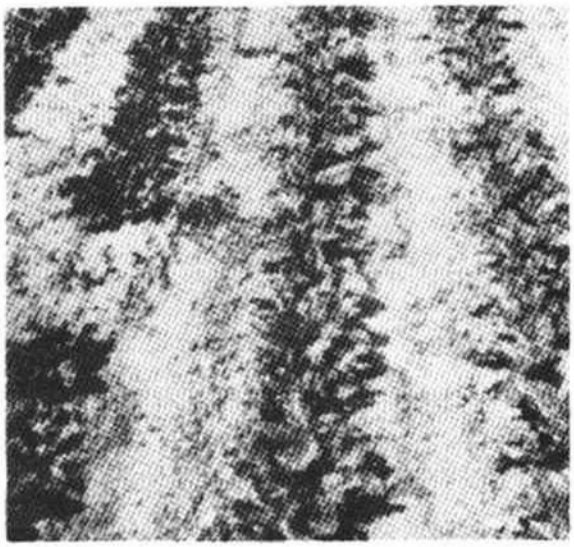
Fertiliser dressings applied to sugar beet at four dates (kg/ha).

Farm	Date	N	P_2O_5	K_2O	Mg	Na
Jex	1912	0	0	0	0	0
Sprowston	1928[1]	56	68	61–94	0	0
Sprowston	1936	75	68	126	0	0
Morley	1978[2]	143	77	300	30	160

Sources: 1. Sugar beet trials in Norfolk 1924–1927. *The Norfolk Agricultural Station, No. 7.*
2. Farm Guide. *Norfolk Agricultural Station, 1978.*



Control



Treated

Trial of Propham/Endothal immediately after sowing, 1958



Logarithmic screening trial, 1979

Plate VI. *Plot experiments in herbicide control of weeds in sugar beet*

developments. The first tractor was bought in 1932, the first combine harvester (estimated to cost £350) in 1942, and the last horses were sold in 1955. These events were but the forerunners of the extensive — and expensive — mechanisation of the last 20 years. The cost of implements and machinery is now a heavy drain on a farmer's resources, and the Station contributes to wise choice and effective use among the range of types now on the market.

The fourth major husbandry advance was in agrochemicals, the range of synthetic compounds that have revolutionised the control of weeds, pests and diseases. The revolution began with the discovery towards the end of the second World War, of the effectiveness of certain readily synthesised plant hormones in destroying broad leaved weeds in cereal crops. Spring spraying of cereal crops with these hormone herbicides soon became universal practice. About the same time, the exploitation of DDT and BHC began a new era in insecticide practice. Successes in the control of weeds and pests were such that chemical industry was turned to the development and testing of new compounds to widen the range of chemicals useful in agriculture.

It soon became evident that the use of agrochemicals posed problems that could only be solved by extensive and long-term field experimentation. The disadvantages of the early pesticides — persistence, and consequent pollution of the environment and destruction of beneficial as well as harmful insects — are well known. With herbicides there were also problems. On the one hand, inadequate selectivity resulted in damage to the crop to be protected, and on the other, the range of activity was in some cases restricted, and allowed some weeds to escape, and to multiply and become a major nuisance.

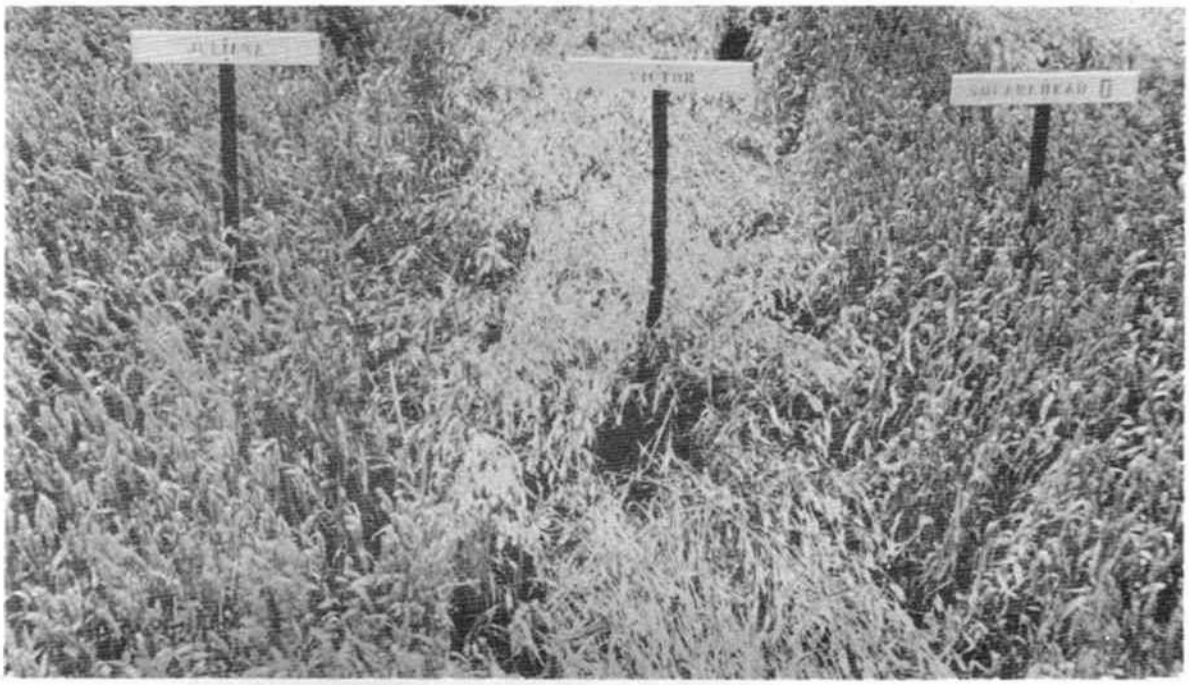
Experimental work on the Station has been devoted primarily to the establishment of satisfactory weed control regimes for the sugar beet crop. The beet crop presented the biggest challenge, and offered the greatest rewards, to those working on herbicides. But herbicides have a place in the husbandry of all crops on the farm, and the existence on the Station of an extensive and successful experimental programme on weed control in sugar beet provided a base for herbicide work on other crops. In particular, there was the need for work on the control of wild oats, which is the major weed in a farming system based on intensive cereal cropping. Herbicides became available that were sufficiently selective to kill wild oat seedlings in young wheat or barley. These were used on the Station, not only on cereal crops, but as components of mixtures devised to give season-long control of the whole range of weeds in sugar beet. The advent of weed beet has led to studies of control of the weeds of beet in crops other than sugar beet. In the approach to these problems is to be seen the same change as was discussed in fertiliser practice; herbicide practice is changing from applications designed for particular crops to treatments planned over the rotation as a whole (cf. fertiliser practice, p.42).

Pesticides have been used chiefly to control aphid vectors of virus diseases of sugar beet and potatoes. In some recent years, aphids have also been sufficiently serious on cereal crops to justify control measures. Effective and economical use of insecticides depends on accurate monitoring of the build-up of the insect population, and sound assessment of the damage that may occur in relation to the cost of control measures. In sugar beet the damage is direct in the initiation and spread of virus yellows in the crop. In potatoes it is indirect, in that the spread of virus in the crop is best controlled by preventing the establishment of foci of infection in the seed crop of the year before.

With high yield farming systems it is economic to control diseases that at low yield levels were best left alone. Hence there has developed in recent years an interest in fungicidal control of cereal diseases. The Station has led the way in the use of sprays and seed dressings, first to control cereal mildews and later to suppress epidemics of the whole range of cereal leaf diseases, and to reduce eyespot infection in wheat.

All this amounts to a heavy load in the testing programme. On the one hand, there is a wide range of pests and diseases that might be controlled if suitable agrochemicals were available at the right price, and on the other, the industrial research organisations produce new materials in great numbers. So the evaluation of new agrochemicals is a constant and sometimes burdensome load on the Station's programme.

It was by improvement in these major husbandry areas — fertility levels, cultivation efficiency, and the cotnrol of weeds, pests and diseases — that the great increases in yields since the last war have been achieved. These are factors that have affected the whole farming system. The improvement of individual crops and livestock enterprises will now be considered.



Variety trial of long strawed varieties, showing lodging, 1953



Variety trial of short strawed varieties, no lodging, 1979.

Plate VII. *Wheat variety trials*

The Yield of Cereals on the Station's Farms

Yield testing of crop varieties has been an important activity of the Station throughout its history. Simple plot comparisons of current and new varieties were made by the Station staff at Jex Farm and at Middle Farm. From the time of the move to Sprowston, the NIAB has been closely involved in all variety trial work, and from the early 1930s it has supported the trials, in the early years by paying for a member of the Station staff, and more recently by secondment of two of their own men.

Variety testing has grown in volume, both by the growth of NIAB responsibilities until they now cover the whole range of British crops, and by the increase in the numbers of new varieties following the expansion of plant breeding both in Britain and on the Continent. The trials on the Station are an integral part of the national variety testing programme, and are fully reported in the NIAB publications. For the purpose of this history, their chief interest is that they provide an index of crop yield on the Station's farms over a period of almost 70 years. Trends in yields are best illustrated from the cereal trials, and data extracted from them, quoted by permission of the Director of the NIAB, are given in Figs. 1–6.

Records of comparisons of spring barley varieties are available from 1909, and of winter wheat varieties from 1910. Oats, both winter and spring, were under trial from 1932, spring wheat from 1953, and winter barley from 1960. These dates reflect the importance of the cereal species for Norfolk farming in general and the Station's farms in particular. Spring barley and winter wheat have from the beginning been the prime cereals. Oats had an important place while cultivation was by horses. Spring wheat was low yielding and unreliable until the production of the post second World War generation of varieties, and is still generally a second choice to barley for spring sowing. Winter barley in the same way is a second choice to winter wheat, but its position also has been improved by the breeding of new varieties giving high yields of grain with good malting quality. In recent years all these cereals have been maintained in trial at the Station as part of the country-wide system of variety trials run by the NIAB.

At Jex Farm from 1909 to 1915, single plot comparisons were made of winter wheat and spring barley varieties. As varietal comparisons they are, of course, imprecise. No data are available between 1916 and 1922. Beginning in 1923, at Middle Farm and continuing at Sprowston from 1925 to 1937, results were recorded from comparisons laid out on Beavan's half drill strip design. In these, some confidence can be placed, but unfortunately over the period during which the Beavan layout was used, only in winter wheat trials over three years was a common control variety used in all pairs. In plotting the winter wheat data (Fig. 1), only those three years are entered for that period. They were 1923 at Middle Farm and 1925 and 1926 at Sprowston. For spring barley at that time, only yields of the standard variety are given. Randomised block designs were adopted in 1938, but trials had to be given up during the second World War. From 1945 there are complete runs of data from well designed trials. In some years more than one trial of a cereal was conducted. For those years the trial was selected in which the most important varieties of the period were included.

All the important cereal varieties were under trial from time to time. Very many that proved to be of no interest were also included, but these were dropped as soon as their performance had been evaluated. They are not considered further. Varieties which were good enough to be retained in the trials for not less than five years may be regarded as "Elite". They are the varieties that were of substantial interest at the time, and they provide evidence of changes in yield over the period of the Station's life. Not all of the Elite varieties were grown extensively. Year by year, one or two varieties in the trials could be picked out as leaders at the time. They were commonly used as control varieties while they led the field, and for two or three years after the emergence of a new leader. They are shown in the Figures as "First Choice", with the periods of their dominance.

