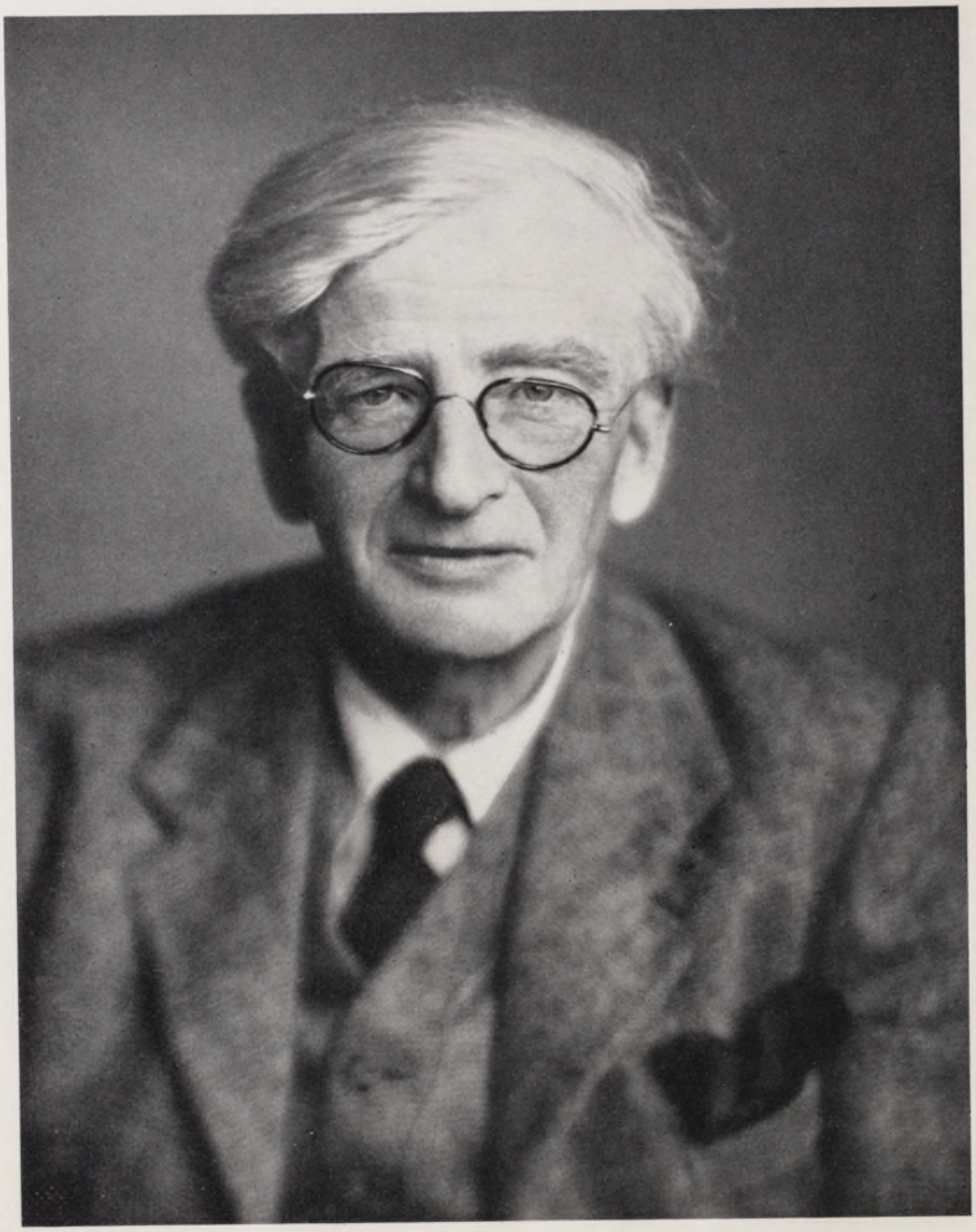

REGINALD GEORGE STAPLEDON

1882-1960

Reginald George Stapledon, born 22 September 1882, at Lakenham, Northam, near Bideford, came of a long line of North Devon landowners and farmers; a family tradition linked them with Walter de Stapeldon (1261-1326), Bishop of Exeter and founder of Exeter College, Oxford. His grandfather, James Stapledon, of Bideford, had, however, like many other men of Devon, broken away from the land and became a master mariner; his father, William (1829-1902), did likewise, sailing his own barque from Appledore and included among other enterprises much gun running to South America. The log survives of an adventurous voyage in 1852 to Australia where most of the crew deserted to take part in the gold rush. He was capable and forceful, vehement in condemning the bad conditions under which shipowners expected their captains and crews to sail, very observant and with an almost poetic appreciation of nature—traits which reappeared markedly in young George. Shortly after the Suez Canal was opened in 1869 he set up a shipping agency in Suez and Port Said; it prospered and brought him wealth, the friendship of de Lesseps, and the confidence of the Canal community. All this necessitated long absences from home, and when finally he returned he was smitten by a stroke which kept him bed-ridden for some years before he died in 1902. Perhaps for these reasons he seems to have little direct influence on George's development.

The outstanding influence of George's childhood was his mother, Mary, daughter of William Clibbett, the last builder of wooden ships in Appledore; a man of pronounced literary tastes and strong character who obstinately refused to abandon wood for iron or to turn off his workpeople—and he died penniless, but owing nothing. Mary was very beautiful; she had had little formal education and was largely self taught; she was an enthusiastic admirer of Darwin, Huxley and other advanced thinkers of the time and became an agnostic: free thinkers they were then called. George was devoted to her and she to him; she had ample leisure, a staff to relieve her of household duties, and some social isolation resulting from the fact that she was her husband's second wife, the first having been her sister, and such marriages were not much approved in those days. Like her husband she was a great lover of nature and took George botanizing over Braunton Burrows, then floristically rich; she took him also for long drives in the byeways of their attractive district, and gave him a small garden where he grew flowers and fruit for her, in friendly competition with the gardener who, like many others of his tribe in those days, was somewhat of a poet and a philosopher. For

George it was an idyllic childhood; he became and remained a keen gardener, and his familiarity with the famous golf course at Westward Ho! made him later a keen golfer. His happy relations with his mother lasted all through her long life. She died in 1928 at the age of 86.

His father had ten children: two sons and a daughter by the first wife, and four sons and three daughters by the second: George was the ninth, and the youngest of the boys. None of his brothers took up an academic career, but all led useful and successful lives: the eldest became Managing Director of a large shipping firm in Liverpool and his son Olaf is the well-known writer; another was a successful land agent; a third was a solicitor in Calcutta; and a fourth entered the Army and became a full Colonel. There was no family tradition of any ancestral scientist on either side.

