

# BRITISH SUGAR BEET REVIEW

*Special issue*



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THE STORY OF BROOM'S BARN

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## FOREWORD

BROOM'S Barn Experimental Station is one of three sites which form the UK Agricultural and Food Research Council's (AFRC) Institute of Arable Crops Research (IACR). Unlike its sister research stations, Rothamsted Experimental Station and Long Ashton Research Station, its activities are concentrated on one crop and in this respect it is recognised as being the national centre for public-funded research and education on sugar beet. Appropriately, it is situated in the centre of the major sugar beet farming region, just seven miles from British Sugar's largest factory and main packaging plant at Bury St Edmunds, Suffolk. The station's historical background is of considerable interest and is documented here by its first research director, Dr. Raymond Hull. In 1935 the sugar beet industry in Britain was totally reorganised when the companies which owned the sugar factories amalgamated to form the British Sugar Corporation. At the same time, the Sugar Beet Research and Education Committee (SBREC) was set up, funded equally by the sugar beet growers and the new corporation; this arrangement is still operative and part of the research fund so established provides about 95 per cent of the finances supporting Broom's Barn's activities. Dr. Hull was appointed in 1935 as a result of the sugar industry initiative and working from his home at Hackthorn, Lincolnshire, he surveyed the many diseases found on beet in England, particularly establishing the importance of virus yellows as a major cause of yield loss. The intensive study of this disease led to close collaboration with workers at Rothamsted Experimental Station and the strong links so established persist to this day.

During 1949 the work was moved to temporary buildings on a disused airfield near Lincoln and the scope of the work expanded to include studies of fertilisers and sugar beet pests. However lack of land and shortage of accommodation was severely restricting development and in 1959 money was provided by the SBREC to build a new research station at Broom's Barn farm. This new research station, headed by Dr. Hull, was formally opened in July 1962.

A valuable consequence of the funding policy adopted has been the closeness of the ties between Broom's Barn, the field-staff of British Sugar and the sugar beet growers. A substantial part of the research programme has always been done in collaboration with British Sugar's R&D department at Holmewood Hall, using experiments in commercial beet crops. Broom's Barn and British Sugar work very closely together to design and interpret detailed surveys of the UK crop. These provide a comprehensive body of information on current farming practices which can be linked with crop yields and the incidence of diseases and pests.

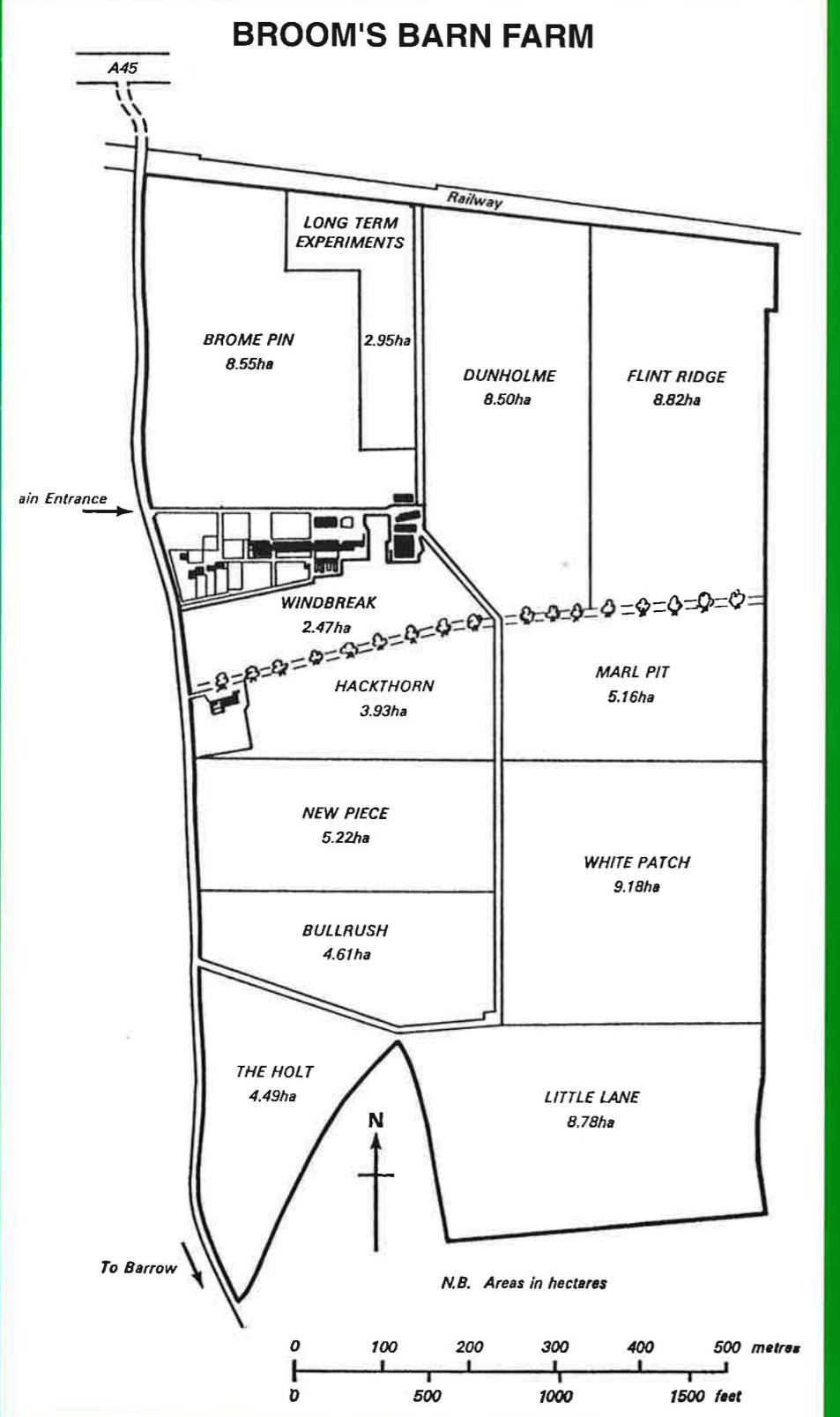
The 77 hectare farm at Broom's Barn, provides two fields, totalling about 13 hectares, for sugar beet experiments each year. The laboratories built in 1961-62 have been substantially modified, most recently with the addition of analytical, physiological, biochemical and micropropagation facilities, and now accommodate more than 50 staff. The principal buildings provide offices, laboratories, computing facilities and a tarehouse with adjoining laboratory. In addition there are glasshouses, controlled environment facilities and studios for photography and the preparation of display materials.

The weather station, which is one of the agrometeorological stations reporting to the national Meteorological Office, records temperature, rainfall, wind, sunshine, evaporation and radiation. Near the farm buildings is a suction trap for catching small insects flying at 12 metres and a pressure tube anemograph recording wind direction at the same height. This trap is one of a nationwide network which is integral to the operation of the aphid and virus yellows forecasting and warning system.

Over the years, Broom's Barn in collaboration with other research organisations, has influenced beet thinking in Europe through the International Institute of Sugar Beet Research (IIRB). Its input has been principally to 'concepts' and 'techniques' with some near-market work of relevance to other countries. It has been involved in many successful developments in relation to crop agronomy, crop nutrition and pest and disease control. With a view to developing a stronger pan-European role, the station is strengthening its longer term, strategic research programmes.