Considering the secular trend in yield, the chart of mean yield of winter wheat Elite varieties (Fig. 1) showed a substantial rise over the years. In the 1910s mean yield was of the order of 2.5 tonnes per hectare. From the middle 1950s to the present time it was around five tonnes per hectare — double the yield at the beginning. In spring wheat (Fig. 2), the series only ran over recent years, by which time the gain in winter wheat yields had been realised. Yields were of the order of 3.75 tonnes per hectare, and there was little evidence of a rising trend over the two decades. Winter barley data (Fig. 3) likewise only covered the recent period. Yields were around 4 tonnes per hectare, with little evidence of a rising trend. The spring barley record, which is a long one (Fig. 4), is similar to that for winter wheat in showing a general rise in yield, leading to about a 50%

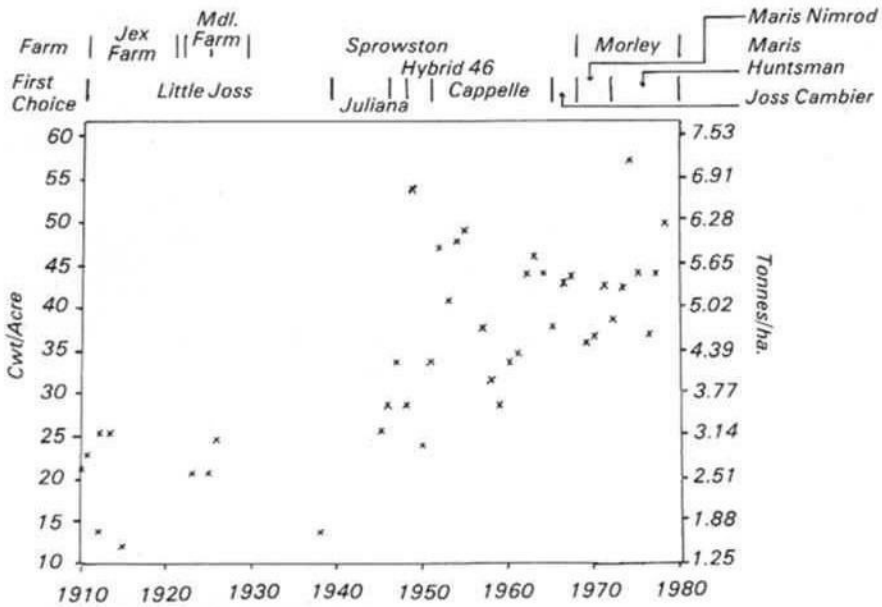


Fig. 1 Winter Wheat: Performance of Elite Varieties

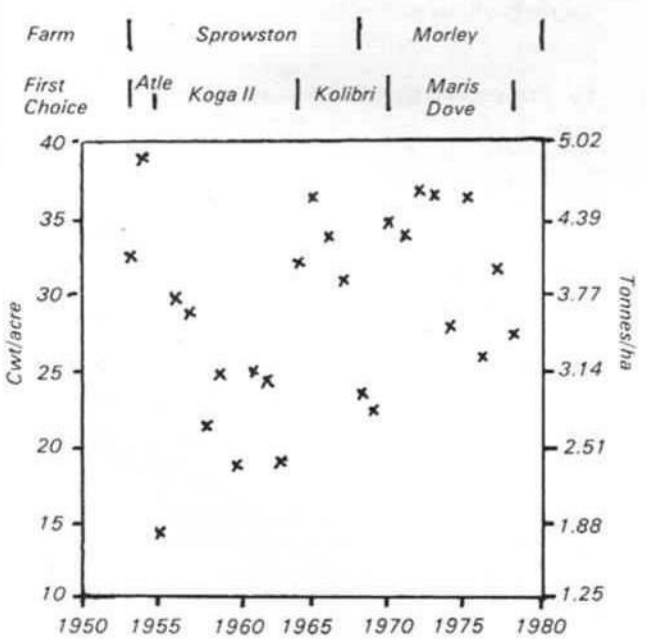


Fig 2. Spring Wheat: Performance of Elite Varieties

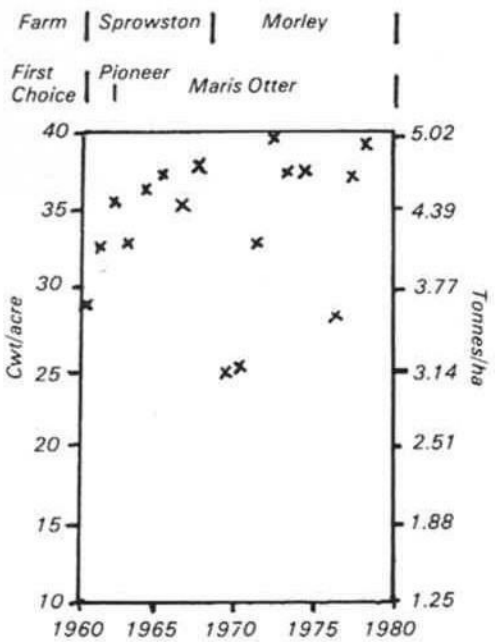


Fig. 3. Winter Barley: Performance of Elite Varieties

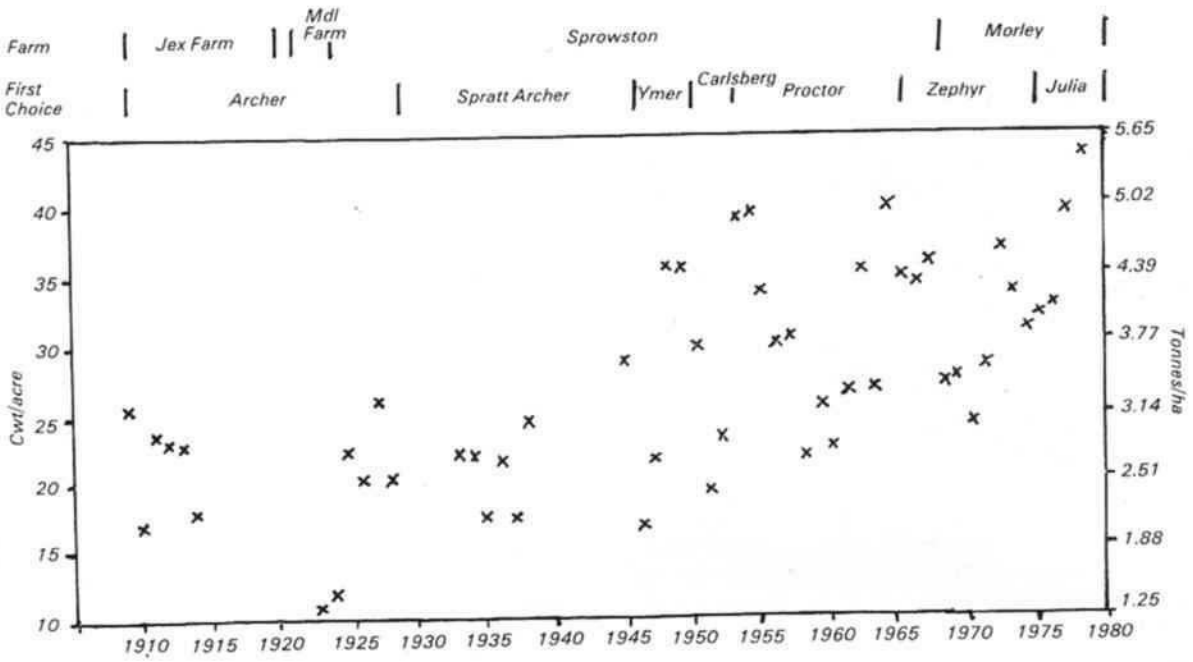


Fig. 4. Spring Barley: Performance of Elite Varieties

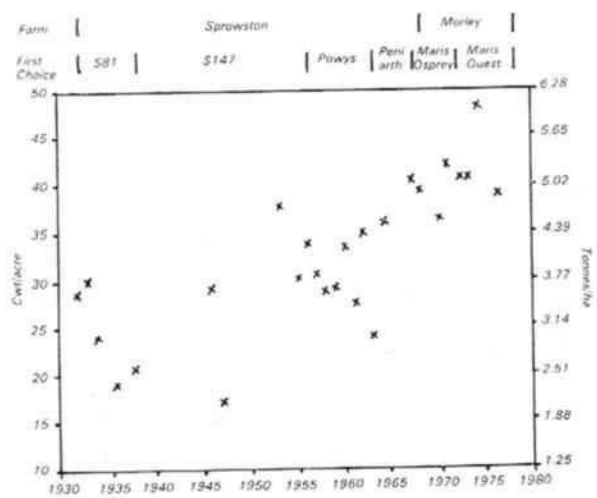


Fig. 5. Winter Oats: Performance of Elite Varieties

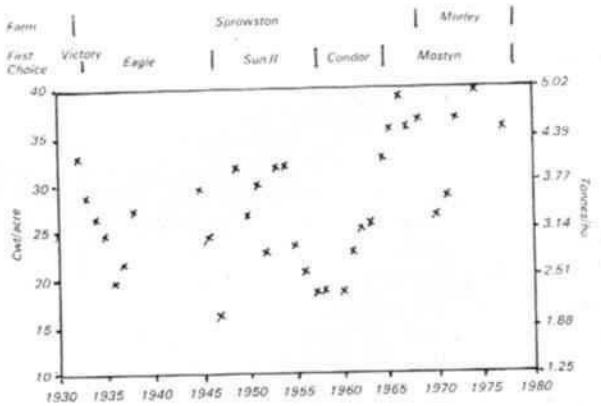


Fig. 6. Spring Oats: Performance of Elite Varieties

increase from the 1910s to the 1950s. Yields in the early period ranged around 2.5 tonnes per hectare, and from 1950 around 3.75 tonnes per hectare. Winter oats (Fig. 5) showed an increase comparable with that in winter wheat, but in spring oats (Fig. 6) the trend, though detectable, was not large.

From the data for those cereals that were in trial before the second World War — winter wheat, spring barley and winter and spring oats — it appears that most of the rise in cereal yields was achieved in the decade 1945–1955. These are trials data, and what was realised in well-managed trials was probably not achieved in general farming until the following decade, partly because of the time lag in getting Elite varieties that had been identified in trials multiplied for general distribution. Nevertheless, it is significant that the general rise in cereal yields took place over the period when the new inputs into agriculture, which during the war either had not been on the market or had been rationed, first became freely available. It was before the great increase in plant breeding yielded the spate of new varieties characteristic of the 1960s. While it is not possible to make a meaningful partition of yield increases between varietal change and husbandry improvement, it is clear that this great surge in yields owed as much to husbandry changes as to new varieties.*

The Introduction and Improvement of the Sugar Beet Crop

The supply of sugar from beet was built up on the continent of Europe both as a counter to British dominance of the cane sugar crop in the West Indies, and as a means of earning currency in Britain under free trade. The currency earned went into the purchase of British industrial goods, partly for consumption and partly to initiate an industrial revolution on the lines that had been so successful in Britain.

In consequence of this historical situation there was powerful opposition to the establishment of the crop in England. On the one hand, the colonial cane sugar interests were bitterly opposed to it, and on the other, industrialists, profiting from their ability to trade without restriction throughout the world, found the sheltering of a new crop in British agriculture against their commercial interests and also against the economic theory in which they believed.

The decision to foster the sugar beet crop in this country was a political one, powerfully reinforced by the shipping losses and consequent shortage of sugar in the first World War. Establishing the crop as a profitable component of the farming of eastern England was a formidable agricultural enterprise. In this the Station took the lead, and Lord Hastings' testimony to its influence (see p. 21) was universally endorsed. Other stations now share the load of experimental work, but the Norfolk Agricultural Station plays a large part in the continuing improvement of the husbandry of the crop.