In 1890 at the age of eight he went as day boarder to the United Services College at Westward Ho! a private school founded by a group of Army officers for their sons: Rudyard Kipling had been a pupil and presumably had made it the setting for *Stalkey & Co.** Conmell Price, whom Stapledon describes as a great headmaster, and who had started the school in 1874, had still four more years of service, but George was too young to come under his direct influence—though one of his Speech Day phrases was never forgotten: 'always the late starters are the best enders.' George found the masters 'a drab lot', he was not conscious of deriving any benefit from them, he gained no distinctions and after he left in 1900 to go to Cambridge he had to spend a year with a 'crammer' in London to make sure of passing the entrance examination.

In October 1901 he entered Emmanuel College and took geology, chemistry and botany for the Natural Science Tripos. But he developed no enthusiasm for any of these subjects. He was, of course, well off and under no compulsion to work hard, being intended for the family business; like others in similar circumstances in those days he was there to develop poise and acquire the arts of gracious living. He was mildly interested in geology but not in chemistry or botany, although he attended lectures by Marshall Ward and A. C. Seward, who was his tutor. He records that apart from a certain amount of golf and of botanizing he was somewhat bored and he was not taken very seriously: indeed he relates that Seward treated him rather as a joke. In the Tripos he got a second class and went down in June 1904, undistinguished and not conscious of any marked influence of any of his teachers.

Three months later he entered the family firm on the Suez Canal and was well trained in the keeping of detailed and accurate records, which proved invaluable to him in later years. But he was not happy; in fact he hated it; he retained only one pleasant memory: a holiday in the Lebanon where he did some geologizing. After two years he decided he could stand it no longer; his grandiose ideas of business expansion were not encouraged, the climate did not suit him, and he wanted to go back to Devon and grow fruit. Very

* The school was later amalgamated with the Imperial Service College, Windsor.

wisely his father agreed: in 1907 he became a pupil on a large fruit farm in Kent. It was an interesting period. Wye College had for some 13 years been making scientific studies of fruit problems and the best of the growers were showing a lively interest therein; Stapledon clearly felt the stirrings for he relates 'it was there I suddenly came to life and realized that I was really a potential scientist'. He wrote for advice to his old College tutor, Professor Seward, who advised him to return to Cambridge and take the diploma course in Agriculture. This he did in October 1908. The course then normally lasted two years, but as the first year was devoted mainly to the pure sciences which he had already taken in his Tripos he was allowed to proceed direct to the second year lectures. It was a youthful vigorous school and much good scientific work was being done. T. B. Wood, who had devotedly tended it since its small beginnings in 1894, had at long last in 1906 been appointed Professor of Agriculture and was introducing into the science of animal nutrition new concepts based on Emil Fischer's work on the proteins, Gowland Hopkins's studies of the vitamins, and Kellner's calorimeter methods of investigation. R. H. Biffen, under the stimulating influence of W. Bateson, was applying Mendelian concepts to the breeding of wheat and had already produced his famous variety Little Joss; while F. H. A. Marshall was continuing investigations on animal reproduction which he had begun under Cossar Ewart in Edinburgh. On the University farm experiments on seed mixtures for grassland begun by T. H. Middleton were still continued, as were S. F. Armstrong's pasture surveys.

But whatever may have been Stapledon's hopes and anticipations before he came to Cambridge none of this appealed to him. He was of course much above the average student age, being now 26, which would hamper student intercourse though it did not prevent friendships with a few who afterwards rose to distinction. Others, however, found him 'very ordinary, with an annoying trick of arguing with anybody and propounding odd and often absurd theories to the senior people as well as criticizing their teaching methods', as one of them wrote. Looking back years afterwards he himself considered his time at Cambridge 'a rather colourless interlude'; forestry ('which I read as a bye-play') was the subject that most appealed to him: the reader was Dr Henry, an amusing and eccentric Irishman 'whose enthusiasm thrilled me', and he writes: 'I was much more deeply influenced by (him) . . . than by any other professor, teacher, or master under whom I had ever sat.' Excepting Dr Henry, he wrote, 'I made no inspiring contacts with my professors and teachers.' Neither at school nor at the University had formal class instruction seemed to do much for him; he felt he gained more from his mother's mode of self education. He took his Diploma in June 1909 and left Cambridge, undistinguished, and having apparently made as little impression as when he had gone down five years earlier. But although he did not realize it at the time, Cambridge had given him two gifts of vital importance for his future work: its technique for analyzing botanically the herbage of a field, which he could modify to suit his requirements; and an ecological

outlook, which he may have derived from Dr Henry, as his first ecological references dealt with woodlands.

Immediately after leaving Cambridge he proceeded to the Royal Agricultural College at Cirencester where he had been appointed Assistant in the Department of Natural History, which included botany, zoology, and geology. The Head of the Department, J. R. Ainsworth Davies, who was also Principal of the College, had long been Professor of Biology at the University College of Wales, Aberystwyth, in the days when that title included those three subjects. They had now grown beyond that stage, and Ainsworth Davies, wanting to split off botany, set it up as a new department which was handed over to Stapledon. His first assignment was to help the Forestry Department (then his chief interest) by examining the ground flora of their experimental field, but he was quickly attracted to the field experiments of Edward Kinch, the Professor of Chemistry.

Years afterwards Stapledon said that he owed the beginning of his interest in grassland to Kinch, the outstanding figure on the staff at that time, and the type of man to whom Stapledon would certainly be drawn. He was a native of the region, born 61 years earlier at Faringdon only 18 miles away, soaked in knowledge of country lore and much else—'ask Kinch' was usually the answer to a difficult question—'a fascinating companion on a country walk' as one of his pupils, Lord Bledisloe, described him, also a keen gardener. Mellowed by a great sorrow in early days, when after a year of happy marriage he had lost his young wife, he was deeply interested in his students and young colleagues and always ready to help them. He had first come to the College in 1869 as Assistant in the Chemical Department, but left four years later for a short spell in London; then in 1876 he went to Japan as Professor of Chemistry at the Imperial College of Agriculture, Komaba, Tokyo. Westernization was only just beginning: he had known the old Japan and had brought back with him some examples of Japanese art and crafts which he delighted to show his visitors. He had returned to Cirencester in 1881.

He was well versed in the Rothamsted investigations and had in 1888 started a repetition on a smaller scale of the Park Grass experiments on the manuring of permanent grass for hay, the same treatment being given year after year to each plot so that the effects were cumulative. At Rothamsted not only were weights of hay taken, but botanical analyses were made also. Hitherto this had been impracticable at Cirencester and Kinch now asked Stapledon to undertake it.