Within Europe there is no comparable sugar beet research centre with the breadth of research activities that have been developed at Broom's Barn, supported by the underpinning research at Rothamsted Experimental Station and the collaborative research at some universities. In general, equivalent organisations in Europe have concentrated on near-market research and extension, with the more strategic and fundamental projects being carried out at universities and by the private sector. The Sugar Beet Research and Education Committee has been singularly successful in administering the funding of sugar beet research within the UK, which has resulted in the development of closely co-ordinated programmes involving British Sugar, the Ministry of Agriculture, Fisheries and Food (MAFF), the Agricultural and Food Research Council (AFRC) and research associations. Most of the extension work arising from Broom's Barn's research developments is carried out by British Sugar's Holmewood Hall. Broom's Barn has always enjoyed a successful relationship with plant breeders and seed producers, which has been considerably strengthened in the last few years, particularly in the areas of seed quality and pest and disease resistance. Some projects, sponsored by seed companies, are aimed at improving seed performance, developing virus yellows resistant varieties and producing rhizomania (*Polymyxa*) resistant varieties. Through these and other contacts, Broom's Barn has developed an international high reputation and is rapidly strengthening worldwide. Much of this success undoubtedly derives from Raymond Hull's foresight and management of SBREC resources over a long period and recognition of his services to the industry came in 1968 with the award of an OBE. Today he still enjoys the rural atmosphere of West Suffolk, living only a short distance from Broom's Barn. This account provides fascinating reading which I hope will be appreciated by the sugar beet community worldwide.

Tudor Thomas,  
Head, Broom's Barn Experimental Station  
December, 1992





*The start of it all – the 'little house' at Hackthorn*

# THE ORIGIN OF BROOM'S BARN EXPERIMENTAL STATION

## BEGINNINGS

IT seems that destiny decreed the establishment of Broom's Barn. The sequence of events, the attitudes and encouragement of the people and organisations involved, the apparent opportunities fortuitously missed, all inexorably lead to the ultimate conclusion – building a research station primarily concerned with the sugar beet crop.

By the year 1991, when this account was written, I am probably the only survivor who can tell the whole story. Inevitably, therefore, it tends to be an autobiography and for this I must apologise.

During the Napoleonic wars sugar production from beet had been developed in continental Europe in order to frustrate the English blockade of sugar imports from tropical countries and had developed into a thriving industry. Several attempts during the 19th and 20th century to introduce the crop and industry into England had failed since an adequate cheap supply of cane sugar was available from the British colonies. However, the experience of the German blockade of Britain during the First World War which cut off these supplies, stimulated further efforts. These were reinforced by the need to support a depressed agricultural industry by introducing a cash crop to replace the root fodder crop in the Norfolk four course rotation.

By the 1920s and early 1930s, five companies had established beet sugar factories, mainly in eastern England, but also two in the West Midlands, two in Yorkshire and one in Scotland. Although the industry was heavily subsidised by the govern-



By DR. RAYMOND HULL, OBE

*An account from ground level*

ment, the price that factories could pay for beet attracted only the most efficient growers, because growing the crop involved considerable capital outlay, advanced agricultural techniques and much hand labour. The factories struggled to get farmers to grow an adequate crop and the field staffs' main task was to obtain contracts and advise farmers on growing procedures.

The sugar companies had joined with the National Farmers' Union to establish an informal research committee under the aegis of the Ministry of Agriculture to support research on growing the crop, with funds jointly subscribed by the industry and growers. Agronomy experiments were financed at Norfolk Agricultural Station then at Sprowston, near Norwich under the direction of Frank Rayns and fertiliser experiments at Rothamsted Experimental Station under E. M. Crowther. In 1934 the committee asked F. R. Petherbridge, the Ministry's Advisory Entomologist at the School of Agriculture, Cambridge and H. H. Stirrup, Advisory Plant Pathologist at Midland Agricultural College, Kegworth, Nottingham to visit research centres in western Europe concerned with the sugar beet crop. Their conclusions are recorded in Ministry of Agriculture Bulletin No. 93 'Pests and Diseases of the Sugar Beet'. The research committee

then decided to finance surveys of pests and diseases in the British crop, starting in April 1935. David Price Jones was appointed to investigate pests, supervised by Petherbridge at Cambridge, and I was appointed to survey diseases under the supervision of Stirrup at Sutton Bonington. I had just completed my PhD work at Imperial College, London and the Fruit and Vegetable Preservation Research Station at Chipping Campden after graduating in Botany and Plant Pathology. The appointment was for one year, possibly renewable.

At that time the two Nottinghamshire factories were struggling for survival, whereas sugar beet growing was more popular with traditional arable farmers in Lincolnshire. It was deemed expedient for me to establish myself in the vicinity of Lincoln and co-operate closely with the agricultural staffs of the Bardney and Brigg factories, whose agricultural organisation was efficient and progressive. So, after two or three days at Sutton Bonington, I drove off to Lincoln to find myself lodgings with Mr. and Mrs. Shearman at Sudbrook Lodge, and to make contact with the agriculturists at Bardney (E. M. Howard who had recently replaced G. F. N. Battle) and at Brigg (W. Swannack and J. McCloy). They were most helpful and hospitable and determined to teach me sugar beet growing and agriculture in general. They arranged for me to have days in the field throughout the growing season with each of the fourteen fieldmen. These excursions revealed the range of disease problems – seedling diseases, downy mildew, leaf spots, yellowing of the foliage, deficiency diseases and later root rots, mainly violet root rot (*Helicobasidium purpureum*) and clamp rot (*Botrytis* sp.). The best I could do to sort out the seedling problems was on a table in the Shearman's wash-house, looking with a hand lens at the fungal growth in boiled water from infected hypocotyls and roots.

With a monthly salary, even though of uncertain duration, Mollie and I decided to marry in August. The cottage with roses round the door to live in did not seem to be forthcoming, the only offers were large Georgian farmhouses and mansions. One such possibility was a farmhouse at Lusby in the Wolds on a long lease at a rent of £5 per annum, but we decided it was too isolated and too far east. Fortunately, on one visit to the estate agent he suggested the Dower House at Hackthorn, from which he had just come. Major (later Colonel Sir Weston) Cracraft Amcotts had recently inherited it with the Hall and estate, and decided to reinstate it as a single house after dual tenancy. He agreed to rent it to us for a year. We duly established ourselves for domestic life in this delightfully situated Georgian house, now known as The Little House, and sugar beet work proceeded in a side kitchen that served as laboratory and office. Little did I think we were to live there for the next 26 years.

Come autumn, the crop was harvested and would all be processed by the end of the year. The idyllic life in Lincolnshire of the newlyweds was under threat. At the end of the year I was to work at Sutton Bonington. The future was uncertain, so we decided to hold on to our lease and arranged lodgings near Sutton Bonington; we could at least return home at weekends! But it did not work out that way.

William Swannack, the agriculturalist at Brigg Factory, was the Lincolnshire Sugar Company's representative on the research committee. He was anxious for me to remain in Lincolnshire and continue to co-operate with the factories' agricultural staffs. At the committee's December meeting, he got the decision that I should move to Sutton Bonington changed. We thankfully cancelled the lodgings we had arranged and celebrated Christmas at home. The grant was to be renewed for another year and financial provision made for some equipment. We were able to renew the lease on the house and Major Amcotts agreed that I should carry on the sugar beet work there. We put a wooden bench in the kitchen/laboratory, ordered glassware, an autoclave and incubator, and bought a few reference books. The equipment was oil heated – no electricity, no gas, no running water. An old student microscope came from Sutton Bonington. I now felt ready for work in 1936. My wife acted as unpaid secretary, taking telephone calls, typing letters and producing monthly and annual reports on our pre-1910 typewriter.