The potential advantages of the new crop in Norfolk farming were, first that it offered the prospect of an extra and much needed cash crop, and secondly that it provided work for a large labour force at periods in the year when there was labour to spare. The extra cash crop has been the continuing advantage gained. As the large labour force ebbed away for social and economic reasons, high labour demand became a disadvantage, and labour saving on the beet crop became one of the major topics of study at Sprowston and later at Morley.

The history of the Station's work on the crop has been one of changing priorities among problems of seedling establishment, fertiliser practice, spring mechanisation, chemical weed control, and mechanised harvesting. All these had to be kept under constant review in the context of a changing farming situation. And all had to be considered together, and not as separate studies.

The Station's first sugar beet crop was grown at Jex Farm in 1912. It was drilled with a standard continuous flow Smythe drill and was hand singled. The land had been manured but not fertilised. Yield from a two hectare field was 65 tonnes of clean beet, or 32.5 tonnes per hectare. Dirt tare was 32.6%. The crop was sold to the Anglo Netherlands Sugar Corporation. Costs amounted to £34 per hectare, and returns from the factory to £28 per hectare. To this it was estimated that from £3.6 to £4.8 per hectare should be added as the value of the tops, plus any further value from the extra tillage that might be realised in the following crop. Thus the crop just about paid for itself, but the report concludes that against the advantage of an immediate cash return must be set the inconvenience of the extra work and the interference with cultivations in the autumn period.

Clearly something better than this was required if beet was to make a useful contribution to the

* See also Silvey, V. (1978) The contribution of new cereal varieties to increasing cereal yield in England and Wales. J. Nat. Inst. Agric. Bot. 14, 367–384.

Norfolk farming system. Indeed, apart from an early trial of dried beet pulp as cattle feed, little more was done until 1923 when a much extended beet trials programme was begun. During the rest of that decade, the programme included the first population studies (census of an acre, trials of varying row width at constant total population, and the use of a crude spacing drill), manuring and fertiliser rates and timing, the use of salt for beet, and variety trials.

The first Sugar Beet Demonstration Officer was appointed in 1927 and by 1930 the Station was growing 12 hectares of beet. At that time spring work had changed little. Drilling was with a corn drill with some coulters removed, and singling and weeding were by hand. A plant population of 75,000 per hectare was aimed at. Harvesting was by ploughing out and hand pulling, cleaning and topping. Yields were of the order of 26 to 30 tonnes per hectare.

By the outbread of war in 1939 the crop was well established, and throughout the war and in the post-war period home grown beet sugar had a vital place in the British food ration. During the war little experimental work was carried on, but the advisory service, built up in numbers and in authority under the War Agricultural Committees to meet the war time need, worked from Sprowston and based their advice on the Sprowston work. Beet yields in Norfolk remained about the same, of the order of 26 to 30 tonnes per hectare. Recommended plant populations were 75,000 per hectare, attained by hand thinning. Fertilisers were in short supply, and recommended applications were not always possible. Weeding was by hand and tractor hoe. The labour force was augmented by the Womens' Land Army, and later by prisoners of war. Harvesting was still by ploughing out and hand pulling.

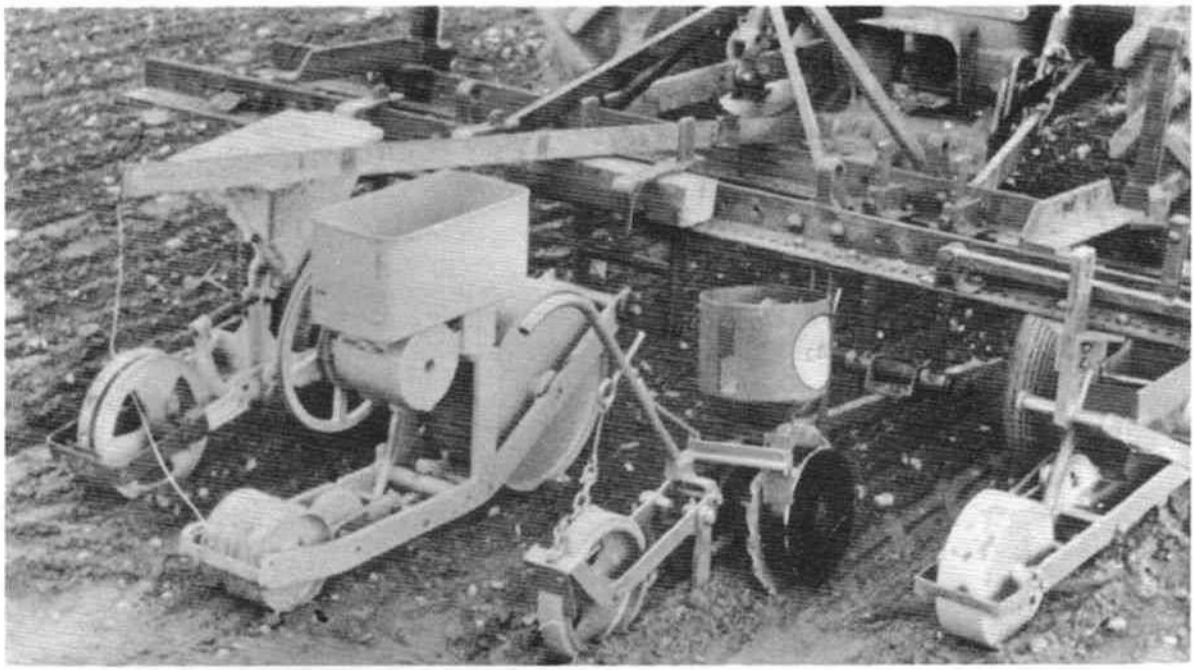
A steep decline in the number of agricultural workers began when the war ended, and experimental work on sugar beet in the post-war period became dominated by the need to mechanise the crop if it was to remain a part of a low-labour system of arable farming. Three major problems faced the experimenters: to establish a suitably spaced stand of seedlings; to control weeds until the beet leaves made a closed canopy between the rows; and to mechanise the topping, lifting and cleaning of the mature crop. Studies went on concurrently, since the three areas of interest were interrelated, but in some degree it will be necessary to report them separately.

The nature of the beet seed cluster was a major obstacle to precision planting. Several small seeds are enclosed in a hard, irregularly shaped, almost spiny case. Not only were the clusters difficult to space regularly, but also each one of them gave rise to several seedlings, growing so closely together that they were difficult and tedious to separate in thinning. First attempts to overcome this problem involved various methods of dismembering the cluster. The seed clusters were broken up, and the pieces were sieved to give portions containing fragments of similar size. The first process tried — a shearing process known as "segmentation" — was too drastic, and yielded a large proportion of damaged and inviable seed. A more moderate rubbing technique proved satisfactory, giving after graded sieving a seed sample with good germinating capacity that was widely used under the name "rubbed and graded" seed. Rubbed and graded seed was produced at Sprowston in 1947. Though it proved possible in this way to produce units mainly containing a single seed, the units were irregularly shaped. However, the use of such seed did save labour in thinning, because the time spent in separating multiples was much reduced.

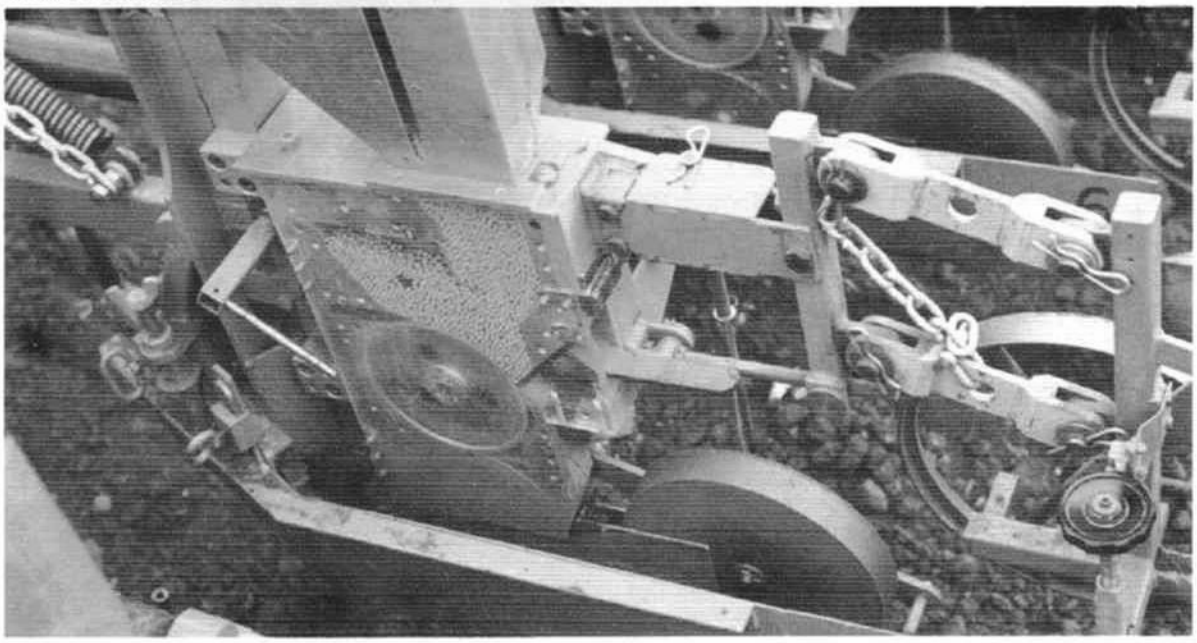
Experiments on plant populations and on the effects of singling at different stages went on in parallel with those on the form of seed sown, since all were interrelated in their effect on labour use. A thick stand of seedlings meant slow thinning. Early thinning gave the surviving seedlings the best chance, but a spread of thinning over time was necessary when labour was in short supply. And the more even the spacing of the seedlings, the quicker the hoemen could work.

By 1950, progress with the establishment of an even stand of seedlings was such that it was possible to study mechanical thinning. Some work on cross blocking had been done as early as 1932, but had not led to practical application. In 1949 cross blocking was tried on a stand grown from rubbed and graded seed, giving a more even plant than natural seed. Trials of spacing drills followed, together with down-the-row thinners, and then studies of the effects on the one hand of leaving doubles, and on the other of irregularity in spacing. Irregularity reduced yield by as much as 10%, and doubles were a nuisance in harvesting, contributing to the reduction in realised yield of up to 15% that was experienced with machine harvesting.

It was apparent that success in mechanising the establishment of a well-spaced plant population would be of limited value so long as weeding in the row remained dependent on hand work. However,



Early precision drill, 1953.



Prototype precision drill by the National Institute of Agricultural Engineering, 1978.
Courtesy of NIAE

Plate VIII. *Precision drills for sugar beet*

advances in herbicide technology were such that selective weed killers were then becoming available. The extensive and successful work on chemical weed control began with simple substances — salt, sodium nitrate, sulphuric acid and TCA — but synthetic compounds such as endothal and propham were soon introduced.

The first synthetic herbicides were lethal to broad-leaved plants, and sugar beet is broad leaved, but as the range of available compounds widened, advances in selectivity were achieved. Rayns saw the potential of chemical weed control in sugar beet. He wrote, "There is also much promise in the chemical control of weeds which, although it lags behind the cereals in its application to roots in current practice, may in the end give us a weedless root crop at singling."

The original aims in studying the use of herbicides in the beet crop were:

1. to reduce weed competition in the young crop;
2. to shorten the time taken in hand singling;
3. to provide a clean seed bed on which to operate the newly developed precision drills and mechanical thinners.