This was the beginning of his association with grassland.

At Kinch's suggestion he widened the scope of his enquiries by analysis of the herbage of other Cotswold pastures,* and fortunately for him the two seasons in which he did this were sharply contrasted, 1910 being fairly normal

* He used a modification of the Cambridge method. A frame one foot or alternatively six inches square was laid on the grass, and note was taken of the number of different species and their names, or the number of individual plants or of tillers of each species. The sampling was systematic, not infrequently 100 would be made in a field.

while 1911 was exceptionally hot and dry. Several important generalizations emerged from these observations. Each of the hay plots had developed its characteristic flora, as at Rothamsted, the species most favoured by the treatment having repressed those less favoured. This effect of competition had already been discussed by A. D. Hall. The flora finally established remained unchanged so long as the conditions remained unchanged, but it shifted to a new equilibrium if the conditions altered.

These two factors, competition, and the dominating effects of environment (including treatment) explained several well-known observations. Competition affected not only the components of the flora, but also explained why poor grass lands carried far more species of plants than rich ones: nothing could grow very vigorously and therefore any plant arising from seed blown in had a chance of survival, while on the richer grass land the favoured species grew so vigorously that only equally vigorous intruders could hope to succeed. Stapledon found some twenty to thirty species on the good grass lands, but on the poor land he found over sixty.

But he was far more interested in the ecological problem, the effects of environment in determining the vegetation type. The first requirement was ability to classify the types, and he thought he could do this if he had sufficient botanical analyses, the species in each case being classified in the usual ecological groups: dominant, sub-dominant, etc. In natural habitats there was good correlation between association and environment; he wanted to find out whether it existed for grassland, an association created artificially and then for a period of years left undisturbed except by the grazing animal —the history of most of our permanent grassland. 'It only needs to be proved', he wrote, 'that the flora of an area is essentially a function of the environment, and that chance is not a serious disturbing factor, for ecology to become a very important economic subject . . . a knowledge of the one affords material for accurate deductions concerning the other.' Years later he expanded this theme in connexion with his visit to Australia. In these associations he thought the weeds would be particularly useful as diagnostic agents.

The most important of these observations, however, was made in the hot dry season of 1911. There were heavy casualties among the sown grasses in the pastures, but unsown indigenous plants of the same species had survived much better. One grass in particular attracted his attention: Hard fescue (*Festuca duriuscula*). In the 1913 paper he writes: 'It is probable that, if large amounts of seed from the endemic variety could be collected, results as satisfactory as those recently obtained by the use of wild Dutch (i.e. white) clover might be forthcoming.'*

The search for indigenous varieties, and their utilization for the production

* *J. Agric. Sci.* 1912-1913, **5**, 129-151. The reference is to D. A. Gilchrist's demonstration at Cockle Park from 1906 onwards of the striking superiority of wild white clover over the cultivated varieties. Years afterwards Stapledon declared that he had 'avidly absorbed' Gilchrist's ideas which, as his study of grassland extended, stimulated his interest in the difference between the indigenous strains of grasses and clovers and those imported from the Continent and Commonwealth. (v. Cecil Pawson, *Cockle Park Farm*, 1960, p. 27.)

of improved varieties of grasses and clovers, became the main purpose of the great Welsh Plant Breeding Station that he later built up. The numerous observations of records provided him with material for several important papers.*

He was obviously happy at Cirencester. He was much liked by the students and mingled with them a good deal, joining in their tennis, concerts and other activities: 'he seemed too young', one of them wrote, 'to be regarded as a don to be revered'. He would put up a notice to the effect that on Sunday afternoon he was going for a country walk and any student that would like to join him would be welcome. These walks became very popular and the students were greatly impressed by his power of keen observation, 'with his eyes on the ground to identify every blade of grass, even when not in flower'.

He stayed three years at Cirencester: they were the crucial years of his life: it was there that he found his life's work. He had been a late starter, but he came within the spirit of his old Headmaster's well-remembered dictum and was one of the best enders.

A much wider field opened up for him when C. Bryner Jones, Professor of Agriculture at the University College of Wales, Aberystwyth, obtained a grant from the Board of Agriculture for the appointment of a botanical adviser. Stapledon was chosen. His main task was a botanical Survey of Central Wales: this was expected to take several years. He had also to advise the farmers on botanical matters, and to devote not more than 100 hours per session to teaching in College. There was as yet no Department of Agricultural Botany, and for administrative purposes he was to act under the direction of the Professor of Agriculture, but in matters of research the Professor of Botany had to be consulted. The salary was to be £200 per annum for the first two years, rising thereafter to not less than £300. He took up his duties in October 1912.

He proceded energetically with the botanical survey. Fortunately for him O. T. Jones, then Professor of Geology, and a group of students were engaged in a geological survey of the region. Stapledon camped with them and made long expeditions on foot into the hills, collecting many sod samples which in the evenings he tore to pieces, identifying and counting the plants, then calculating the percentage that each species contributed to the total. Like some other biologists of his day† he was not strong in mathematics, and his companions were sometimes amused at seeing him use the multiplication table in these operations. These and his earlier analyses laid the foundation of his unrivalled knowledge of the herbage plants, and also provided for the first time a basis for the classification of grass lands which he had been seeking. His maps of the distribution of his vegetation types‡ showed distinct

* *Sci. Bull. Royal Agric. Coll.* No. 2, 29-36, 1910 and No. 3, 34-43, 1911; *J. Agric. Sci.* **5**, 129-151, 1912-13, and **6**, 490-511, 1914 (effect of manures).

† Especially the seniors. Gilbert would not allow the use of logarithms at Rothamsted and some of the older geneticists distrusted the incursion of statistical science into their subject. Bateson much preferred the 'sieves of a trained judgement'. (Pres. Address Brit. Assoc. Section D, 1904.)

‡ He described some of these in 'Plant communities of farm land'. *Ann. Bot.* **30**, 160, 1916.

correlations with the geological maps, the governing factor being apparently the water relations.

These expeditions brought him into contact with the Welsh hill farmers whom he soon learned to like, and they liked him. But he found their agriculture deplorable. Oats were the chief crop, but the sorts grown, he declared, would be classed by most agriculturists as weeds. The other crops were poor, too. Part of the trouble arose from the very poor quality of the seed supplied. He went thoroughly into this question and produced a scathing report on the local seed trade, which led to a speedy improvement.

Many of the hill grazings were very poor,* carrying on the average no more than one sheep to the acre even in summer. He resolved to improve that, and in collaboration with Abel E. Jones he published in 1916 the first of a series of studies which continued throughout his working life.