The decision to continue in this job was not easily reached. The future of the beet sugar industry was uncertain [Ref. 1]. The 'Greene Tribunal' had issued a majority report recommend-



*The office block and main laboratory at Dunholme. BELOW: Dr. Hull (centre) with members of his Dunholme staff.*





*A group of visitors pose among some good looking beet at a manure experiment organised by Rothamsted Experimental Station in conjunction with Brigg factory.*

*BELOW: Early days at Broom's Barn and a drainage problem clearly illustrated by the water-logged ground*



ing the withdrawal of government subsidy and closure of the industry [Ref. 2]. I was pressed on arrival in Lincoln by the sugar factory agricultural staff to attend a protest meeting of farmers in the Drill Hall against the Greene report. 'Greene' protests are not entirely new! The Lloyd minority report recommended continued financial support of the industry and its rationalisation. The Government had not decided which course to take, but eventually accepted and acted on the minority report. The various sugar companies were amalgamated as the British Sugar Corporation, with a government appointed chairman and head offices in London and proceeded to develop as a corporate industry.

The director of the Chipping Campden Research Station had enquired whether I would like to return to work there in a permanent position as microbiologist. At that time of economic depression, jobs were hard to come by, and any offer demanded careful consideration. Although tempted – the research station at Chipping Campden in the Cotswolds would be a very pleasant environment to work in – I thought the job would be largely confined to the laboratory and factories, whereas my strong inclination was to field experimentation, an inclination that had been fuelled by a visit to Rothamsted as a student. The sugar beet job offered this opportunity. With Stirrup's approval I arranged to see Mr. W. R. Black, the Ministry of Agriculture's representative on the research committee. Although he could give no assurance, he gave me the impression that there was a good chance of the beet industry surviving and recommended the job I was in. So I decided to pin my future on sugar beet.

## EARLY DEVELOPMENTS AT HACKTHORN 1935-1939

With such limited facilities for experimental work, lack of a defined research problem and direction, the work inevitably concentrated at first on surveys. Close co-operation was maintained with the factory fieldmen by giving a brief talk at each of their monthly meetings and making frequent field excursions with them. As they became familiar with disease symptoms, a scheme for them to make monthly reports was started. At first these reports were purely descriptive and it became obvious that to get reliable data for comparing incidence in different districts, development during the year and incidence in different years, the survey must be on a quantitative basis. With the encouragement of W. C. Moore at the Ministry of Agriculture's Plant Pathology Laboratory, a scheme of monthly counts of diseased plants by each fieldman was instigated. Later this was extended to all factory areas in Great Britain and in due course provided a unique and valuable record which proved so useful later in organising control measures against virus yellows.

During the campaign, diseased roots, found in factory tare-

house samples, were saved for weekly examination to record the nature and incidence of root diseases and storage roots. Rothamsted organised a series of fertiliser experiments in growers' fields, executed by the factory fieldmen. Helping them to layout, record and harvest these was the stimulus to arranging similar experiments of my own with minor nutrients to cure deficiency diseases – manganese, boron and later magnesium. This led to co-operation with Dr. J. B. Hale of Rothamsted who analysed leaf tissue to determine the content of minor and major nutrient elements and assess the critical levels resulting in deficiency symptoms. The magical effect of dressings of manganese sulphate turning certain stunted yellow crops into vigorous green ones within two weeks was a great boost to science's reputation. Growers and fieldmen began to think that these boffins had something!

Seedling surveys showed that the dominant pathogen was the seed-borne fungus *Phoma betae*. Organo-mercury seed dressing powders had recently been developed for controlling fungal pathogens on agricultural seeds, so numerous experiments were arranged to test proprietary products on sugar beet. Growers sowed 12-20 lbs per acre of natural seed with machines that dropped the seed from a hopper three feet above ground, through tubes to coulters whose working depth was scarcely controlled by weights on the lever holding them and the firmness of the seed bed – a far cry from the modern precision drills sowing monogerm seeds spaced seven inches apart! The experiments contrasted rows sown with untreated or treated seed. Since the powder treatment lubricated the flow of seed, seeding rates were measured by collecting seed delivered by each coulter in muslin bags over measured lengths. The forest of seedlings that germinated was eventually thinned by cross hoeing and hand singling to a stand of spaced plants. Small wonder, therefore, that the small increase in emergence and survival resulting from seed treatment was not reflected in the final stand. However, at harvest, the roots from the treated seed had fewer lesions of *Phoma* that caused decay in storage clamps. Simple experiments such as these with primitive equipment kept us busy and gave understanding of growers' problems.

An amusing incident illustrates the state of sugar beet cultivation in the 1930s. Although relatively large fields were cropped with sugar beet in some areas, small crops of an acre or so were

not uncommon. In Lincolnshire, the factories organised competitions for the best crop in different acreage categories. A Belgian consultant engaged to advise them on beet growing practices, was taken to the winning crop of about one acre in the smallest area category. The grower proudly demonstrated his crop in which beet stood regularly over the whole field from hedgerow to hedgerow, spaced every 12-14 inches in rows 14 inches apart, never a missing plant and all of uniform size. Monsieur Gaspart, who understood English perfectly but would not speak it, looked at the crop with appropriate amazement and enquired through the interpreter how it had been grown. The grower expounded at length that since seedbed preparation every operation had been done entirely by hand; the 'management' (fertiliser) spread by hand (of course, farmyard manure had been ploughed in during the autumn), the seed sown with a hand-pushed 'Planet' drill, the plants gapped, singled, then hand-hoed to control weeds. "Everything done by hand – never a horse in the field". At this time, tractors were found only on the larger farms and on the smaller ones all operations were done by horse-drawn equipment – ploughing, seedbed preparation, sowing, steerage hoeing and ploughing out the roots for harvesting. This contrasts with the modern crop in large areas, a minimum contract of 40 acres for economic production, grown and harvested by machine with no hand labour whatsoever, weeds being controlled by herbicides and pests and diseases with pesticides when cultural practices are inadequate to contain them. Crops yield 15 to 25 tons per acre of roots, in contrast to 5 to 10 tons per acre in the 1930s. Growers, the corporation's agricultural staff and research have certainly created a revolution in sugar beet culture.

To continue the story, the Lincolnshire grower obviously thought that this silent foreigner did not show adequate incredulity of his achievements, so kept repeating, "All hand work, never a horse in the field – no horses." After the third repetition, Monsieur Gaspart responded, "Oui, j'ai compris, pas de chevaux, pas de chevaux." The grower exasperated, quickly replied, "No, no, we don't use the shovel-hoe on this stony soil – we use the chop-hoe. They only use the shovel-hoe on the kind soils in the Fens and south Lincolnshire silts." With a smile all round, all honour was satisfied! The grower would proceed eventually to hand-load his beets into a horse-drawn cart and deliver it, load by load, to the factory. This contrasts with deliveries now of forty ton loads, to satisfy the needs of factories requiring 10,000 to 15,000 tons of roots every 24 hours every day of the week during the three to four months of the autumn and winter campaign.