The chief problems to be faced were first mammalian toxicity, and when safety on that count was assured, then selectivity. The herbicide must be effective against as many as possible of the weeds in the crop, but must not depress the yield of beet. Then it must be reliable in action in an uncertain climate and on a wide range of different soils. In selectivity, great advances have been made. Herbicides are now in regular use that kill most broad-leaved weeds and leave beet seedlings almost unaffected. So choice of chemical and experiments on dosage have played a large part over the years, so as to maximise weed control without causing unacceptable damage to the crop. Soil incorporation was compared with surface application. Contact acting types must be applied on the surface. With many other herbicides soil incorporation reduces the variation in herbicide action due to variations in the weather.

Two further advances became available as the weed control work progressed. The efficiency of spacing drills, developed to sow processed seed of the rubbed and graded type, was much improved by "pelleting" the seed. This involved covering the rubbed and graded seed units with a smooth coat of an inert substance that broke up when buried in moist soil. More important was the discovery of a strain of beet in which the seed clusters were reduced so that each contained one seed only — the "genetic monogerm" condition.

Pelleting offered the prospect of substantial improvement in husbandry immediately. Monogermity was not so readily exploited. A long-continued breeding effort was necessary before monogerm types were produced which conformed to current standards in respect of such characters as root yield, juice quality, and resistance to bolting.

Without waiting for the refinement of the monogerm type by plant breeders, an early Bush Mono stock was used in the establishment of a 1.6 hectare field of beet at Sprowston in 1963, drilled to a stand (13cm. spacing), and with chemical weed control in the early seedling stages. The crop was successfully established with a stand of 80,000–90,000 seedlings per hectare. It was grown and harvested without hand work. The practicability of complete mechanisation was thereby demonstrated, but also it was shown that full mechanisation would involve considerable cost with perhaps a reduction in harvestable yield.

Weed control work in sugar beet was greatly influenced by progress in drilling to a stand. With the advent of monogerm varieties it became possible to reorganise the whole programme of spring work in the beet crop. With effective chemical control of weeds and the elimination of singling by drilling monogerm seed to a stand, the prospect emerged of growing the crop entirely without hand work. So herbicide work developed towards whole season weed control, using both pre-emergence and post-emergence treatments. And each advance in weed control involved further tests of damage to beet seedlings, checks to growth, or reduction in sugar yield. Some refinement has been achieved by the identification of compounds suited to particular soils — e.g. the highly organic soils of the peat fens — but ensuring effective action in a range of weather circumstances is largely a matter of judgement by the operator on timing and dosage.

Sowing monogerm or rubbed and graded seed to a spacing that was not to be adjusted later by hoemen involved accepting the risks of irregular germination and establishment. Trials of plots drilled to a stand compared with plots hand singled to approximately 75,000 plants per hectare showed that the greater variation in total population and the greater irregularity in plant distribution within plots drilled to a stand resulted in a loss of yield of

10–15%. The use of herbicides to control weeds also involved a cost and there was always the possibility that the chemicals might retard growth at least during the seedling stage.

In addition to yield losses from an irregular stand and from herbicide damage, there was a loss of roots from the beet harvester. Under field conditions beet inevitably grow to different sizes, whereas any harvester works most efficiently when the harvested product is uniform in size and shape. In field practice with sugar beet, a loss of 10–15% results from failure to harvest all the roots, particularly those at each end of the size range.

These considerations set the pattern of the research programme for the decade following 1963. By that time a yield potential had been reached varying from 36 to 48 tonnes per hectare according to the season, and the aim of the programme was to narrow the gap between potential and realised yield by minimising losses at three periods of (1) seedling establishment, (2) crop growth under herbicide control, and (3) mechanical harvesting.

The effectiveness of seedling establishment depends on the extent to which good germination conditions are provided. A series of spring mechanisation trials was begun in 1964. Cultivation practices were studied using new designs of cultivating equipment as they came on the market. Optimum row width and optimum spacing within the row were studied in spacing trials alongside the trials of seed bed preparation. The degree of regularity in spacing achieved affected uniformity of root size, and hence the efficiency of the harvester in collecting roots at lifting.

As the efficiency of spring work improved, outside trials were undertaken to study the new husbandry techniques on a range of soil types. The outcome of this series of trials was to synthesise a spring cultivation practice consisting of shallow seed bed cultivations with one of the modern types of cultivator, followed by drilling to a stand, overall sprayed with a herbicide either shortly before or shortly after sowing. To extend the duration of weed control the crop was also sprayed later with a post-emergence herbicide.

Variety testing has been increasingly concerned with monogerm types, and with polyploids. On the Station, polyploidy has on the whole shown little advantage. Monogermity has the great advantage that it makes possible the establishment of a well-spaced stand without hand work. The breeding effort put into the improvement of monogerm stocks in respect of good root yield, juice purity, high sugar content, and freedom from bolting, has paid off to the extent that multigerm varieties are no longer sown on the Station except for experimental purposes, and nearly all of the national crop is now grown from monogerm seed.

The results of the experimental programme must be assessed primarily in terms of the saving of labour. Mechanisation and chemical weed control are not cheap and it is for the farmer to determine the extent of mechanisation that is in his interests. The labour available is very limited so mechanisation and chemical weed control are necessary. The achievement of the Station has been to raise the efficiency of this form of production.

Season to season differences are so great that it is not possible to assess from yield figures the extent to which the Station has succeeded in pushing realised yields nearer to potential yield, but the evidence of the improvements in husbandry is clearly to be seen. The better seed bed preparation and the improved drilling techniques now recommended greatly improve the expectation of establishing an adequate and uniform stand of seedlings. Chemical weed control is now generally efficient, though some uncertainties remain. Weather at or after sowing may affect herbicide action, and changes in species composition of the weed populations and the emergence of new weeds, such as weed beet, pose further problems for the experimental scientist.

Experimental programmes for crop inprovement are of necessity long term, and three main areas of investigation retain their importance. Primary cultivations and seed bed preparation still offer scope for improvement. The screening of herbicides goes on as new chemicals appear on the market. Herbicide mixtures, the avoidance of herbicide damage, season-long weed control, and weed control as a contribution to clean cropping throughout the rotation — e.g. wild oat and weed beet elimination — have increased in importance. The progress of varietal improvement in monogerm stocks is monitored by the NIAB in variety trials, and with these are associated seed quality trials such as pellet composition, grading according to density, and seed priming. Plant distribution and machine harvesting continue to require attention. Finally, there is the wider interest in the place of sugar beet in the rotation as a whole, and in the radically different cultivation systems, such as direct drilling, that are now being studied.

The Replacement of the One-Year Ley

In revising the farming system to increase cash income, the Station's greatest success was in the establishment of the sugar beet crop, thereby replacing the fodder root break with cash roots. A similar improvement in cash earnings was to be obtained if the one-year ley in the four course rotation could be replaced by a cash crop. The incentive to replace the ley break was increased as horses were replaced by tractors, and as the sheep flock was given up. The need for hay was reduced, and grazing for the sheep was no longer required.

Between the wars there was a shift in vegetable production from the market gardens of Bedfordshire and the environs of London to the large farms of East Anglia. The Station undertook trials of Brussels sprouts, and was among those that first drew attention to the merits of the Cambridge-bred varieties. However, Brussels sprouts did not become an important crop on the Station, or indeed in Norfolk generally until the adoption of modern factory processing methods.

Potatoes were first grown on the Station in 1933. In the second World War the opportunity arose to develop the potato crop on a larger scale. Potato growing had been in the hands of market gardeners over most of the country and of specialist farmers in such areas as the Fens. It was national policy to increase production very substantially, and to spread it widely over the country. Norfolk was an area in which, apart from the silt lands, the crop had hardly been grown commercially, and in which it was to be encouraged. The Station undertook both to grow it on a considerable scale, and to offer advice on it to farmers.

Potatoes turned out to be much more than a response to the emergencies of war. They were integrated into the rotation and as long as the Station remained at Sprowston potatoes made a steady contribution to cash income. At Morley they are less well suited, but are still a useful crop, even though profit margins are less consistent than at Sprowston. Moreover, the associated experimental programme is of continuing importance to Norfolk farmers.

The experimental programme began with variety testing and with studies of husbandry practice. For many years the standard established varieties — Majestic and King Edward — were not superseded, but from the 1950s a proportion of the acreage was planted to the crisping varieties Bintje and Record. More recently Pentlandfield and Maris varieties have been prominent.

Husbandry work was largely devoted to land preparation, reduced cultivation systems, bulking trials, and studies of the influence of cultivation practice on ease and efficiency of harvesting. Herbicide work is recorded elsewhere. It is sufficient here to note that the herbicide programme primarily devoted to sugar beet made possible work on weed control in potatoes at little extra expense.

The cost of seed potatoes has always been an important factor in the economy of the crop. The limiting factor in producing seed potatoes at home is virus disease, and the availability of effective pesticides made it possible to set about preventing the spread of virus by controlling its aphid vectors. In the Station trials it was shown that with careful and rigorous insecticide control, it was possible to produce at home seed potatoes in which virus infection was at a very low level. Trials of home-produced versus bought-in seed showed that yields from good home-produced seed were as good as those from Scotch seed.

Peas are an old-established crop in English farming, and they were tried as early as 1932 in the search for alternatives to the ley break. Their disadvantages are well known. They are difficult to keep clean of weeds and unless the weather is favourable at harvest they are difficult to dry. Consequently the grain is often of poor quality. Dry peas were grown for some years, but there was at that time no way of overcoming these disadvantages. The situation was changed by two new factors. First, the food processing industry developed the packaging, freezing and distribution of green peas, with a consequent large scale demand for peas for freezing. Secondly the development of herbicides made weed control in the crop a practical proposition, and the Station was in a position to extend the herbicide programme to exploit the new opportunity. The development of viners made the threshing of green peas possible, and the crop expanded rapidly in Norfolk in the 1950s. Experimental work on peas at the Station was limited to variety trials and tests of herbicides.

Vining peas were grown on a substantial acreage at Sprowston, and, besides the cash return from the peas, yielded a large quantity of haulm that made valuable silage for feeding to beef cattle. The replacement of static by mobile viners made it more difficult to recover the haulm, but if the weather is good it is possible to make a pea haulm hay in the field, so in most seasons there is still a useful by-



Potato varieties susceptible (left) and moderately resistant (right) to blight. 1956.



Sampling pea variety trial, 1979.

Plate IX. *Trials of potatoes and peas*

product from the crop.

Vining peas, like sugar beet, go through a factory process before they reach the consumer. There is only a restricted open market for the farmer's produce, and the acreage under the crop and its distribution in the country is very dependent on the capacity and the location of the processing factories. Crops are usually grown on contract with processors, and contracts are only available to farmers within transport range of the factories, and up to acreages that are estimated to yield the amounts the processors require. In sugar beet, the size of the market for home grown sugar is politically determined, and the acreage for which contracts are offered does not vary widely from year to year. For peas, however, the situation is less stable. Frozen peas are expensive to store. Yield varies considerably from season to season, and consumption also may vary from year to year. So the acreage for which contracts are offered varies according to stocks in hand and market prospects at the time. Thus in addition to all the agricultural problems and possibilities with other crops, in working with the pea crop it is necessary to maintain a system sufficiently flexible to encompass considerable changes in acreage in response to year to year fluctuations in demand from the food industry.

To sum up, there was no single answer to the problem of replacing the one year ley by a cash crop. However, with the more flexible rotations now customary, vegetable crops have been introduced onto Norfolk farms, and have increased cash income. Potatoes and peas have been the most important, but others such as Brussels sprouts and carrots have a place on farms with suitable land, and with access to processing.