In 1914 he became acquainted with one of Professor Yapp's Honours Botany Students, T. J. Jenkin, who, quite independently of Stapledon's work, had based his Honours Thesis on some interesting observations he had made on the changing flora of a sown pasture on his father's farm in Carmarthenshire. He had noticed the superiority of self-sown indigenous *Festuca duriuscula* over the commercial variety and had suggested that it should be cultivated to provide a seed supply for farmers. As Stapledon had in his 1913 paper been thinking along the same lines (except that his suggestion was the collection of the wild seed) he proposed to Jenkin that they should join forces and produce a joint paper on indigenous plants in relation to habitat and sown species. This appeared in 1916, and is one of the most important on the subject.† The commercial foreign varieties may give better yields for a few years, but they are sooner or later ousted by the indigenous varieties; it is therefore better to start with these, or even simply to make the conditions more favourable for them when they will more speedily develop of their own accord—an alternative that he had advocated in his 1915 lecture to the Agricultural Education Association but discarded later when the improved varieties of grasses and clovers became available. A list of the plants that should be studied is given.

This investigation was the beginning of a collaboration, which, with a short break early in the 1914-18 war, lasted all of Stapledon's working life.

At first the war had not interfered with Stapledon's activities, but by the end of 1916 the food situation was becoming desperate and a special Food Production Department was set up to increase the home output to the utmost. Stapledon was seconded from Aberystwyth and made Director of the Official Seed Testing Station long intended but never yet established, now, however, to start operations in the Department's offices. It was badly needed, as supplies of seed presented difficulties; it proved so useful that in the first year some 14 000 samples were tested.

The Food Production Department was disbanded when the war ended

* Described in *The sheep walks of mid Wales, chief types of vegetation*, Aberystwyth, 1914.
† *J. Agric. Sci.* **8**, 26-64, 1916.

(November 1918), but the Seed Testing Station was retained. Stapledon, however, returned to Aberystwyth, attracted strongly by a new development. In the struggle for more home-grown food the Welsh farmers had been severely handicapped because the modern improved varieties of crops that served so well in the lowlands were unsuited to their higher altitudes and higher rainfall. A great benefactor of the College, Sir Laurence Philipps (later Lord Milford) gave £10 000 for the establishment of a Welsh Plant Breeding Station and an endowment of £1000 a year for the first ten years. Stapledon was appointed Director and his college post was raised to an independent Professorship.

Before taking up the appointment he visited Denmark and Sweden in company with R. H. Biffen and a few others to see their well-equipped stations for seed control and plant improvement, and he made some useful contacts, notably with Turesson, whose studies of the wild grasses and dicotyledons of Sweden had shown that one and the same species might be found in somewhat modified forms in different environments while still remaining in the same morphological taxa. This work was then attracting considerable attention among botanists.

On returning to Aberystwyth in 1919 in his new dual capacity he found there was no room in the College. A new building was out of the question, but a disused foundry in the town was bought, gutted and converted to provide accommodation for the Agricultural Faculty, and here his new Department was housed for a number of years. Land was acquired about two miles outside the town for the Plant Breeding Station. Work began in May 1919, the staff consisting of Stapledon, one research assistant, and somewhat later, a gardener from Kew. These slender resources were, however, soon augmented: the Development Commission recognized the Station as being eligible for their grants on condition that its work on grass and herbage plants should not be restricted to Wales. This was agreed and in 1920 expansion began. As Senior Scientific Officer he appointed T. J. Jenkin; the junior staff was built up from students, many of whom like Martin and Iorworth Jones came from small Welsh farms, a fertile source of good human material. Stapledon had the gift of choosing his staff well and inspiring in them a deep sense of loyalty and his own vivid enthusiasm for the work they had undertaken.

Having selected a man he assigned him a section of the work, discussed a programme with him, and left him to get on with it, though being always ready with help and advice. The method answered well; it produced men who today are leaders in the particular branches in which they had started at the Station.

The initial programme of work fell into two broad divisions: a search for possible new crops to diversify and enrich the rather meagre systems of farming practised in Wales; and the improvement of crops already grown. The search for new crops yielded little result: none of those tried proved more useful than those already cultivated. On the other hand the efforts at crop improvement were highly successful. Three groups were investigated:

grasses; clovers and lucerne; and cereals with some green fodder crops. The work on cereals soon produced results. It was chiefly on oats, being much the most important arable crop in Wales, occupying nearly half the cultivated land, and was in charge first of C. V. B. Marquand, and then of E. T. Jones who later became Director of the Station. The varieties of *Avena sativa* and *A. strigosa* used by the Welsh farmers were poor, but reasonably tolerant of their conditions. There was already an established technique for selecting and breeding cereals, and after some years of trial and error new varieties were produced, each more productive and better suited to its appropriate conditions than the older sorts. These were well received at the time and two varieties of white winter oats, among the first available to farmers, proved very popular in England; but they have now been superseded by the new varieties bred at the Station.

Clovers and grasses, however, were entirely novel subjects for plant breeders and new techniques were required. The methods suitable for cereals were not directly applicable to grasses because, while cereals are self fertilized, grasses are in the main cross fertilized, the pollen usually being carried by wind. Some varieties,* however, have a certain degree of self fertility and some plants are male sterile.

The first step was to make a collection of as many plant types of the wanted grasses and clovers as could be found. Within any limited and long undisturbed ecological environment the majority of the population was expected to be ecotypical. A wide range of genes within a species would be found only over a sufficiently large range of contrasting ecological habitats. The collection had begun modestly in 1915 when samples of the fine-leaved fescues were collected and studied. But the programme was quickly widened. Both Stapledon and Jenkins travelled widely to survey grasslands, often taking small sample sods as they went; they did this also wherever either of them found on a long undisturbed site an interesting specimen of one of the dozen grasses and clovers they intended to study.† These samples were sent to Aberystwyth, the plant or tillers teased out and planted first in boxes of sterilized soil, then transplanted in rows each of ten plants two feet apart. These were then divided into two sections: one was cut each year for hay and aftermath, the other was cut monthly to simulate the effect of the grazing animal. Observations were made on characters of agricultural importance: habit of growth (leafy or stemmy), length of growing season (time of flowering), winter hardiness, rate of mortality, susceptibility to disease; in selected cases T. W. Fagan of the Agricultural Department determined the mineral constituents and nitrogen content of the leaves.

The collection became enormous. Stapledon called it a 'vast museum'

* At first these were called 'strains', but as the word 'variety' was already in use for other plants it was later adopted for herbage plants. The Welsh Plant Breeding Station also uses the word 'cultivar'.