I had always been interested in photography, so made a collection of photos of diseased sugar beet. When the Dufay colour process became available I accumulated a collection of photos which eventually illustrated Ministry of Agriculture's Bulletin No. 142 'Sugar Beet Diseases'. All the photos were taken with my quarter plate camera and processed in open dishes in a wine cellar under the back stairs of The Little House (funds did not allow purchase of a lab. camera at this time). Mounted in 3 1/4 inch square lantern-slides, the films were used for talks to Bardney and Brigg factory fieldmen and to growers' meetings in village halls.

In 1937 Dr. A. R. Wilson was appointed to assist Stirrup at Sutton Bonington and undertook parallel work to mine in the Colwick and Newark factory areas. We co-operated well and participated in each other's field experiments, particularly in the laborious work of digging the beet, knocking off the adhering soil, separating the tops from the root and weighing and sampling for sugar content and juice purity determinates. In 1937, W. N. Moore joined me, straight from the village school, part-time at first. His meticulous work, whether in the field or indoors, made a significant contribution to the standard of our work, first at Hackthorn, then at Dunholme and finally at



*Construction under way and – below – on-site meeting of the Broom's Barn Experimental Station working party.*



*Broom's Barn.*

The Beet Sugar Act of 1936 [Ref. 3] was passed into law and the several beet sugar companies were amalgamated into the British Sugar Corporation. A clause in the Act regularised the informal research committee and stipulated that the corporation and the growers (represented by the National Farmers' Union) should contribute to a levy, based on the tonnage of beet delivered to the factories, for financing research to improve the efficiency of producing the crop. The fund would be administered

by the Ministry of Agriculture on the recommendations of The Sugar Beet Research and Education Committee (SBREC), on which were represented the corporation, the growers, the Ministry and the Agricultural Research Council, with an independent chairman appointed by the minister.

Regular visits to the factories gave me opportunity for informal discussions with the agriculturists about the progress of the work. E. M. Howard, agriculturist at the Bardney factory, was now a member of the SBREC and had recently visited sugar beet research stations on the Continent. He was enthused with the idea of developing such a centre in Great Britain. He confided that the SBREC had decided to put aside a sum of money from the levy each year to accumulate the capital for such a project [Ref. 4]. Was this the time of conception of the idea that took 25 years to gestate and eventually resulted in the building of Broom's Barn? The Ministry lawyers ruled that the annual levy for research must be spent each year and could not be accumulated into a capital reserve, so this project was abandoned. Annual grants continued to be made to the various national research stations and universities for specific projects.

## WAR-TIME PERIOD

Uncertainty prevailed on the outbreak of war in September 1939. Those of us with agricultural expertise were soon instructed that our duties were to aid food production and participate in civil defence. Experimental work continued on a restricted basis, and all other available time was occupied by secondment part-time to War Agricultural Committees, general agricultural advisory work, civil defence and Home Guard duties.

Much land that had lain derelict for many years because it had been unproductive was brought into cultivation. Sugar beet grown on it developed numerous problems – mineral deficiency diseases, root rots, especially violet root rot (*Helicobasidium purpureum*); seedling failure because the soil was acid and seedling losses in late sown crops from *Aphanomyces*. These occurrences encouraged numerous experiments in growers' fields. The experience of organising these experiments demonstrated the need for land to be under our own control for several years on which more detailed and meticulous experiments could be done. Another important factor was restriction on travel; allocations of petrol coupons were very limited.

The first area of land we acquired was a small allotment rented from the Hackthorn estate. It was derelict, infested with couch grass and over run with rabbits. We dug it and cleaned up the weed infestation by hand – no herbicides at this time – wired it around, sowed seedling experiments, inoculated plants with downy mildew and made transfers of yellows virus with *Aphis fabae* on to grown plants.

In 1940 we invited the agriculturists and senior fieldmen from eastern factory areas to Hackthorn. We met in the Village Hall – a converted tithe barn behind The Little House – and conveyed to them what we knew of disease incidence, particularly virus yellows and downy mildew. A problem was how to feed them at a time of severe food rationing. My wife, with the help of the village ladies, acquired several rabbits to make rabbit paté, Mrs Daubney supplied us liberally with milk, some sugar came from Brigg factory, we scraped together some tea, butter, eggs, and commodities to make plain cakes and so fed the 25 or so visitors on the lawn. No beer; only an apple concoction made from windfalls! This meeting was the precursor, not only of regular lectures and open days in the field, but of a tradition of hospitality. Without my wife's regular hospitality to all visitors Hackthorn, Dunholme and Broom's Barn would not have been the pleasant work places with a friendly reputation that they were.

In 1941 we rented a half-acre field from W. Daubney and here made more extensive experiments with both root and seed crops. We worked the land with a motorised cultivator, known as the two-handled man killer – a well deserved name; we sowed with a hand pushed Planet drill, cultivated the rows with a wheeled hoe and the long handled hoe. Harvesting was by hand lifting fork, knocking and topping. The seed crop was cut by hand, stored in hessian bags in my garage, then the seed

stripped from the stalks by hand during the winter months. We were raised in a school of hard physical labour and improvisation. In the war years and for some time afterwards equipment was scarce or unobtainable.

We next rented a field of about two acres from Taylor at Hackthorn Cross Roads and borrowed first his horses and later his tractor and implements to cultivate it. We had a beet contract with Brigg factory and a dispensation to grow beet on the same ground in two consecutive years, generally forbidden under the terms of the contract. In these later years of the war the field experiments on these lines were expanded. A. R. Wilson was transferred from sugar beet work at Sutton Bonington to work on potato storage. His replacement, A. S. Nickelson, joined me at Hackthorn. Co-operative work with Hale at Rothamsted, on mineral deficiency diseases and with Watson on aphids and yellows was intensified.