Livestock

Norfolk farming has traditionally included the use of a wide range of livestock. Horses were the motive power of the farming system until displaced by tractors. Folded sheep and yarded beef cattle were integral parts of the New Husbandry system. Ancillary livestock consumed farm wastes, and provided housekeeping money for the farmer's wife, as well as milk, eggs, poultry and bacon for the farm kitchen. The Norfolk Agricultural Station began with the whole range of stock. The account of the entry into Jex Farm at Michaelmas 1908 (p.12) records the purchase of horses, bullocks and ewes, and it is noted that pigs, turkeys, geese, fowls and ducks were still to be bought. Some of the latter were maintained as special enterprises for a considerable period. The County egg-laying trials were conducted on the Station, and the County supported advisory work on poultry between the wars. Over the same period, a small pig enterprise was maintained. Both poultry and pigs had a bad record of disease, and were given up in 1945. Turkeys, on the other hand, were taken up seriously in 1954, when finance was provided from American Conditional Aid. Disease control in poultry was much better by then. The flock was slaughtered when there was an outbreak of Newcastle disease, but otherwise the health record was good. The unit was maintained for ten years and the Station's work made a valuable contribution to the technology of turkey production.

Of the three major livestock species, the history of horses and sheep on the Station is of decline and eventual disappearance. The replacement of horses took time. The first tractor was bought in 1932, and the last horses were not sold until 1955. The use of energy from oil instead of energy from oats, beans and hay released land for crops for direct sale, and so contributed to the main thrust of the Station's work, the increase in crop production for cash sale. The displacement of sheep was a less clear-cut exercise. The flock was heavily dependent on fodder roots for autumn and winter feed, and the introduction of sugar beet posed a direct threat to it. That threat was lifted when it was shown that sugar beet tops offered an alternative to fodder roots for feeding sheep. The Station never had a ewe flock. Sheep were bought in for folding, as long a they were needed for sheeping trials. When these came to an end they were given up, more on account of their high labour demand than because of the loss of the fodder roots. The farming system was simpler without them, and in an era of low farming returns, once it was accepted that they were not essential for the maintenance of fertility, there remained no particular inducement to keep them.

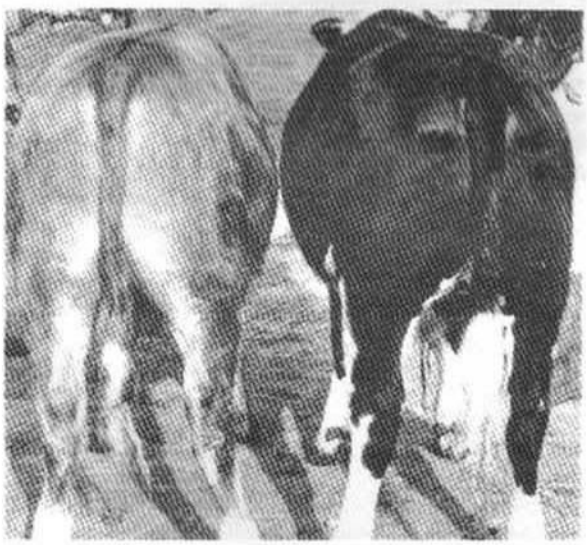
Cattle offered two possibilities; winter beef out of yards, or milk from summer grass and from yard feeding in winter. Milk production had not been an important enterprise in Norfolk, but it was developed considerably by Scots dairy farmers who took Norfolk farms in the 1920s and 1930s and brought their cows — mostly Ayrshires — with them. The Committee considered starting a dairy enterprise, but they never had enough land at their disposal to service a dairy herd without cutting back in the experimental and demonstration work on arable crops. However, dairying became an important aspect of the advisory work. Hygiene in milk production was poor and milk frequently carried tuberculosis and brucella. Better production methods were established through the Accredited Scheme and by organising a Milkers' Competition. The Milkers' Competition, with its final rounds at the Royal Norfolk Show, became the largest of its kind in the country.

A close association was developed with the County Medical Officer in the campaign to rid the milk supply of tuberculosis and brucellosis. Cooperation with farm workers in the milk enterprise was also essential for success, and an annual "Milkers Mardle" was organised and proved very popular. This close cooperation between the advisory staff and the workers proved rewarding, and was the forerunner of the Stockmens' Clubs and the Farm Machinery Clubs that were set up after the second World War. In this, the Station led the way, these clubs being set up in many parts of the country after the war, on the Norfolk model.

Work on beef production was easier to organise. Each of the Station's farms was equipped with cattle yards, though they were not of a high standard. There was a long tradition in the county of fattening store cattle brought in by dealers from grazing counties, so there was no need to begin by breeding



18 month beef: Friesian steers, 1954.



15 month beef: Charolais X Friesian and Hereford X Friesian steers. Demonstrated by Sir John Hammond, 1964. (Reproduced from Farming World).

Plate X. *Beef from the dairy herd*

beef calves. And there was an incentive to maintain an interest in yarded cattle, in that husbandry work on the fertility of arable land showed the value of FYM. For it became clear as the straw disposal trials progressed, that FYM had an important place in the production of the cash root crops — sugar beet and potatoes — that the Station had been successful in bringing into the Norfolk farming system.

These considerations ensured that the cattle did not go the way of the sheep, but other factors also arose to consolidate the place of yarded beef in the emerging farming system. The market moved away from fat beef from big mature steers, and a demand arose for much smaller, leaner joints. Sir John Hammond and those who worked with him showed that the changed demand could be met by fattening male calves from the dairy herds, and in particular from Friesian dairy herds. The Station moved from purchasing dealers' cattle ready to go into the fattening yards to contracting for autumn born male calves from a neighbouring dairy herd. This involved calf rearing, a new enterprise and one to which the results of dairy research could be applied. The calves were winter reared, summered at grass, and finished on a ration based on pea haulm silage in yards in

their second winter. This "18 month beef" system was pioneered at Sprowston, and later taken up widely in the country.

Buildings were needed both for calves and for fattening cattle. As early as 1946 a building sub-committee made recommendations. They reported that "the sub-committee believe that the future of straw disposal is either to make first class muck or to recognise that muck made in open yards is often nothing but wet straw and that it would be more economical to leave the straw on the land and plough it in with the appropriate addition of nitrogenous fertilisers." When the purchase of Oak Lodge and its farm buildings in 1958 made it possible to provide an efficient and economical beef unit, the old horse stables were converted into a calf rearing unit, and covered yards were built for fattening.

The Station undertook straightforward farmer-oriented trials of feeding systems, and comparisons of breeds and crosses. The latter included trials of Charolais crosses following the introduction of the breed from France. Indeed, only a few months before his death Sir John Hammond gave a demonstration on carcasses of Charolais crosses from an experiment at Oak Lodge financed by the Ministry of Agriculture. (Plate X.)

Economical production of beef depended on producing a large part of the feed on the farm. The grass on the Station provided summer grazing and hay as a contribution to winter feed. Experiments in crop drying were carried out after the second World War, but did not lead to a remunerative enterprise on the Station farm. In the root break of the arable rotation, high dry matter varieties of mangels were grown for a time. Sugar beet by-products, on the other hand, made a substantial and continuing contribution to livestock rations. Beet pulp, ensiled wet, dried, or dried and dressed with molasses, was used consistently from the time it first became available. The value of the tops was demonstrated, but between the wars and for some time after it was cheaper to buy in imported feeding stuffs than to conserve beet tops. In recent years the balance of advantage has changed, and beet tops are now collected and used, either fresh or ensiled.

Ensiling has been used as a way of conserving forage and saving wastes. Maize was grown for this purpose at one time, but with the varieties then available, and the equipment used, it was not successful. The most successful use of silage was for the conservation of pea haulm from vining peas, in the years when the crop was hauled to static viners. Potatoes have been ensiled satisfactorily, as a result of experiments carried out in collaboration with ADAS, and the procedure worked out promises to be useful for the preservation of both wastes and surpluses.

Buildings are expensive and long-lasting, and it is not given to many agricultural institutions to design and build a livestock unit twice in 20 years. The move to Morley made it possible to build there a beef feeding unit, planned with the advantage of experience of the Oak Lodge unit. The old cowsheds on the farm were suitable for adaptation for calf rearing, and a large shed roofed with a metal imitation of Yorkshire boarding was erected as a fattening shed. With the Oak Lodge experience of the need for experimental feeding facilities, a section of the fattening building was equipped for individual feeding. The shed came into use conveniently for the revived interest in conservation and feeding of beet tops, and the opportunity in years of surplus to ensile potatoes for stock feed.

For the future, it may be said with some confidence that the place of beef in the farming system is assured, in that it is a means of utilising by-products of various kinds as they arise in the course of practice of a flexible farming system.

Part 3

Appraisal

by J. B. Hutchinson

Achievements

The area served by the Norfolk Agricultural Station has always been one of predominantly arable farming, with much the greater part of the land in the tillage rotation. Traditionally, permanent grass was limited to river meadows with a high water table, park land kept in grass for amenity or for reasons of topography, and home pastures where working horses and house cows grazed. Historically, the era of the 18th century Norfolk improvers was characterised by the rationalisation of the farm, the careful return of the elements of fertility to the land, and the corollory of minimising the export of fertility off the farm to the town. The arable land was farmed on the four course rotation, and the major sales off the farm were of cereals, and of meat, dairy produce and wool from the livestock enterprises. Minor sales, very important in the household economy, were of eggs and poultry. Turkeys were often kept, and were sold around Christmas. Ducks were kept in some parts of the County.

Outgoings included land charges (rent, or the servicing of borrowed capital), maintenance and repairs. Farm equipment costs were largely payments to local craftsmen, and purchases of manure and fertilisers were small, so the land charges were the chief expenses. The whole added up to a largely self-sufficient rural economy.

The success of the system depended on the overall price level for agricultural produce, and on a satisfactory relationship between the price of livestock products and of cereals. By the 1880s, when the Norfolk Chamber of Agriculture and Farmers' Club began to think about experimental work, this productive and well balanced system had been hit by a deep farming depression. The virgin lands of the New World yielded food in abundance for the growing industrial cities, and the price level for farm produce fell drastically. The relationship between prices for crops and for livestock also changed, greatly to the disadvantage of livestock enterprises. So Norfolk farmers, committed to a system designed for, and successful in, circumstances that had passed away, found themselves under extreme economic pressure.

All good things harden and become stereotyped over time, and in due course lose their advantages. The New Husbandry of the 18th and early 19th centuries — rather particularly the product of Norfolk thinking and enterprise — was, by the early decades of the 20th century, so inflexible as to have become an impediment to change. And change was needed if Norfolk farmers were to withstand the impact of the over production of food following the opening up of the New World.

The inter-War years were years of change, in response partly to the pressures on the industry and the emergence of limited new opportunities, and partly to the advantages of belated, but welcome, Government aid. By 1939 the classic Norfolk four course rotation had ceased to be the inviolable code of practice that it had been in 1920. There still remained traditional constraints, particularly in the tenancy agreements of rented farms, but these were swept away under the impact of the critical food supply situation in the second World War. The combination of advice and sanctions by which British agriculture was shaped to meet the needs of the war years resulted in an entirely new climate of opinion in 1945.

This was fortunate, in that an entirely new social and economic situation had emerged. The world's

growing industrial population had caught up with the potential for food production, and a new relationship between town and country was generated. The period of change and intensification that followed was a period in which the self sufficient rural community was integrated in the urban economy, and farming was thereby enabled to take advantage of industrial technology. The fertility drain inherent in a society that pours its waste into the nearest river was made good with industrially produced fertilisers. Industrial chemists devised means of chemical weed control that gave the farmer an advantage over his adversaries that he had never had before. Power and equipment became available that gave him much better means of meeting the hazards of weather and the problems of soil management. In return the farms provided food for the urban population. It is a measure of the success of high farming with massive industrial inputs that food supply not only kept pace with the vast increase in city populations, but also fed the western world more lavishly than ever before.