† Cocksfoot, Timothy, Meadow fescue, Perennial rye grass. Tall oat, Tall fescue, Crested dog's tail and Rough stalked Meadow grass. The two last named were given up after a few years, partly because they showed less variation than the other species.

and the number of observations was colossal. In one investigation on red clover R. D. Williams writes that he had made individual observations on ten different characters in 30 000 seedlings over a period of three years.* Stapledon's training in recording in his father's counting house at Suez must have proved invaluable. It was of course magnificent material for an ecologist; A. G. Tansley naturally became very interested and although not a frequent visitor he gave much valuable help over many years, which Stapledon thankfully acknowledged. As an Associate Member of the British Vegetation Committee he met other ecologists and widened his own interest in the subject: his paper on *Cocksfoot ecotypes in relation to the biotic factor*† is one of the classics of agricultural botany. Turesson came also from Sweden and spent a week in the early days: 'One long stimulation' is Stapledon's record. Bateson's visit was an unforgettable event: 'He thrilled all of us . . . generous of his appreciation and of critical advice.' These visits helped to break down the isolation he might otherwise have felt; he took little active part in the work of scientific societies and rarely attended scientific meetings. A visit to the United States in 1923 gave him the opportunity of seeing something of their work on plant breeding, but it was an oppressively hot summer and he was unable to complete his programme.

During the 1920's British agriculture was passing through long periods of depression and as usual the part of the farm that suffered most was the grassland. Much of it was in a deplorable condition and Stapledon felt that improvement was desperately needed. He was particularly anxious about the hill grazings and unceasingly sought methods of improving them. He repeatedly acknowledges valuable help and facilities given him by two enterprising landowners, Mr S. M. Bligh of Cilmery Park, Builth Wells—'A very volcano of ideas and a pioneer practitioner in the art of land improvement' Stapledon called him—and Capt. Bennett Evans, who owned much land in the Plynlimmon hill region. Beginning with the high land already in cultivation, but where the grass was in very poor condition, Stapledon had for several years investigated two general methods of improvement. One, the ecological method, was to make the conditions as favourable as possible for the better herbage type so that it could readily develop. Given time it would come automatically, the indigenous varieties being widespread. Wild white clover and a few of the grasses, notably rye grass, were the desirable basis and the requirements for clover satisfied the grasses. A dressing of phosphate, either basic slag or mineral phosphate (as Somerville's much publicized 'Manuring for Mutton' experiments had shown) and in some cases lime, together with a good harrowing, often sufficed. But it was quicker and better to plough up and reseed,‡ and from the outset he had tried to devise suitable seed mixtures. Early experiments with clover seed imported from various countries showed the superiority of the indigenous varieties and this proved generally true of

* *Bull. Welsh Pl. Breed. Stn.* Ser. H. No. 2. 1927.
† *J. Ecol.* **16**, 71-104, 1928.
‡ *J. Min. Agric.* **32**, 15-25, 1925.

grasses also. The numerous trials with seeds mixtures made from 1915 onwards were summarized in 1925.*

The higher land, and land that could not be ploughed, was torn up by heavy harrows or other devices and then sown:† 'scratching' Stapledon called this process, but it was rather more than that and required powerful tractors, as also did the strong ploughs when it was decided to use them. These experiments were all on a small scale; they showed what was possible, though not what was practicable from the economic point of view.

Unfortunately early in 1926 he suffered a serious breakdown in health, and his half-brother, who was Chairman of the Blue Funnel Line, arranged for him and his wife to make the long sea voyage via the Cape to Australia and New Zealand, and to stay there for some months. They sailed at the end of February and did not return till mid-November, the College having given him a year's leave of absence.

It was for him a particularly interesting time to visit New Zealand. For long the natural fertility of the soil had been failing, and by the early 1920's the position had become very serious. E. Bruce Levy had been appointed to find ways of improving the grasslands and had already done valuable work, mainly on ecological lines. Stapledon fully recognized the importance of these factors, but insisted (and he could insist with great vigour) that 'strain', or as it is now called 'variety', could outweigh their significance and even nullify the agronomic value of any soil improvement. 'He led New Zealand', writes Bruce Levy, 'to a thorough realization of the significance of strain and pedigree in herbage plants, and set in motion intensive strain trials of agronomic strains of grasses and clovers . . . Strain and pedigree in herbage seeds in New Zealand have been among the most important factors in our development of marginal lands and in the surer and fuller intensification of our grassland farming systems.' So impressed was the Department of Agriculture with the possibilities thus opened up that Stapledon was asked to send out one of his staff to continue the trials. This he was able to do later, and he chose one of his ablest young colleagues, William Davies,‡ to work as Plant Geneticist at the Palmerston North Research Station, where he did such good work that on the occasion of the 7th International Grassland Congress in 1956 the University of New Zealand conferred upon him its Honorary D.Sc. degree.

But if Stapledon gave much to New Zealand he also received much. In the rich dairy districts of the North Island he saw more intensive management of grassland than anywhere in Britain. Instead of having the grassland in large fields each open for grazing over the whole area for the whole season it

* *Advisory Bull. Univ. Coll. of Wales*, with William Davies, who was put in charge of this work in 1923.

† Stapledon made much use of the cleanings of wild white clover seed: sufficient clover was left to establish the plant and the foreign seeds would usually do no harm even if the resulting plants survived on the hills, while some, e.g. *Lotus corniculatus*, would be useful (v. the 1915 lecture).

‡ Now Director of the Grassland Research Institute, Hurley, Maidenhead. After two years in New Zealand he spent a year in Australia to inspect the grassland experiments in each State and report thereon to the Commonwealth Council of Industrial and Scientific Research.

was divided into small paddocks each grazed only when at full vegetative growth, then fertilized and rested till full growth was again attained. This effect of resting and grazing in enhancing productiveness interested Stapledon greatly and was further studied at Aberystwyth when he returned.*

In Australia he saw the various stages in the conversion of the native flora—the stable climax vegetation—into the unstable transient forms that dominated the countryside. 'No knowledge', he wrote, 'could be more essential to the national exploitation of a country than a proper appreciation of the relationships—successional relationships—of the different types of vegetation to each other and to the varied soil and climatic conditions which obtain.' This knowledge would facilitate the conversion of the natural vegetation into a more desirable type and indicate ways of maintaining it.