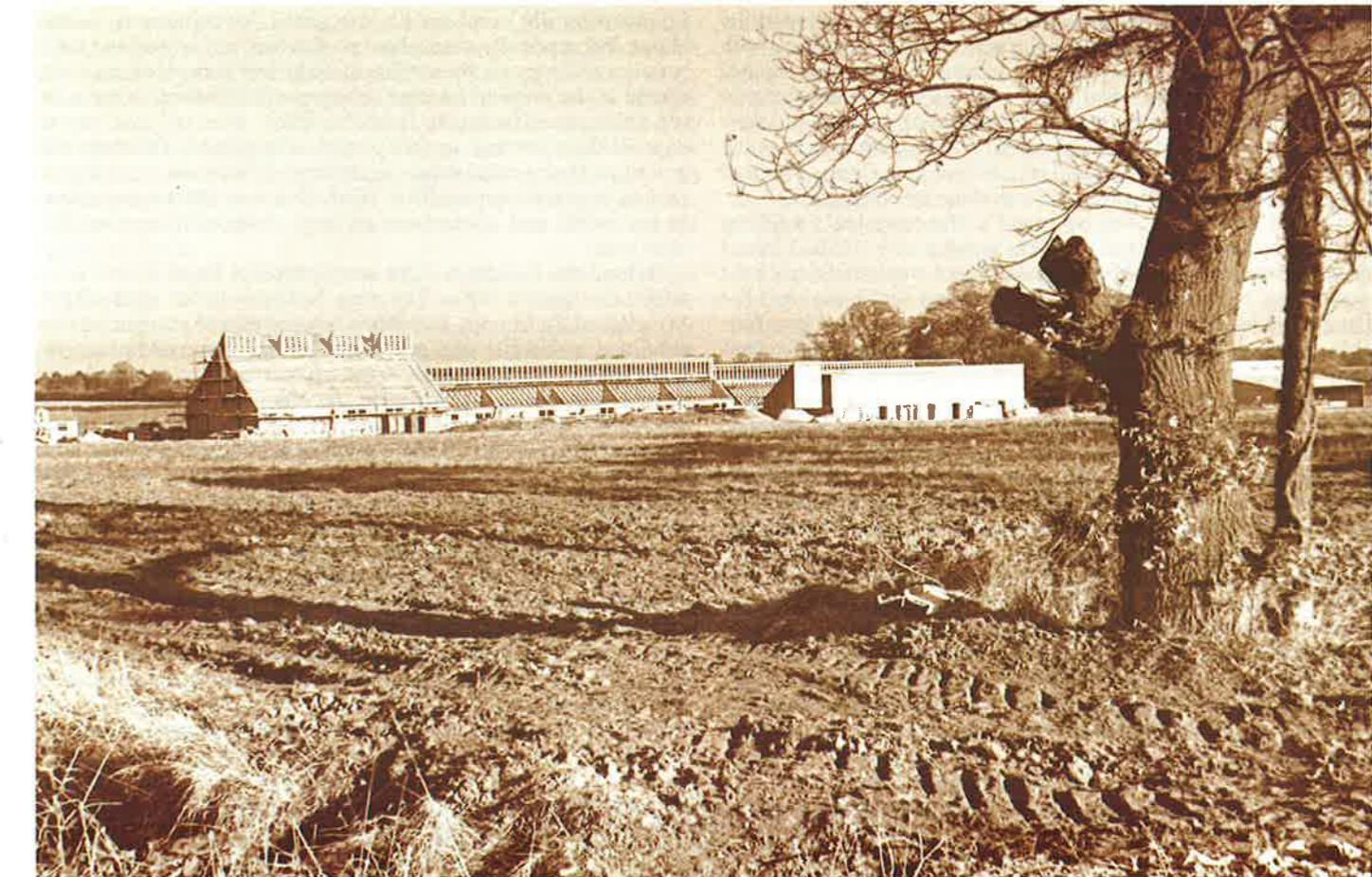
When my landlord, Colonel Amcotts, returned from the forces at the end of the war, he said he wished to terminate my lease on The Little House. What a quandary I was in! The Ministry's specialist advisers at Sutton Bonington were to be incorporated in the new National Agricultural Advisory Service in their own Regional Headquarters at Kegworth, so the old arrangement was not deemed an appropriate one for administering the sugar beet work. The liaison with Rothamsted was informal, but the Director (Sir William Ogg) was willing and anxious to have the work centred at Woburn Experimental Station.

At this time, housing was extremely difficult to come by and there were strict limitations on new building because of shortage of materials and labour. The chairman of the SBREC, Colonel F. Balfour, was sympathetic to my personal situation and the Committee instructed the Ministry's Land Agent to bid for a vacant dereliction property known as The Rookery at Aspley Guise to which the work would be transferred from Hackthorn and centred on Woburn Farm. However the sale went to a bid in excess of the Ministry's prescribed cash limit.

We then investigated the Duchess of Bedford's vacated wartime hospital at Woburn but it was obviously unsuited to our needs. Another effort was made to find a site for a joint establishment with the Weed Research Organisation, which had to move from Oxford. We jointly investigated a farm for sale near Woburn, but on reaching the crest of a rise we looked upon a forest of brickworks' chimneys belching forth fumes and concluded this was not the place for either of us. A move to Woburn was not generally favoured; it was too remote from the main sugar beet growing areas, so this project was abandoned.

## DUNHOLME 1949-1960

Our problem of accommodation remained. Colonel Balfour tried to persuade the School of Agriculture, Cambridge that we should join the sugar beet pests group there, which had continued research on pests, particularly *Aphis fabae* and nematodes, since 1935, but they were not interested. Sutton Bonington was essentially a school of agriculture and not a research centre at that time, so was not the ideal institution for us. Norfolk Agricultural Station, Sprowston, had not the scientific expertise appropriate for our needs. There were plans afoot for building a new national plant pathology institute which might provide space for us, but of course that did not materialise. When Stirrup moved from Sutton Bonington to the NAAS regional headquarters in October 1946, there was the opportunity to transfer the grant from Sutton Bonington to Rothamsted. I saw this as the culmination of the informal co-operation that we had built up. The transfer was agreed and we became part of the plant pathology department under F.C. Bawden who was always very supportive of our work. But it was clearly understood that they could not house us in the laboratories at Harpenden. The Rothamsted staff was expanding rapidly and they were desperately short of space. I, too, preferred to retain our independence to work with the problems occurring in the field, to cultivate the co-operation and help of the 100 or so fieldmen who were our eyes and co-operators in experiments throughout the sugar beet growing areas.



Broom's Barn Experimental Station nearing completion.

At this stage I was invited to attend the meetings of the SBREC as an adviser. The meetings were held in Cambridge Terrace, Regents Park. The Committee, Ministry officials, representatives of the Sugar Beet Seed Producers' Association and of all the grant-receiving organisations, met together. Col. Balfour, a career diplomat, presided. He was often tested by the Scottish growers' representative who, in an almost unintelligible dialect, frequently wanted to absorb an undue amount of time discussing damage by rabbits and hares and strangles, subjects of limited interest farther south. The scientists gave their reports and submitted proposed programmes of work and estimates. I could well sense the feelings of the Ministry and ARC representatives, "What can we do with this maverick from the wilds of Lincolnshire – his set-up does not fit anywhere in our organisation!". The seed producers thought that "public enemy no. 1" was out to ruin their seed growing business by his proposals for virus yellows control. These involved measures, described below in the section on virus yellows, enforced through their contract to supply the British Sugar Corporation, their only customer, which appeared troublesome and expensive but which, in the event, resulted in greatly increased yields of better quality seed. The sugar corporation and growers appreciated our work so we usually won through. Col. Balfour's diplomacy maintained a friendly atmosphere in the meetings. One could assess the reaction of the industry and growers to one's work much more effectively in these meetings than in the more formal ones of later years.

Much of our effort had been directed to solving the problem of virus yellows and the course of that work is described later. By 1944, growers' concern about the effects of the disease had mounted and they felt it threatened the future of the crop. A meeting of growers at King's Lynn called by F. Rayns, director of Norfolk Agricultural Station and Executive Officer of Norfolk War Agricultural Committee, demanded action. Committee Paper No. 115 was prepared advocating the only measures known at that time that could be taken against the disease, which were to eliminate overwintering sources of infection, and cultural practices mitigating infection in the root crop.

The sugar corporation's agricultural staff impressed this information on growers. The SBREC expanded research on the disease in 1947 by appointing T. W. Tinsley at Sprowston, J. W. Blencowe at Rothamsted and L. F. Gates to work with me at Hackthorn. However, official activity to rehouse us seemed to have died down, but the pressure of work and a growing family in The Little House made some solution essential. Sir Weston agreed to my continued tenancy when we moved the work to Dunholme, and the family continued to enjoy life at Hackthorn for another 12 years.

During Home Guard activities, I had become familiar with the nearby satellite airfield at Dunholme, and now saw numerous buildings lying empty and being vandalised. I contacted the clerk of works who, although he could not give me permission, agreed to turn a blind eye to me virtually squatting in one of the sound buildings with paraffin lamps and buckets of water, etc., and using it as a dispersal point for the overflow of activities from Hackthorn. By August 1948 the SBREC had obtained War Office sanction for us to occupy the group of buildings on the entrance road to the airfield. With a grant to carry out essential repairs, connect water and electricity, we began occupation. The following paragraph from the introduction to our report to the SBREC for year ending March 1950 describes the bones of the development.