The Norfolk Agricultural Station was set up by men who were in the very difficult circumstances of the farming depression. It was destined to provide information and advice, not only during the depression, but also in the emergency years of two world wars, and in the quarter century of agricultural expansion that followed. Those who initiated the enterprise had the advantage of the interest and whole-hearted support of Prof. T. B. Wood, the Drapers' Professor of Agriculture in Cambridge, and Mr (later Sir) John Hammond, themselves Norfolk farmers with farmers' problems and the farmer's point of view. So, in their self-help enterprise there arose from the beginning a partnership between science and practice that governed the planning of the experimental programme, and the dissemination of the ideas generated on the Station.

The partnership was not always an easy one. Change was the whole purpose of the work of the Station, but change does not come easily to farmers with long term commitments. The minutes of the Committee meetings in the early Sprowston years reflect unease, and in some cases formidable opposition, when changes in the classical farming system were proposed. Nevertheless, flexibility and room for experiment were introduced without serious discord.

After the second World War, it was not immediately apparent that the world situation had fundamentally altered. There were some who looked back apprehensively to 1920 and the abandonment of British agriculture by British urban society. They prepared to revert to a low cost, low output farming system. Most farmers, however, took the political risks and seized the opportunities offered by high farming. Once the necessary inputs became freely available, they used them with energy, and with good judgement born of the hard choices and limited prospects of the past.

The nature of the new situation was soon appreciated, and there followed the rapid dissemination of new agricultural technology, which generated a grand period of agricultural growth.

In this great range of agricultural circumstances — deep depression, wartime emergencies, and the challenge of the need to feed a growing population — the Norfolk Agricultural Station provided leadership for the Norfolk farming community. This leadership was not a matter of a series of separate and unrelated advances in farming practice. Rather, it was a consistent pursuit of change and adjustment in the farming system as a whole.

In the early years at Jex Farm, the Station began the long campaign for pure seed of farm crops. Their seed barley was the only reliable stock in the country. By 1920 seed purity and seed testing had become the responsibility of the NIAB, and the NIAB variety testing scheme was worked out from the beginning in collaboration with the Norfolk Agricultural Station.

The recognition of the place that sugar beet might occupy in the farming of eastern England was particularly due to Rayns at Sprowston. It called for foresight and imagination, for the returns from the early sugar beet crops were barely adequate to keep it in the programme, and the effects of the crop on the farming system as a whole were diverse and daunting. Moreover, as the Station's work cleared the farmers' doubts on the maintenance of fertility, showed that he could dispense with the sheep flock without disaster, and solved the problems of the use or disposal of by-products, so new questions arose from the changing manpower situation. Spring mechanisation was worked out at Sprowston and Morley, and there the pioneer work was done on advanced fertiliser practice, and the use of agrochemicals for the control of pests, diseases and weeds. Then at Morley, the integration of cultivation practice, drilling to a stand and weed and pest control, were demonstrated in heavy, clean crops of beet. Indeed, the sugar beet work is perhaps the best illustration of the continuing leadership through

experiment and advice in changing farming circumstances.

Programmes were closely integrated. The original enquiries into seed drill performance and seedling distribution, for example, were carried out on cereals, and the first precision drill invented under the stimulus of that work was a drill for cereals. But the most important outcome was the development of precision drills for sugar beet.

In like manner, the demonstration arising out of the sugar beet work that fertility could be maintained without keeping stock to make FYM had important consequences for the husbandry of the cereal crops. Straw disposal trials at Sprowston laid the foundations of knowledge on which modern intensive cereal husbandry is based, and provided factual information on the costs and benefits of specialist cereal farming.

The Station's work was dominated by the need to increase the cash income of the farming system. For the greater part of its life, the cash return from livestock enterprises was low compared with that from crops, and successful application of the Station's conclusions usually resulted in reducing livestock, or eliminating them altogether. There were exceptions to this which the Station exploited. The most profitable livestock enterprise was dairying, for which the Station never had facilities. However, under Sir John Hammond's guidance the use for beef production of surplus calves from the dairy herd was explored in the Oak Lodge buildings at Sprowston. This was indeed an exercise in the exploitation of waste products. The calves were in a sense "waste" from the dairy herd, and pea haulm silage, chat potatoes, beet top silage, and cereal straw were among the waste products that were exploited in producing beef. One other livestock enterprise — turkey production — had a place in the programme. Taking the opportunity offered by American Conditional Aid, the Station led the way in changing turkey production from a minor farm yard activity to an intensive commercial enterprise.

These are some of the topics studied on the Station, most of them continuously over more than half a century. They were studied by the members and for the members, because from the beginning the Station belonged to the members. In the early years members of the Committee managed the farm. They not only owned it they had to see that the books balanced at the end of the year. As the Station grew in strength, the Committee recruited the staff and determined the directions in which the programme developed. This tradition of running their own affairs and balancing their own budget has been of great importance to the credibility, and indeed the authority, of the Station's advisory work. There is no higher body to make good deficiencies or to absorb profits, and Norfolk farmers are well aware that the advice they receive from the Station has been, in Prof. Wood's phrase, backed by the Station's own cheque book.

This independence, repeatedly emphasised by Lord Hastings at Annual General Meetings, and defended with determination against all attempts to absorb the Station into County or Government institutions, found expression in the membership scheme which was launched in 1924. As an index of the growth of interest in, and commitment to, the work of the Station, the numbers of members are given below for four dates, together with the numbers of holdings of 20 acres or more recorded in the June returns for Norfolk in those years.

Year	Members	Holding 20 acres and over
1930	496	6898
1944	871	5345
1957	1121	6103
1977	970	3782*

* 10 ha and over

The figures give a rough index of the proportion of the larger farmers who were members, and it will be seen that though the number of farms and farmers fell, the index rose. Perhaps the most significant single act of support for their Station by the members was the subscription of £15,000 in debentures in 1950 to finance the purchase of Church Farm, Sprowston. Less easily assessed, but of greater enduring importance, is the regularity and confidence with which something like a quarter of the larger farmers in Norfolk seek the advice of the Station staff.

The history of the staffing of the Station deserves attention, first because the success of its work is so largely attributable to the quality of the men who served it, and secondly because of the massive contribution of the Sprowston-trained men to the advancement of agriculture in other parts of the country both during and after the second World War.

The farm was run originally by a farm manager under the direction of two of the Committee members. Scientific direction began with C.

Heigham, who was appointed Director/Secretary in 1922. In 1924 S. T. Johnson was appointed Assistant Director and H. B. Cowell crop recorder and meteorologist. By 1926 there were the Director and Assistant Director, two field trials men, a sugar beet demonstration officer and a poultry officer. In the 1930s there were usually four men at Sprowston, and in addition a West Norfolk office was maintained at King's Lynn, with an advisory officer and a poultry officer. For East Norfolk a similar staff worked from Sprowston. The advisory staff was employed by the County Council, but the team was so well integrated that it would be misleading to differentiate between Station and County Council staff in the record.

During the second World War the staff was much reduced, and the emphasis was on advisory work, all members working in collaboration with the War Agricultural Executive Committee. With the establishment of the National Agricultural Advisory Service after the war, the advisory appointments were discontinued, and the advisory staff and some of the experimental officers transferred to the NAAS.

In 1947 the Director and Assistant Director were supported by two field assistants, a sugar beet virus yellows officer, and a student assistant, making six in all. The staff was seven in 1951, including for the first time a member of the staff of the NIAB seconded to manage the variety trials. The growing importance of chemical weed control was recognised by the designation of one post for this work in 1952. The staff grew to 10 by 1963 and 12 by 1966, remaining unchanged thereafter. (Turkey centre staff are not included.)

The pattern that has emerged is of a Director supported by an Assistant Director until 1968, when the post of Assistant Director was discontinued and two Senior Technical Officers were appointed. The trials staff of nine or ten includes two NIAB appointments, and at least one concerned with chemical weed control and paid for by the SBREC. There are two officers on secondment, formerly from the NAAS and now from the ADAS.

Recruitment was for many years almost exclusively from the School of Agriculture, Cambridge, among men with a Natural Sciences degree who had gone on to take the Diploma in Agriculture. In the 1960s and subsequently, the Station has drawn more widely on the Agricultural Faculties of British Universities.

The Station established a leadership in the application of agricultural research to farming practice in the 1930s and maintained it through the stress of war and the changes of the post-war period. In consequence it became a major recruiting ground, first for County advisory staff, and later for the NAAS and the EHFs. Many County Officers in the NAAS and Directors of EHFs were Sprowston trained. In addition, the close contact between the Station and the NIAB and the Weed Research Organisation has been cemented by the exchange of staff that has gone on in connection with their work on the Station. Successive Directors, Assistant Directors and senior scientific and management staff are listed in an Appendix.

The achievement of the Norfolk Agricultural Station was more than the establishment of relations of confidence and understanding between a local experiment station and its farmer members. It was set up to improve communication between Universities and Research Institutes on the one hand and practical farmers on the other. In this it was very successful, and made a contribution of national significance. The Station was well placed. Besides the usual sources of information and advice, Prof. Wood ensured that there was always contact with the Cambridge School of Agriculture. He provided most of the staff in the early years from among his students. Sir John Hammond used Sprowston as a major out-station for his beef work. Rayns drew on other Universities and Research Institutes also, adopting for example the new ideas first put out from Rothamsted on the design and conduct of field experiments. He thus for the first time brought rigorous testing procedures under the scrutiny of practical farmers.

The traffic was two-way. Advances in practice and in knowledge do not always begin in the research laboratory, to be handed down to the practical man. Ideas and information arising in practice also serve the needs of teaching and research. From the time that the Station was established at Sprowston with a substantial experimental programme, it became a force in agricultural education and research over the whole country. Sprowston papers were a part of the research literature, and Sprowston findings and practice held a prominent place in agricultural teaching. Thus the Station met a need, formerly scarcely recognised and never properly filled. This was the need for an organisation in the middle ground between research and practice, interpreting each to the other and promoting the exchange of information and ideas.

One other significant feature of the Station's

activities should be recorded. Advisory work must carry conviction, and nothing is so convincing as to see precept put successfully into practice on the experimental farm. But it is one thing to demonstrate the results of successful experimental work, and quite another to carry the costs of the experimental programme, which inevitably includes disappointments as well as successes.

In the last five years the availability of basic resources has altered radically. Though there are not at present actual shortages, forecasts of needs and estimates of availability are such that prices have risen enormously, even though demand is at the moment almost static. The depression in the 1920s was accompanied by heavy falls in price. The recession of the 1970s has been aggravated by enormous rises.

Agriculture has in earlier times experienced periods of rapid advance, and of stagnation and sometimes of decline. Advance has come from the conjunction of new opportunities and new ideas, and when these have been exploited a static period has followed until some other new factor made a new advance possible. Enclosures, making the farm a more independent unit, and the ideas of fertility conservation by the integration of crops and stock, gave the opportunities and ideas for the New Husbandry. By the end of the 19th century their force was spent, and in terms of world food supply the initiative passed to those who exploited the virgin lands of the New World. The balance was redressed when population created the demand and industrial technology provided the means for the advance in productivity after 1945. British farming has reaped that harvest, and if we are to look forward to further increases in productivity we must seek new initiatives.