What impressed him most in this journey, however, was the enormous potential but unrealized value of the grasslands of Australia, New Zealand and such of the South African veld as he had seen during the ship's stay at Cape Town. None of these countries had a properly equipped grassland research station, and he recommended that one should be established on generous lines like the Svalöf Station in Sweden; also that in each country proper agrostological surveys should be made.†

He returned to England much improved in health and found a lively interest in agricultural development both at home and in the Commonwealth. The first Imperial Agricultural Conference had been held in Westminster Hall in October, and was just ended; its recommendations had included the establishment of Imperial Agricultural Bureaux‡ for the dissemination of information on their respective subjects to agricultural departments throughout the Commonwealth. One of these dealt with grass and forage crops, and was to be located at the Plant Breeding Station with Stapledon as Director. His proposal for the establishment of a great research institute was not accepted, however.

At home he found a greater interest in grassland than ever before. The Ministry's campaign for its improvement was being vigorously prosecuted and he thought the time was ripe for him to issue a book on the subject for the guidance of farmers; to widen its scope he collaborated with J. A. Hanley, one of the most experienced Agricultural Advisers of the time. They wrote *Grassland, its management and improvement* (Oxford University Press, 1927). It was well received, but the depression of the early 1930's disheartened farmers and they lost interest; when finally the tide turned the Second World War was on, and reprinting was impossible.

Unfortunately in 1928 he had another nervous breakdown the effects of which lasted a long time: nevertheless he continued to work as much as he possibly could. Meanwhile some of the plants in the Station's collection

* *J. Min. Agric.* **34,** 201-212, 1927. Martin Jones and Iorworth Jones, *Bull. Welsh Pl. Breed. Sta.* Ser. H. No. 11. 1930.

† *A tour in Australia and New Zealand: Grassland and other studies,* Oxford Univ. Press, 1928; also papers in *J. Min. Agric.* **34,** 1927.

‡ Later renamed Commonwealth Agricultural Bureaux.

appeared sufficiently promising to justify extended farm trials, and by 1930 selections of grasses, clovers, and oats were being tested throughout Britain.

Stapledon realized that selection alone would not provide the range of characters wanted; combinations of characters were required which could be obtained only by breeding. Fortunately the search for suitable techniques had been successful, after what he described as 'eleven years of trial and error', and the first results were published in 1931.* Following his usual practice he had alloted the grasses mostly to T. J. Jenkin, the clover to R. D. Williams, and kept Cocksfoot (*Dactylis glomerata*) for himself. He chose Cocksfoot because in the Aberystwyth region it occurred more commonly than any other grass in more or less well-defined ecotypes, it was also more highly self fertile than most of the other local grasses, and, as one of the most persistently leafy of grasses, it had high agricultural value. It soon appeared that the pure line technique was unsuitable, there being too much heterozygosity. Recourse was therefore had to mass hybridization. About 30 desirable parents were selected from the 'vast museum', they were selfed, some 200 'quintessential plants' were selected from the progeny but not emasculated, they were enclosed together in conditions intended to exclude foreign pollen, and at the proper time shaken by a simple mechanical device to ensure distribution of the pollen. In each generation there was re-selection, and non-conforming plants were rejected. The method was frankly empirical and subjective, 'largely selection and trial on what would now be termed poly-cross lines', a colleague described it.

Stapledon was not interested in genetics or cytology. At the outset he disclaimed any intention of aiming at genetical purity. This he considered might be necessary for crops like wheat that have to be processed, but not for forage crops where the difference between higher and lower purity is chiefly a difference in weight per unit area rather than in quality. Many generations, he wrote, would be needed to attain complete genetic purity, whereas a 70 per cent purity could be attained much sooner and would represent a great advance on existing varieties of grasses. It was not that he was satisfied with 70 per cent purity: he was imbued with a deep sense of urgency, the pressing need to improve the grasslands of the country, especially in the hill districts, and as the new varieties were a great advance on those then in use he wanted to get them out to the farmers as quickly as possible. Like some other very successful plant breeders he had a clear vision of what he wanted to produce, and the artist's intuition to guide his choice of initial material.

The method is open to the objection that some degree of heterozygosity is inevitable, rendering the variety liable to instability: indeed at one time there was a blurring of the differences between certain varieties, but this was rectified by reconstructing them. His judgement had, however, been so good that his first strain of Cocksfoot to be distributed, S. 26, developed from five plants found in a gorse brake in Devon, and put on the market in 1937, still retains its popularity as do two later ones, S. 37 and S. 143.

* *Bull. Bur. Pl. Genet. Aberystwyth*, **3**, 1931. R.G.S's section is on pp. 35-45.

While Stapledon was producing the Cocksfoot varieties, T. J. Jenkin was working on Perennial Ryegrass (*Lolium perenne*), Timothy, and other grasses with equally successful results: some of his strains, especially S. 23 rye grass, are still very popular. His technique, however, differed from that of Stapledon, being based on genetic principles.* So also was the technique of R. D. Williams who produced the very valuable S. 100 white clover and S. 123 red clover.

Considerable time elapses between the production of a new variety at a Plant Breeding Station and the appearance of its seed on sale to farmers. For the market, of course, it must be produced in tons. Grasses being cross-fertilized, with wind as the carrier of the pollen, special care has to be taken to avoid contamination during their multiplication. Anything from 12 to 16 years may elapse between the first crossing and the marketing of the resulting new variety; for the two clovers just mentioned the interval had been 17 years: from 1920 to 1937.

Stapledon did not wait for this final stage: having got sufficient seed of these better varieties of grasses and clovers for experimental purposes he was anxious to organize a large-scale demonstration combining all the methods of improvement of hill grazings that had proved effective in his numerous trials. He drew up an ambitious scheme estimated to cost £20 000, a large sum in those days and far beyond anything the Government would provide. He and the College Principal, H. Stuart Jones, sent a letter to *The Times* pointing out that large areas of grass in our country now regarded as inevitably derelict could, by these new methods, become an asset of immense importance, and appealed for funds to show the way. The letter was published on 11 July 1932: soon came the response by Sir Julien Cahn who generously offered £3000 a year for seven years. A lease was taken of a hill farm near Devil's Bridge with grazings up to 1350 ft altitude, and some 2500 acres of sheep walk up to 1850 ft altitude, much of the herbage being of the very poor Molinia-Nardus type with Nardus-Fescue in the drier places and rushes in the wetter parts. The customary procedure was to keep the sheep on these walks during the summer, but to remove them during autumn and winter, those ready for market being sold, the in-lamb ewes and some others transferred to lower lying fields on the farm and the weaker ewe lambs boarded out on lowland farms between October and early April. This was a costly and often unprofitable business, and Stapledon sought to improve the cropping system of the arable part of the farm so that it could carry more sheep in winter, thus reducing or eliminating the cost of boarding out. His further object was to make the summer grazing more profitable.