"The work was gradually transferred during the year from Hackthorn to Dunholme. The main building at Dunholme has been decorated, supplied with water, electricity and drainage and the laboratory, office, dark room and conference room furnished. Other buildings are being used for a garage and machinery store, seed store and seed dressing shed, root washing shed, tool shed and fertiliser store. The glasshouse has been moved from Hackthorn to Dunholme and plans are afoot to build an extension to it. Another small building has been adapted for use as a potting shed and it is proposed to build a small, lean-to glasshouse against it for use as an insectary. It is hoped to convert another of the buildings into a caretaker's dwelling."

Certainly only the bones; much had to be done to make it a practical work place. We collected together benches, steel cup-

boards and endless useful equipment that had been 'dumped' by the RAF. We lined the walls of the office/laboratory block with plaster board taken from other buildings. A solid fuel central heating boiler, radiators and pipes were located on another part of the airfield and transferred to our building – we could now work in the winter without overcoats. Linoleum was rescued from various buildings and laid on our concrete floors. Much of the work we did ourselves; some was done by contractors.

The old guardhouse was equipped as the caretaker's dwelling and was occupied by Josef Iwanicki and his wife. He had joined us when released from the Polish Air Force, stationed during the war years at Dunholme. He did stalwart work making the Dunholme buildings and environment presentable and comfortable, ensuring their safety and worked endlessly on field experiments, functions he continued at Broom's Barn for many years.

Grants were always tight in those days. The grant was paid to Rothamsted, we certified the bills and sent them to Harpenden for payment. We had a small monthly petty cash float for small local payments. All wages and salaries were paid from Harpenden, where the annual accounts were also prepared. We prepared the estimates for the grant required each year and justified them at the SBREC's meetings.

Land for experimental work was a recurring problem. The fields we had hired at Hackthorn were now inconveniently far away to work with our own equipment. Local farmers reluctantly offered us the use of fields for a year in a derelict, weedy state but we wanted continued control so that we had clean, level, uniform and friable soil for our experiments. Gradually we managed to get control of several areas on the airfield

bounded by dispersal tracks, too small for farmers to bother about. We gradually cleared them of debris and weeds and ran a rotation of crops on them. The airfield was a requisitioned site rented to the original farmers before eventual return to them, so we sub-rented from the farmers. They were all anxious to expand their acreage in this period of profitable farming, and having suffered requisition for several years were reluctant to rent us appreciable parcels of land. One was more sympathetic to our needs and let us have an area of about five acres year after year.

Behind the buildings there was a derelict knoll of 2-3 acres which had been a copse. The trees had been felled by the RAF. We cleared the stumps and debris, ploughed and cropped it. Our need was a sizeable area of a crop in which we could plant isolation plots about 15 yards apart of beet seeders for our work developing lines of beet tolerant to yellows. We tried numerous crops but all failed to grow faster than the beet seeders, so did not provide the desired isolation. German visitors said they used hemp for this purpose and they sent us a supply of seed which we sowed in all innocence. The hemp grew well eventually, but failed in our temperatures to outgrow the beet. The lads harvesting the beet reported great elation after working in the crop. By this time I realised what we had done, and not wanting to emulate the career of my Old Mancunian predecessor [Ref. 6], I ordered the crop remains to be burnt on the site and sent up in smoke over the field. In those days little was heard of marijuana. The next year autumn sown Fiskerby mustard proved the ideal screen crop.

With more spacious accommodation we were able to take on



Meeting of the Sugar Beet Research and Education Committee (circa 1950).

more responsibilities. Rothamsted wished to terminate the fertiliser experiments that they had organised in co-operation with the factory agricultural staffs in each of the sugar factory areas. However, the SBREC wanted experimental work in the factory areas to continue. Hence S. N. Adams was appointed to Dunholme to continue the experiments and expand the work into other aspects of crop nutrition. A chemistry laboratory was equipped for this work. We did not have enough land for fertiliser experiments so all his experiments were dispersed on growers' fields.

At the School of Agriculture, Cambridge, a change in the supervision of the work on pests resulted in discord and R. A. Dunning, who had been Assistant Entomologist there for several years, resigned from his post. His work was valued by the committee and the corporation's agricultural staff, and after a short interval he joined us at Dunholme to extend our work into investigation of pests other than virus vectors. He continued to make invaluable contributions to our knowledge on this subject and to the general organisation of the work at Dunholme, the transfer to Broom's Barn and as Deputy Head until he retired in 1985.

Although we were located a long way from other research organisations we did not feel unduly isolated. We made regular journeys to Rothamsted and were influenced by the scientific expertise there. We had contact with scientists throughout Europe and America through the International Institute of Sugar Beet Research and the American Society of Sugar Beet Technologists and had regular visits from their members. Now we had space and field facilities, we were able to arrange regular training courses for the corporation's field staff. This greatly improved the accuracy of the monthly surveys of pest and disease incidence in the crop throughout Great Britain. We also organised the steckling inspection scheme, in which all stecklings to be used for producing sugar beet seed were certified, or condemned for destruction if they contained more than a small number of diseased plants. The inspectors, appointed from National Agricultural Advisory Service officers and from the corporation's field staff came to us each year for briefing and training in the inspection procedure.

From time to time the corporation would send trainee fieldmen to work with us for some months or a year, so a good rapport was built up with the corporation's agricultural staff. We also arranged at least one open day each year for the SBREC members and all the agricultural staff of the corporation, who were invited to bring along interested and influential growers. All this helped to put Dunholme and our work on the map and lead to the eventual decision to establish Broom's Barn.

## WORK ON VIRUS YELLOWS

Since much of our effort had been concentrated on virus yellows, a brief account of how the work developed seems appropriate here. The surveys in the 1930's showed that usually crops in south Lincolnshire turned yellow in August or earlier, whilst those in the north remained mainly green until harvested. My first report in 1935 referred to this as virus yellows, for the symptoms conformed to those described by Stirrup in Bulletin 93. However, I was overruled and it was referred to as 'crackly yellows' of cause unknown; but suspected to be 'physiological'. Many people had their pet explanation – drought or too much rain; the crop "ripening nicely"; excessive use of sulphate of ammonia, freely used at this time on the ubiquitous brassica crops in south Lincolnshire; elsewhere as shortage of nitrogen; lack of sunshine – later, in California I was told the yellowing there was suspected to be due to excessive insolition! Stirrup wanted confirmation of the other symptoms ascribed to virus yellows by the continental workers, namely starch accumulation in the yellow leaves and gummosis of the phloem vessels. Wilson and I spent much time over the next two years in finding

that these symptoms occurred sometimes in leaves of plants with 'crackly yellows' but also in yellow leaves affected obviously with other diseases, for instance, downy mildew.

In 1939, potted plants, on to which were placed *Aphis fabae* collected from field plants with yellows, developed yellowing. This was confirmed by similar experiments in 1940 on outdoor plants grown on our new allotment, and clearly demonstrated the infectious virus nature of the disease. So the baptism as 'crackly' was revoked.

The surveys revealed a striking fact – the early occurrence and concentration of yellowing in crops adjacent to seed crops and the unused remains of mangold clamps. *Aphis fabae* was a frequent pest of sugar beet crops, developed on them in devastating infestations and usually, but not always, resulted in severe infection with yellows. But yellows occurred on individual plants, groups of plants and even entire crops where no *Aphis fabae* had been seen. This left a problem to be solved.