Current opinion, conscious of the success of the application of industrial technology, looks to further technological advance for the further increases in productivity that are expected. That there are possibilities of further substantial advances in yield is evident from trial data. For example, the yields of Elite winter wheat varieties in trials between 1953 and 1973 varied between three tonnes and six tonnes per hectare, a vastly greater range than between Elite varieties in the same trial. These differences between trials arose from differences in weather, in soil conditions, and in the cultivation practices imposed by weather and soil. Every farmer knows that it is not possible to grow all crops in all years to the best advantage. Equally, it is accepted that the best farmers are those who have the skills and the initiative to meet the diversity of conditions and turn their incidence to the best advantage.

Here is an area of uncertainty well worth exploring, and much of the experimental work now in progress is designed to improve the farmer's control of growing conditions, and his ability to sustain high yield levels in spite of the natural hazards with which he is faced. This approach grew out of the work on spring mechanisation in the sugar beet crop. Spring mechanisation led on to the study of seed bed preparation with the object of ensuring rapid and regular germination, followed by growth unrestricted by adverse soil conditions. Minimum cultivation techniques and direct drilling in rotations of cereals and root crops have been studied with similar objectives.

Costs have been met in various ways. The financial position was greatly improved in each of the two World Wars. Experimental work was then at a minimum, and all the emphasis was on the full application of established knowledge. Some capital has accrued from the scale of Sprowston land. The Ministry of Agriculture has contributed by seconding members of the NAAS and more recently the ADAS to the staff of the Station. The NIAB has seconded staff and has reimbursed the costs of variety trials. Livestock experiments have been undertaken for fees. The support of the SBREC for the sugar beet programme has brought in the biggest outside contribution to the Station's budget. In this way the farming income has been supplemented and the budget balanced.

All this adds up to a straightforward, down-to-earth activity. It has none of the glamour of fundamental research, but fundamental research does not lead to agricultural innovation without intermediaries between the laboratory and the farm. The Norfolk Agricultural Station pioneered the role of an intermediary, and in this it has been outstandingly successful. When Mr. Sancroft Holmes, Lord Hatings and Prof. Wood initiated the enterprise at Jex Farm, they fathered an institution that played a vital part in the agricultural revolution that took place 40 years later. Founded to help Norfolk farmers to face a disastrous agricultural depression, the Station went on to lead the campaign to meet the needs of war and of the hungry years that followed. Beginning with the drive to introduce new cash crops into the Norfolk four course rotation, it has successfully led the integration of Norfolk farming in an urban-oriented, high input-high output economy, and it has

demonstrated the need for, and the reward from, the marriage of science with practice.

Prospects

In a sense, history ends at this point, but history is more than a record. It is experience on which planning for the future should be based, and it is therefore appropriate to look at the prospects that are ahead. Human activity is opportunist, and the activities of the past quarter century have been those of exploiting the opportunities offered by abundant resources readily available. High farming has grown and prospered on fossil fuels, on machinery and equipment, and on the products of chemical industry, all offered at moderate prices. Out of these came the great surge in productivity in the decade 1945–1955. This was the era of the application of technology to farming. By 1960 the greater part of the rewards of that application had been reaped, and the evidence of yields in the cereal trials (Figs. 1–6) is that the rate of increase in productivity has fallen off.

The development of new fungicides has opened up a fresh prospect in the management of crop production. Given rapid crop establishment and unrestricted early growth, disease control removes the next constraint on high crop production. The refinement of nitrogen fertiliser application then becomes possible. Thus a new advance in yield levels may be achieved.

These are ideas arising out of the Morley programme, that could lead to a substantial advance in agricultural production. Advance on these lines means primarily seeking improvement in crop varieties, agrochemicals, and the products of agricultural engineering. For the Station this means testing new materials as they come out, and testing has become a heavy burden on the Station's programme already. Testing can become a routine, and could easily come to dominate the experimental programme. That would lead to stagnation.

The present pattern of the experimental programme arose from the great development in experimental techniques that went on throughout the Sprowston period. Through it farming has been given new knowledge and new methods to great practical advantage. However, this is not the only way in which new ideas can be put to the test, refined and established in practice. Indeed the ideas that generated the agricultural revolution in the 18th and early 19th centuries had a very different origin. They were conceived by men who read classical literature, and who travelled and observed widely on the continent of Europe. Amassing accurate information by the conduct of experiments had little part in the establishment of the New Husbandry.

Both strategies have their place. There can be no doubt that the advances gained in the recent era of statistical experimentation were greater than could have been obtained in any other way. Nevertheless, there are questions to be asked that cannot be answered by this type of experimentation, and the experimental strategy of the Station should be reviewed to take this into account. On the one hand, it will not serve farming interests to allow the experimental programme to be dominated by testing work on the vast range of new materials being offered to agriculture. On the other, questions that arise from attempts to plan a versatile and resourceful husbandry response to the uncertainties of farming are not amenable to analysis by statistical methods of experimentation. So there is a need for a programme in which orthodox experimentation has a place, but which also provides for more flexible, wider ranging, larger scale exploratory trials.

Perhaps the most remarkable feature of the post-war revolution in British farming has been the way in which farmers — and farm workers — have developed their personal equipment in knowledge, in judgement and in technical expertise, to enable them to accept and apply the vast range of materials and equipment that became available to them. Their young men have gone to Universities and Agricultural Colleges, or have taken recognised courses in farm work and gained knowledge and experience in Stockmen's Clubs and Machinery Clubs. They manage more capital per man than British industry, and they are probably the most versatile sector of the British working population. With these achievements to their credit, they still expect further advances in productivity. They will need all that the Station has to offer in information, advice, and the exploration of new ideas.

The Station is well able to meet the demands of the future. It has established a central position in the distribution of information, both from its own work and from research institutes. The long and distinguished history of understanding and cooperation between Station members and Station staff, and the close contacts with research institutes, represent an established and well-tried network of communication by which the materials for agricultural progress are disseminated and exchanged. In the course of this history the uncertainty of the future has been a recurrent theme. Uncertainty continues. It is a challenge that the Station is well equipped to meet.

Acknowledgements

by J. B. Hutchinson

Support for the Station's work

This is a success story. The Station speaks with the authority that comes of experience, and above all of independence. That independence has been jealously guarded, but it is not, and never has been, complete. Though farm profits contribute much of its income, the Station could not have achieved the position it holds today without resources in the form of grants, research facilities, equipment, and staff secondments provided by men and institutions in the agricultural industry.

In acknowledging these it is appropriate to begin with the first and perhaps the most powerful of them. Lord Hastings let Jex Farm to the first Committee, rent free for eight years. Then came the Board of Agriculture, and they were followed by their successors, the Ministry of Agriculture. Beginning — rather reluctantly when the Station was young and untried — with a grant from the Development Fund and going on over the years to the secondment of two officers from NAAS/ADAS, together with generous support with laboratory services and soil surveys, the association with the Board and the Ministry has gained in strength and in intimacy as the years have passed.

Norfolk County Council provided advisory staff jointly with the Station until the national advisory service was set up. Norwich Corporation lent a room in the Bridewell Museum for 26 years.

The first research grant to the station was by the Royal Agricultural Society of England, who in 1922 agreed to pay annually £500 to the Station's funds. Rayns commented that it was this grant that made it possible to undertake serious research. Beginning about the same time and continuing to the present day, the NIAB financed their annual series of variety trials. When the sugar beet crop was established, its Research and Education Committee began the support for the Station's beet research programme that has been continued generously ever since. More recently, the Royal Smithfield Club and the Potato Marketing Board have financed projects in their respective spheres. Many commercial firms have provided chemicals, equipment etc. free for trial work.

This support has been decisive in determining the size and range of the research programme that the Station could offer in the service of Norfolk farming; and the appreciation of the Committee and Members is here recorded.

Personal thanks

I have had the advantage of listening to many of those who had a part in this history. Lord Hastings I never knew, but I sat on the Committee with the late Mr. Stanley Stimpson, who supervised the Newton St. Faith's Farm, and who was still on the Committee when I began to write this history. I had long conversations with the late Dr. F. Rayns. Mr. J. C. Mann has not only provided a great range of information, but has commented on, amended, and corrected the successive drafts that I have shown him. I have drawn on the experience of other long-serving members of the Committee, particularly Mr. James Alston. When I needed records, data, photographs, and a host of other details, Miss G. M. Cooper, the Secretary, has been almost infallible. In preparing the illustrations for publication I have been greatly helped by Mr. S. G. Revell, photographer in the Department of Applied Biology, University of Cambridge. The Director of the National Institute of Agricultural Botany, Dr. P. S. Wellington, has advised on the work of the NIAB at the Station, and readily gave permission to use data extracted from NIAB trials. Mr. S. P. McClean, the present Director, has been most helpful in the final stages of the work. To all these I am indebted and I am especially grateful to the present Chairman, Lord Townshend, for his generous support. Working with, and on behalf of, the Chairman and Committee of the Norfolk Agricultural Station has been a happy and stimulating experience.

Appendix I

Senior Scientific and Management Staff

Post	Name	Period of Appointment	Subsequent Appointment
Director	C. Heigham, B.A.	1922–1924	Rothamsted and Newcastle
	F. Rayns, C.B.E., M.A. Sc.D. *(Hon Causa)*	1925–1960	Retired
	A. C. Owers, M.A.	1960–1978	Retired
	S. P. McClean, B.Sc.	1978—Present	
Assistant Director	S. T. Johnson, M.A.	1924–1930	Seale Hayne
	J. C. Mann, M.A.	1930–1946	NAAS, Norfolk
	S. Culpin, M.Sc.	1946–1949	EHF, Gleadthorpe
	A. C. Owers, M.A.	1949–1951	EHF, Terrington, Director, Norfolk Agric. Sta.
	P. J. Jones, B.Sc	1951–1955	EHF, Gleadthorpe
	P. N. Harvey, M.A.	1956–1960	EHF, Gleadthorpe
	B. M. Scott, M.A.	1960–1968	Meat Research Institute Bristol
Senior Technical Officers	E. J. Mundy, M.Sc.	1968–1972	EHF, Terrington
	W. E. Bray B.Sc., (Hons.)	1968–Present	
	D. B. Stevens, B.Sc., Dip. F.M.	1972–Present	
Secretary	J. B. Forrester	1908–1923	Retired
	C. Heigham, (Director Secretary)	(1923–1924)	
	A. R. Trory	1931–1940	
	E. Stanbury (Mrs.)	1940–1941	
	D. M. Jenkins (Mrs.)	1941–1946	
	R. Lowe (Mrs.)	1947–1949	
	M. G. Stammers	1949–1950	
	G. M. Cooper (Miss)	1951–Present	
Farm Manager	M. Mordaunt	1908–1909	
	A. C. Dawson	1909–1915	
	H. Cook	1915–1920	
	M. Harvey	1922–1950	
	R. H. Dixon	1951–1974	
	D. A. Sutton N.C.A.	1974–Present	

Appendix II

Publications

Advisory material has been published for members in the Station's annual reports, in "The Sprowston Farm" and "The Morley Farm", and between 1931 and 1939 in "Husbandry", a house journal edited by J. C. Mann. The staff have over the years written extensively in agricultural magazines and newspapers. Further, they have contributed to the exchange of information in the agricultural profession with numerous papers read at meetings and conferences.

Scientific data and conclusions have been published in a long series of papers in agricultural science journals. These papers, and the Lord Hastings Memorial Lectures published by the Committee, are listed below.

Papers in agricultural science journals.

"Member of staff" (1926) A census of an acre of barley. Jour. Roy. Agric. Soc. E., 87, 103–123.

Rayns, F. (1927) Field trials in the manuring of malting barley. Jour. Roy. Agric. Soc. E., 88, 131–146.