Moses Griffith, Agricultural Adviser for Merionethshire, and a good farmer, was put in charge; work began in March 1933, and yielded striking results,† which Stapledon intended should be seen. He had a wonderful gift of presentation. From the road one saw on the hillside a great patch of green

* Described by him in *Bull. Welsh Pl. Breed. Stn.* Ser. H. No. 2. 1924. The method was devised in 1921.

† Reported in *J. Roy. Agric. Soc.* **97**, 33-53, 1936, and *Welsh J. Agric.* 1935 and 1937.

herbage dotted with sheep happily grazing, surrounded by the dark wild forsaken vegetation to which, however, they occasionally had recourse apparently in search of some nutrient not adequately provided by the plants sown. When Sir Julien's gift was exhausted the scheme was financed by the Ministry of Agriculture till 1947 when it came officially to an end. The work still goes on, however, the land being now included in the Ministry's Experimental Hill Farm.

The information obtained has wide and lasting value, and with Stapledon's other work and that of his colleagues it has provided most of the techniques now employed by farmers for upland reclamation. By the irony of fate the grass varieties he himself produced did not turn out to be the most suitable for the purpose: the really pivotal grass, according to P. T. Thomas, the present Director of the Station, is another of its products: Jenkin's remarkable S. 23 rye grass; this, Thomas states, has been responsible for more grassland improvement on the hills than all others put together. But Stapledon's influence and advice stimulated reclamation of large areas of hill land during the war, much of which still remains greatly improved: notable examples are on the Kerry Dolfor hills and the Shropshire hills in the Bishop's Castle and Clun areas.

Meanwhile the experimental plots at the Plant Breeding Station, always interesting to scientists, were becoming increasingly interesting to farmers, and many came from far and wide to see them: usually in groups. Stapledon himself frequently demonstrated to them. At this he was unrivalled. 'Dressed in country tweeds with plus four stockings of unusual hue and a woollen sweater round his waist in the manner of a cricket umpire', as a colleague described him, carrying a shooting stick used sometimes as a rest, sometimes waved about as a pointer, holding his audience spellbound by his vivid descriptions and his amazingly infectious enthusiasm. It even happened at times that the char-a-banc due to take the party home at 6 p.m. would be kept waiting two hours or more because he was still willing to continue. On occasion for large groups at Cahn Hill, where he had taken to riding, he would demonstrate mounted on a Welsh pony armed with a trumpet-shaped megaphone, a striking unforgettable figure with his finely moulded features and great shock of hair: he must often have reminded his Welsh hearers of a crusader of old calling them to battle in tones as near to the *hwyl* as a *Saes* can ever get. And indeed it was a crusade he was leading: an end to the poverty of the hill farmers and a better life for them through more productive grassland.

Improvement of the grasslands, however, was not the only object for which he was campaigning. Like many others in those days sensitive to the beauty of the countryside, he wanted to stop the devastation that was then proceeding at an appalling rate as the result of very heavy wartime losses of sons and fortune sustained by the county families who had long been its custodians. He deplored the growing estrangement of the mass of the people from the countryside, their failure to recognize its beauty, their desire to speed

through it as quickly as possible, indifferent to the sprawl of the towns and the unsightly erections being put up in what had been attractive little market towns and villages. In 1935 he wrote *The land now and tomorrow* (Faber & Faber) telling of some of the atrocities he himself had seen, of the unnecessary village poverty due to the neglect of our agriculture, and in glowing terms setting forth what rural Britain could be like if changes now quite practicable were made. But this would require widespread appreciation of the ethical, aesthetic and social values of a highly efficient agriculture and a well-cared-for countryside. His remedy was to bring the townsman into the country and to set up National Parks, where a model village, model farms and rural crafts would show the best of country life to the townsman visitor; and rowing, fishing, riding and simple golf (he despised the modern costly 'super golf') would show him its pleasures.

The book had a wonderful reception: repeated reissues were called for, and it must have played an important part in stimulating public interest in the countryside. The idea of National Parks was of course not new: it had been discussed for many years, and the Addison Committee of 1929 had studied it in detail and recommended certain areas as eminently suitable. Their idea, however, was entirely different from Stapledon's: it was to leave wild nature intact in all its pristine beauty allowing no interference by man, and it was this, and not Stapledon's conception, that was adopted when the National Parks Commission was finally established in 1949.

The book has the strong personal interest of revealing the man more fully than any other of his writings; it brings out the streak of poetry in his nature, the visionary's disregard of the practical difficulties that would have benumbed most others, but which had seemed to melt away before his robust enthusiasm.

Then in 1935 came another breakdown in health which much reduced his activity for many months.

Later on the Ministry of Agriculture wishing to intensify the grassland improvement scheme asked Stapledon in October 1938 to do a lecture tour of England and Wales, and also with William Davies and three assistants to make a detailed survey of the grass lands. His theme for the lectures was that the grass now treated as permanent should be regarded as a crop and made to play its part in the rotation. Instead of being left down indefinitely it should be ploughed up and followed by a highly productive sequence of arable crops. When its turn came the ley should be broken up before it began to deteriorate—though he realized that while it remained it improved the physical condition of the soil and increased its productiveness. Country wisdom on the matter was summed up in the old couplet:

> Make a pasture, break a man;
> Break a pasture, make a man.

For this he substituted the slogan 'Take the plough round the farm'. As some 60 per cent of the farmed land of England was in permanent grass the task of

persuading farmers to bring it under the plough was formidable, but this did not deter him: even the renowned fatting pastures of Leicestershire and Northamptonshire were to be ploughed up. This, however, was too much for the stolid countryman: from time immemorable it had been held that to break these up would be almost a sacrilege. A compromise was necessary, but Stapledon estimated that some three-quarters of the permanent grass could advantageously be replaced by arable grass. Ley farming, he maintained, should form the basis of our agricultural policy, and he had made this the subject of his Presidential Address to the Agricultural Section of the British Association earlier in the year.*

Meanwhile the grassland survey was becoming increasingly important, for war was threatening and if it should break out the survey would form the basis of the inevitable ploughing up campaign to increase the area under corn. It was a remarkable undertaking and the most extensive ever made.† There were three operations: (1) zoning, based on the known relation between botanical composition and colour; (2) classifying, based on qualitative assessment of the herbage of individual fields within sample blocks; (3) botanical reading on a few randomly distributed fields within each area: this provided a common standard for the surveyors concerned.