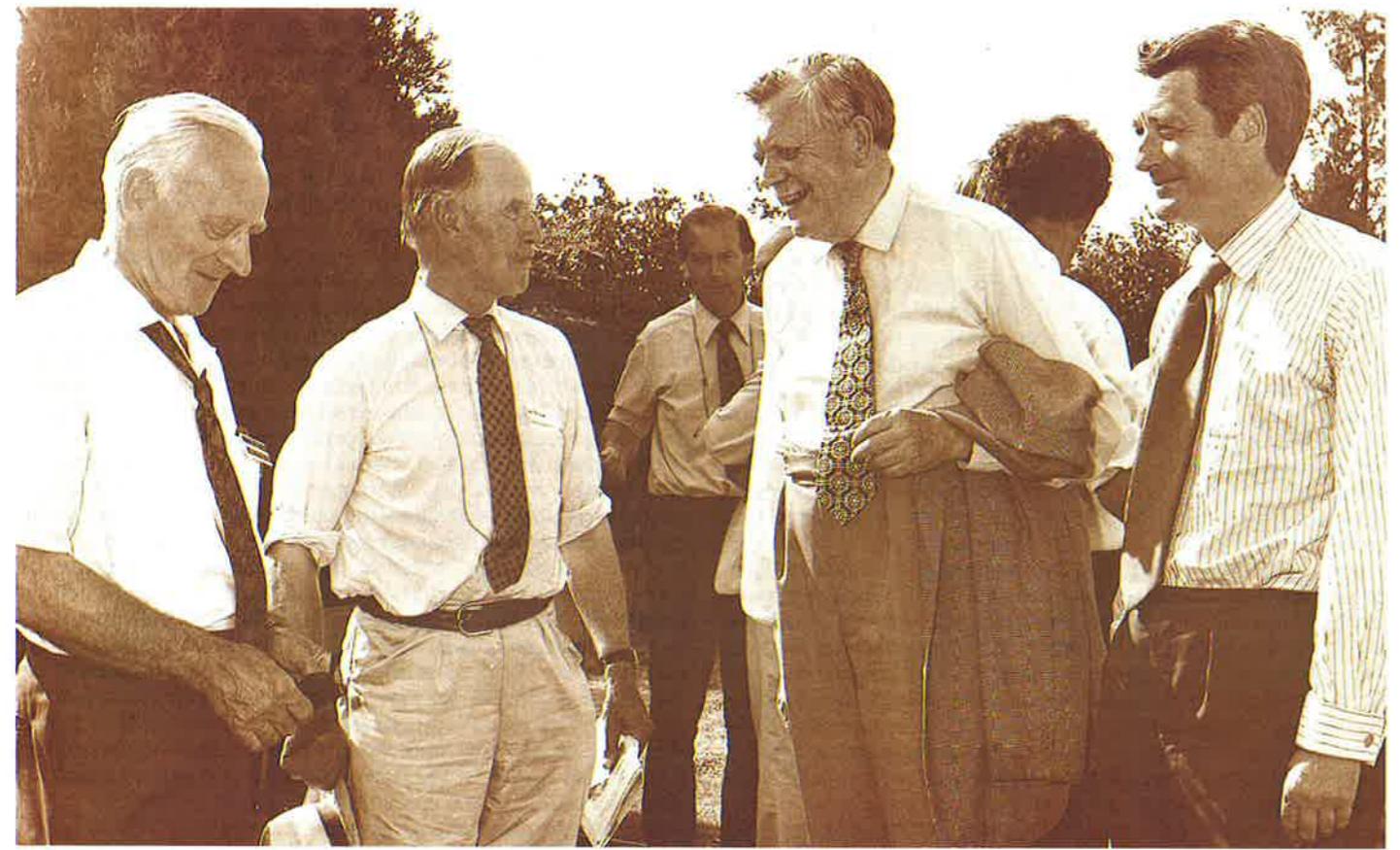
Dr. Marion Watson, working in the glasshouse at Rothamsted, was using two sugar beet viruses, mosaic and yellows, to study the transmitting ability of *Myzus persicae* in relation to feeding times and behaviour. We planned co-operative work in the field which comprised careful examination of plants at frequent intervals for aphids and yellows infection, from early May until the autumn, in fields distributed throughout the Midlands, east Anglia and Lincolnshire. I can well remember the thrill when in May in a field near Worksop we found occasional *Myzus persicae* on recently singled plants. I doubt whether anyone previously had got down on their hands and knees to examine such small plants for these evasive little insects. The results of the survey over several years gave valuable information on the epidemiology of virus yellows.

Knowledge about the virus and vectors cleared the way for organising field experiments investigating factors influencing the incidence of the disease and the losses it caused – time of sowing, time of infection, plant density, plant variety, manuring. Early sown crops were less prone to infection than those sown later. Yield loss was proportional to the length of time plants were infected before harvest. Gappy stands of plants were infected more than dense stands. Variety and manuring had little or no influence on yellows incidence or yield loss. From these results recommendations could be given to growers to mitigate the worst effects of the disease by agricultural practices.

Isolates from field plants with yellows differed greatly in virulence. The most severe produced symptoms on young plants in a few days with vein clearing and necrosis. Others gave similar but milder symptoms, whilst others were slow to produce yellowing and showed no vein symptoms. We termed them severe and mild strains but later, G. E. Russell using the electron microscope at the Plant Breeding Institute, characterised them as two distinct viruses with different physical and transmission characteristics and a different host range. The severe one was beet yellows virus, the mild one beet mild yellowing virus; this latter having similarities to the American beet western yellows virus.

The usual plot size for field experiments on sugar beet was one fortyth of an acre, from which several hundred plants were harvested for yield and sugar content determination. Replicated plots of this size to give results for statistical analysis were not practical when artificial infections had to be made by putting viruliferous aphids on individual plants. By careful selection of site and hand cultivation of the crop we managed to get very satisfactory low levels of plot error using replicated plots in designs suitable for statistical analysis giving 50 or even fewer harvested plants. We were soon handling several hundred plots each year on our own land. At first the plot produce was sent to Brigg factory tarehouse for determination of clean weight, sugar content and juice purity, later to the Central Laboratory at Peterborough. When Dunholme was established we equipped our own tarehouse and laboratory for all plot yield determinations.

Having put out viruliferous aphids there remained the problem of killing them to prevent spread on to the nominally healthy plots. At first the only available insecticide was nicotine. Wilson devised a machine that dripped nicotine into the exhaust gases of a petrol engine and pumped the vapour under a



**A time for reminiscing: Dr. Hull (left) with three former chairmen of the Sugar Beet Research and Education Committee – Sir Peter Greenwell, Sir Edmund Bacon and John Holmes.**

long, trailing, canvas sheet. The machine was dragged over the plots by hand. When doing so, we wore our wartime gas masks but the physical labour involved soon resulted in them being discarded. Then a sudden change in the breeze would send us running away choking with nicotine fumes! Somehow we survived and got the plots fumigated.

Later, systemic organo-phosphorus insecticides which we applied with knapsack sprayers were available for this purpose. These persistent systemic insecticides were used in an extensive series of field experiments throughout the main sugar beet growing areas, testing the influence of different times and frequencies of spraying on the incidence of yellows and yield. Two experiments were outstandingly successful; the one at Norfolk Agricultural Station and the other at Kentford, Suffolk. The one at Kentford, on the site of an autumn harvester demonstration, had a gantry erected at one end from which visitors could get an aerial view contrasting green, healthy, sprayed plots with yellow, stunted, untreated ones. Many growers saw these experiments and rapidly adopted spraying as a precautionary treatment.