Johnson, S.T. (1927) An experiment in the feeding of bullocks in yards. Jour. Roy. Agric. Soc. E., 88, 146–160.

Engledow, F. L., Maher, C. A., Hunter Smith, J., Rhys Williams, H., Fail, H., and Rayns, F. (1928) Yield and plant population in sugar beet. Jour. Agric. Sci., 18, 574–601.

Johnson, S. T. (1929) A note on the sampling of sugar beet. Jour. Agric. Sci., 9, 311–314.

Johnson, S. T. (1929) Bullock feeding on sugar beet tops and pulp. Jour. Roy. Agric. Soc. E., 90, 183–194.

Fail, H. (1929) The effect of barley manuring on the following hay. Jour. Roy. Agric. Soc. E., 89, 134–141.

Bates, G. H. (1930) Effect of consolidation upon the botanical composition of poor grassland. Jour. Min. Agric., 37, 583–589.

Rayns, F. (1930) An experiment on the seeding of barley. Jour. Roy. Agric. Soc. E., 91, 95–109.

Rayns, F. (1930) A note on seed drills. Jour. Roy. Agric. Soc. E., 91, 109–120.

Sykes, E. T. (1931) The time of applying nitrate of soda to sugar beet. Jour. Min. Agric. 38, 162–170.

Rayns, F. (1932) The disposal of sugar beet by-products: Bullock feeding on sugar beet tops. Jour. Roy. Agric. Soc. E., 93, 214–232.

Bates, G. H. (1933) The destruction and control of the great stinging nettle. Jour. Min. Agric., 39, 907–922.

Bates, G. H. (1933) The relation of leaf size to root structure in Trifolium repens. Jour. Ecol.

Rayns, F. and Sykes, E. T. (1933) Some results of fattening bullocks in open yards. Jour. Roy. Agric. Socl E., 94, 62–82.

Rayns, F. (1934) Two decades of light land farming. Jour. Roy. Agric. Soc. E., 95, 117–135.

Rayns, F., and Sykes, E. T. (1935) Notes on manuring. Jour. Min. Agric. 41, 1228–1232; 42, 69–73; 42, 184–188.

Bates, G. H. (1935) The weed flora of lucerne in East Anglia. Jour. Min. Agric. 42, 134–140.

Bates, G. H., (1935) A study of the factors influencing the size of potato tubers. Jour. Agric. Sci. 25, 297–313.

Bates, G. H. and Martin, L. D. (1935) Sulphuric acid spraying of potato haulm to prevent late infection of the tubers with blight. Jour. Min. Agric. 42, 231–235.

West, W. J. (1935) Disposal of sugar beet by-products: the manurial effects of sugar beet tops when fed to sheep and when ploughed in. Jour. Roy. Agric. Soc. E., 96, 148–157.

Rayns, F. (1936) The beet crop in Norfolk farming. Jour. Min. Agric. 43, 38–47.

Rayns, F. and Wright, S. J. (1936) The cultivation and harvesting of sugar beet on the continent. Min. Agric. Bull. 102. HMSO.

Sykes, E. T. (1936) Experiments on the nitrogenous manuring of sugar beet. Emp. Jour. Exp. Agric. 4, 152–161.

Findlay, D. H., and Sykes, E. T. (1938) Spacing and size of King Edward VII seed potatoes. Emp. Jour. Exp. Agric. 6, 253–259.

Bland, B. F. (1953) Maize as a silage crop in eastern England. Jour. Min. Agric. 60, 311–314.

Jones, P. J. (1953) Nitrogenous manuring of S.48 Timothy for seed. Jour. Brit. Grassland Soc. 8, 349–351.

Shepherd, R. W. (1953) Mechanical thinning of sugar beet. Emp. Jour. Exp. Agric. 21, 236–240.

Shepherd, R. W. (1954) The use of nitrogen for sugar beet grown on light land. Emp. Jour. Exp. Agric. 22, 128–132.
Shepherd, R. W. (1954) Manuring Brussels sprouts. Jour. Min. Agric. 61, 115–118.
Harvey, P. N. (1956) The singling of the sugar beet crop. Brit. Sugar beet Rev. 24, 151–153.
Jones, P. J. (1956) A comparison of three varieties of barley at three levels of manuring. Exp. Husb. 1, 10–17.
Parker, C. (1956) Chemical control of weeds in sugar beet. Brit. Sugar beet Rev. 24, 161–164.
Harvey, P. N. (1957) Effect on yield of sugar beet of leaving double plants at singling. Exp. Husb. 2, 29–32.
Bland, B. F. (1957) The use of nitrogen for sugar beet on a heavy loam soil. Exp. Husb. 2, 33–36.
Rayns, F. (1957) The Norfolk Agricultural Station. Jour. Min. Agric. 64, 175–179.
Harvey, P. N. (1957) The use of nitrogen for sugar beet. Brit. Sugar beet Rev. 26, 27–30.
Green, F. R. (1958) Sampling method for harvesting sugar beet trials. Exp. Husb. 3, 70–72.
Harvey, P. N., Whybrew, J. E., Bullen, E. R., and Scragg, W. (1958) Seed rates and nitrogen for winter wheat. Exp. Husb. 3, 31–41.
Harvey, P. N., and Shepherd, R. W. (1958) Comparison of two wheat varieties sown in autumn and in spring. Exp. Husb. 3, 44–48.
Harvey, P. N. (1958) Sowing and thinning the sugar beet crop. Review Article, Field Crop Abstracts 11, 151–160.
Whybrew, J. E. (1958) Effect of delayed singling on the yield of sugar beet. Exp. Husb. 3, 49–53.
Shepherd, R. W. and Harvey, P. N. (1959) Vigour of germination of rubbed and graded sugar beet seed. Exp. Husb. 4, 1–6.
Harvey, P. N. and Short, J. L. (1959) Effect of date of planting on yield of maincrop potatoes. Exp. Husb. 4, 7–17.
Murant, A. F. (1959) Use of herbicides in sugar beet. Brit. Sugar beet Rev. 27, 115–118.
Lucas, J. M. S., Owers, A. C. and Scott, J. F. (1968) VI Turkey Growth Studies: Dimetridazole. Brit. Poultry Sci. 8, 141–146.
Mundy, E. J. and Page, R. A. (1972) Time of sowing spring barley. Exp. Husb. 21, 32–39.
Clare, R. W. and Caldwell, T. H. (1972) Annual versus large single application of phosphate for a five year cereal rotation. Exp. Husb. 22, 69–77.
Mundy, E. J. (1973) The effect of yellow rust and its control on the yield of Joss Cambier winter wheat. Plant Path. 22, 172–176.
Page, R. A. (1973) The use of CCC (chlormequat) on winter wheat. Exp. Husb. 23, 58–64.
Mundy, E. J. and Page, R. A. (1973) The use of fungicides to control powdery mildew in spring barley. Exp. Husb. 24, 94–104.
Mundy, E. J. and Owers, A. C. (1974) Time of sowing, seedrate and nitrogen for spring wheat. Exp. Husb. 26, 8–13.
Mundy, E. J. and Owers, A. C. (1974) Time of applying fungicides for the control of powdery mildew in spring barley. Exp. Husb. 26, 14–21.
Clare, R. W. and Bray, W. E. (1974) Hoeing of sugar beet in conjunction with a pre-emergence herbicide. Exp. Husb. 26, 41–47.
Owers, A. C. and Clare, R. W. (1974) Problems of sugar beet seedbed preparation. Brit. Sugar beet Rev. 42, 4, 9–11.
Bray, W. E. (1974) Chemical weed control. Brit. Sugar beet Rev. 42, 1, 34–38.
Clare, R. W. (1975) Mechanical gapping and drilling to a stand as alternatives to hand singling of sugar beet. Exp. Husb. 28, 99–104.
Bray, W. E. (1975) Weed control. Brit. Sugar beet Rev. 43, 4, 194–196.
Jarvis, R. H., Roger-Lewis, D. S., and Bray, W. E. (1976) Effects of irregular set spacing on maincrop potatoes. Exp. Husb. 30, 28–41.
Nuttall, M. and Mundy, E. J. (1976) Control of powdery mildew and brown rust on spring barley. Exp. Husb. 30, 95–112.
Mundy, E. J. and Sutton, D. A. (1976) The effect on performance of feeding various proportions of bulk feed and concentrates to beef calves from three to six months of age. Exp. Husb. 31, 100–113.
Clare, R. W. (1977) Seedbed preparation for sugar beet. Brit. Sugar beet Rev. 44, 4, 16–18.
Bray, W. E. (1977) Herbicides. Brit. Sugar beet Rev. 44, 4, 21–22.
Nuttall, M. and Clare, R. W. (1977) The utilisation of sugar beet tops. Brit. Sugar beet Rev. 45, 2, 7–10.
Bray, W. E. (1977) Timing and application of post-emergence herbicides. Brit. Sugar beet Rev. 45, 3, 7–8.
Stevens, D. B. (1977) The use of fungicides for the control of leaf and stem diseases of cereals. ADAS Quarterly Rev. 25, 106–118.
Bray, W. E. (1978) Post emergence herbicides: points to bear in mind. Brit. Sugar beet Rev. 46, 1, 47–48.

Lord Hastings Memorial Lectures

1st 1957	Sir John Hammond Livestock Changes in Norfolk since the Year 1780
2nd 1959	Sir William Ogg Recent Trends in Fertilisers and their use
3rd 1961	Dr. F. Rayns A Revolution in Arable Farming
4th 1963	Dr. G. D. H. Bell The Contribution of Barley Breeding to British Agriculture: in Retrospect and Prospect
5th 1967	Sir Joseph B. Hutchinson Practice with Science
6th 1971	Dr. N. H. Pizer East Anglia's Soils Their Varied and Changing Nature
7th 1972	Lord Zuckerman Agriculture in the Economy of the 1980's
8th 1978	Mr. A. C. Owers The Rôle of the Independent Experimental Station and its Impact on Local Farming

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CHANGE AND INNOVATION IN NORFOLK FARMING traces the seventy years of experiment and advice provided by the Norfolk Agricultural Station since it was founded in 1908. The station itself evolved from ideas proposed by the Norfolk Chamber of Agriculture in the late 1880's, a period of agricultural depression throughout the country.

Sir Joseph Hutchinson, Drapers' Professor of Agriculture Emeritus of Cambridge University, with the late A. C. Owers, formerly Director of the station, have written a most readable and balanced account of the station's foundation, survival and steady development since before the first world war to the present day. The success of the station as a self-sufficient experimental farm free from direct governmental control has been due to an enlightened blend of personal involvement by its Norfolk farming members, the free exchange of scientific information and experience between farmers and experimenters and of beneficial agricultural innovation. Its reputation has been kept high throughout the wider agricultural community by many well-known people: Lord Hastings, Professor T. B. Wood, Sancroft Holmes, Sir John Hammond, Frank Rayns and Sir Edmund Bacon, to name but a few.

In its early days the station set out to provide practical knowledge on the production of alternative crops in the face of the economic challenge of cheap food from abroad. It has several notable achievements to its credit. Through its experimental work, the station liberated Norfolk farming from strict adherence to the four course rotation. With the resulting flexible system, the staff pioneered modern intensive cash crop farming. It contributed greatly to the introduction and improvement of sugar beet in particular, as well as potatoes, peas and other crops. It tackled the need to improve husbandry and productivity at all levels for most major arable crops. It developed techniques for the economic fattening of male calves from dairy herds and the use of by-products from arable crops in beef production. It continues to provide experimental data and practical experience in association with universities and governmental research institutions.

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