From the results of spraying experiments and surveys, a critical aphid infestation was assessed which would result in worthwhile decrease in yellows if given a protective spray. To fore-stall the dangers of excessive and useless spraying where yellows did not threaten, a spray warning scheme was instituted. Information about aphid incidence had to be obtained by fieldmen counting aphids on plants at regular intervals, starting in early May. Most of the younger ones embarked on the task with enthusiasm, but the older hands found getting down to find occasional furtive green aphids on newly singled plants a strain on their physical and optical ability! The information was supplemented by trapping migrant aphids, at first on sticky traps and later by suction traps, but the latter could be operated only where a mains electricity supply was available. On the basis of the information obtained, spray warnings were issued to growers. The scheme ensured effective control when necessary and avoided much routine spraying that would have been useless. The eventual development of insecticide resistant strains of aphids was undoubtedly delayed by this scheme,

restricting unnecessary spraying.

Before systemic persistent insecticides became available in the mid-1950s, control recommendations had depended on cultural practices and hygiene. Important sources of virus in the spring were known to be seed crops of *Beta* species, clamped mangolds and fodder beet, and surviving debris from the previous year's sugar beet crop, particularly beet loading sites.

The seed crop acreage had extended during the war years, because the normal supply of seed from continental Europe was cut off. Most of the crop was grown by the continental procedure of sowing in a plant bed during late summer, lifting and clamping the stecklings in late autumn to protect them from frost and transplanting them out in the field in early spring. One mild winter the plants survived outdoors and the practice grew of overwintering in the steckling bed, or even transplanting into the field in the autumn. When enough mother seed was available, the crop might be sown directly into the field. Whatever procedure was followed, the plants might be infected with viruses and fungal leaf diseases in the autumn and aphids on them would survive the winter and build up large populations as the plants grew in the spring. Migrants from these populations spread to the young root crop and initiated early outbreaks of yellows, and mosaic and fungal leaf diseases spread similarly.

One of the controls adopted was to grow the stecklings as far away from root crops as possible. For a while a considerable acreage of stecklings was raised in the north of England, Scotland and other areas unfavourable for aphids and transported south in the spring for transplanting in the traditional seed growing areas. This arrangement reflected that used for seed potato production, which involved similar problems of protection from aphid infestation. Stecklings raised in the beet growing areas were distanced from root crops and protected by insecticidal and fungicidal sprays. Later it was found that sowing stecklings in late spring directly into the field under a cereal cover crop, usually spring barley, gave excellent control and this method of production was adopted on a large scale. The control measures were enforced by the British Sugar Corporation, the only buyer of seed, on all seed producers by the Steckling Inspection Scheme which ensured that only crops

with few or no infected plants were grown on to fruition in the second year.

Mangold clamps proved a tough proposition. No controls were entirely effective in preventing clamp infestation. The removal of all green material when the roots were put into clamp was helpful, but involved a risk of the wounded roots rotting. The main effort was directed to propaganda and persuading growers to finish feeding clamped roots before the new root crop had germinated, and carefully clearing up all clamp debris. Over the years, livestock became fewer in the main beet growing areas, mangold growing dwindled and the problem largely solved itself.

The campaign for control of yellows was catalysed by the activities of the virus yellows sub-committee appointed by the SBREC, under the chairmanship of the executive director of the corporation, Mr G. F. N. Battle. They were able to enforce the control measures in the seed crop, instigate the spray warning scheme, and by publicity and propaganda through the press and the corporation's agricultural staff and the National Agricultural Advisory Service, encourage the hygienic and cultural practices favouring control.

Research on this problem was also stimulated considerably by the virus yellows committee inaugurated by the International Institute of Sugar Beet Research under the chairmanship of Dr. H. Rietberg. The scientists involved with the problem from all over Europe met at least twice a year, exchanged information and experimental results and generally stimulated progress. For all these activities it was a great advantage to have the work concentrated at Dunholme.

The scientific staff had made considerable progress on subjects other than virus yellows – pests, fungal diseases, use of pesticides, agronomic aspects, field experimentation techniques, seed production, seed technology and varietal selection for resistance to pests and diseases. The results are recorded in Rothamsted annual reports and in numerous papers in scientific journals. It was obvious to us, however, that to make good progress we needed better facilities that would give us greater control of the environment in which laboratory and field experiments were executed. Eventually Broom's Barn provided this.

As chairman of the SBREC, Sir Edmund Bacon had been very encouraging and supportive of our efforts at Dunholme. He became chairman of the British Sugar Corporation in April 1957 and in that capacity came to visit us. As I met him at the doorway of our humble huts of which I was quite proud, he looked at me, then along the line of buildings and said: "My God, Hull, you can't work in a place like this – we'll have to do something about it!"

## SEARCH FOR A PERMANENT BASE

That Sir Edmund "did something about it" is in no doubt. His was the finger on the button, and his influence and persistence ensured that the project went through to completion [Ref. 5].

Discussions proceeded with Sir Peter Greenwell, then chairman of the SBREC. An alternative site had not been found. The staff of the unit and their families were established in the Lincoln area; a move away would be disruptive. Why not acquire the existing site from the War Office, put up an appropriate building and acquire more land in the vicinity for our field experiments? What discussions there were between the Ministry of Agriculture and the War Office I know not, but the SBREC appointed a working party to prepare plans. A few days before they were due to meet at Dunholme, contractors' lorries moved on to the airfield past our buildings. On enquiry, I found that they were building a launching site for ground-to-air missiles a few hundred yards from us! The cold war put an end to plans for a permanent Dunholme. In the meantime – since we were still living at Hackthorn – I had started negotiations to buy myself a permanent home in the nearby vacant Riseholme Rectory so this transaction was also cancelled.

The effort was renewed to find an alternative site. The

Ministry's land agents were instructed to report any suitable sites coming on the market and the corporation's agriculturalists were asked to keep a look out. The favoured area was that enclosed by a line joining King's Lynn, Stamford, Cambridge and Bury St Edmunds. There was much debate about just what was wanted. Some favoured a building with about five acres or so of land on which we could do micro-plot experiments. I insisted that we needed 200 acres or so of land on which we could do full scale field experiments, run a rotation of crops and organise long-term experiments. This plan was favoured by the SBREC.

Few suggested sites were forthcoming. One in Rutland was too far west and not suitable; one at Higham in Suffolk, near the site of Broom's Barn, was too undulating with very varied soil. I was not keen on a suggested site on the fens – fenland living did not appeal. Hinchingbrooke Castle, Huntingdon, was available and I prepared detailed plans for use of the main building as offices and staff flats and for the extensive outbuildings as laboratories. The surrounding land was too heavy and wet for arable culture and the Ministry had suspicions of dry rot, maintenance costs, and such like complications in the building, so this project was abandoned.

Eventually, in 1959, Ted Cousins, agriculturist at the Bury St Edmunds factory suggested Broom's Barn Farm. The farm was derelict, the owner had asked for an advance on a very poor crop of sugar beet and indicated his willingness to sell. The soil survey reported that the soil varied considerably from light to strong but that the site was not impossible. An advantage was that the 200 acres was in a regular rectangle, had good communications by road (A45) and rail, was close to an attractive



**Dr. Andrew Dunning spreading insecticide granules in the spring of 1968.**