The survey showed that more than 9 million acres of permanent grassland were 'a standing reproach' but 'fit for the plough'. Much of it had been ploughed up and made productive in the first war, but during the post-war depression had deteriorated or even become derelict. The idea that the grass should come into the ordinary rotation was of course well known and was common practice in the north and west of the country, but the new herbage plants produced at the Station had greatly widened the possibilities. By sowing one field with a late developing ley and another with an early developer it became possible to extend the grazing season which on current practice had lasted some six months only. This problem of extension is still being studied by William Davies and his colleagues at the Grassland Research Institute at Hurley; he is optimistic enough to believe that it can ultimately be extended to cover the whole year.

When war broke out in October 1939 Stapledon wished to have a large scale demonstration of ley farming as a means of rehabilitating the extensive areas of heavy clay soil then more or less derelict in the lowlands just as the Cahn Hill scheme had demonstrated the possibilities of reclaiming waste hill land. The Ministry of Agriculture agreed, and provided funds for a Grassland Improvement Station at Drayton, near Stratford-on-Avon, on a derelict 500-acre farm, much of it on heavy Lower Lias clay: 'the epitome of all that is wrong with rural Britain' was Stapledon's description.‡ Two other equally dispiriting farms were included in the scheme, 1300 acres of poor

* Later expanded into a book *The plough up policy and ley farming*, Faber & Faber, 1939. In order further to popularize the system he and William Davies later (1941) wrote a Penguin book entitled *Ley farming*.

† Mimeographed in 61 parts in 1940.

‡ *J. Roy. Agric. Soc.* **109,** 17-27, 1941. The programme of work is given here.

moorland in Staffordshire, and 1000 derelict acres on the Cotswolds. Stapledon was in charge of all of these, and the changes he effected attracted large parties of farmers; he also did much lecturing to large farmer audiences besides retaining his post at Aberystwyth. He was fortunate in securing William Davies's help, for war-time difficulties with labour and transport made the combined tasks very heavy, grossly overtaxing his strength.

In 1942 he felt no longer justified in retaining the Directorship of the Plant Breeding Station in view of the long absences necessitated by his work for the Ministry from 1938 onwards and the improbability of any relief. He therefore resigned so as to be freer to continue his ley farming demonstrations.

At the end of the war in 1945 his work ceased and he retired into private life. Not, however, to rest and recoup. As with other scientific workers of those days the pre-war pension arrangements were quite inadequate to meet the rising costs of post-war years and there followed a period when he had to do some journalism. In 1947, however, Messrs Dunn's Farm Seeds of Salisbury invited him to become their Scientific Adviser and, later, one of their Directors. This brought him back to his favourite occupation in very congenial circumstances. Messrs Dunn's were old friends; they had been among the first to recognize the importance of the Station's work and to distribute the new varieties of grasses and clovers to farmers. So long as his health allowed he worked very happily with them.

Then began the pitiful tragedy of his last years. In 1952 he had a serious operation, and from then on to the end he was rarely free from illness: angina, kidney trouble, bronchitis each winter, Menière's disease, and then, greatest affliction of all, stone deafness for the last three years of his life. All communication with him had to be by writing. To the end, however, his mind remained unclouded, restless and critical as ever. His interest in agriculture waned but was replaced by a wide range of others; among them poetry, philosophy, psychology and education. He left twelve large note books full of comments and ideas on what he had read. Proust, Rilke, Kirkegaard, Ortega, Arthur Koestler, du Chardin, were among his favourite authors which he enjoyed discussing with a new-found friend whose visits used to lighten the tedium of his long and often painful illness.

He died on 6 September 1960. Tributes to his work poured in from farmers and many others. The B.B.C. organized a programme on the Welsh Service 'I remember Stapledon', and eight months later another one on the Home Service, in each of which a group of speakers took part. Some of his friends have established a Memorial Trust to ensure that his memory shall be perpetuated.

Few men in his generation left a greater mark on the countryside of Britain than he did. Before he began his work grass had been the Cinderella among crops: it could tolerate neglect and in bad times was the first to get it. Great stretches of permanent grass had a woebegone appearance, and produced only a fraction of what was possible: it was a thing apart from the cropped land.

He made it possible to effect a complete integration in all but the drier eastern parts of the country, thus considerably changing the landscape of the farm and giving the greatly increased yields of grass that have been so important a factor in bringing about the recent marked increase in output of milk and meat. His work on the reclamation of hill land shows how large areas of the $5\frac{1}{2}$ million acres of rough grazing in England and Wales could, if and when the need arises, be made much more productive; it has also enabled marginal land to be kept in cultivation when otherwise it might slip back and become derelict: counteracting, in short, the tendency of the boundary of cultivation to drop further down the hill.

The varieties of grasses and clovers produced at the Station have proved of great value not only in the British Islands but in Australia, New Zealand, South Africa and elsewhere.

His scientific work lay in the border land of ecology and the agricultural group of applied sciences, especially of the new applied science of grassland agronomy of which he was one of the chief founders, systematizing much scattered and fragmentary empirical knowledge and building it up into a new subject which, infused by his successors with modern principles of genetics and cytology, promises to attain great importance. He had an unrivalled knowledge of the grasses and of their properties, and the gift of intuitively finding a short cut to the solution of a problem that otherwise might have required long investigation. His ecological outlook enabled him to link up the grass and the land, and to ensure a sound practical outcome from his labours.

Recognition in abundance came to him from widely different quarters. He was early awarded the Honorary Membership of the Highland and Agricultural Society and the Swedish and old Czechoslovakian Academies of Agriculture; in 1932 he received the C.B.E. and in 1939 he was in rapid succession made a member of the Athenaeum under Rule 2, elected a Fellow of the Royal Society on the first application by his sponsors, was awarded the Gold Medal of the Royal Agricultural Society for distinguished services to Agriculture, and was given a knighthood. Unfortunately, however, overwork and strain had again incapacitated him and he was unable to go to Buckingham Palace to receive the accolade: it was bestowed by Letters Patent. University honours came later: after the war the Universities of Nottingham (1951) and of Wales (1952) each conferred upon him the Honorary degree of Doctor of Science. The University of Durham had in 1958 offered its honorary Doctorate of Science which unhappily he could not accept, as by that time he was unable to make the journey to Newcastle where it would have been conferred.

He had the gift of being able to pick out as colleagues young men of marked ability to aid him in his work and of retaining their loyalty and affection for life. In this he was helped by his abiding interest in young people. Starting with only one assistant he built up with their aid a great research station with an enviable and world-wide reputation and which has trained a

succession of young scientists doing valuable work in their subject in many parts of the Commonwealth.

He was not interested in College organization as such, nor in Faculty or Senate meetings; indeed he seemed completely oblivious of any regard for academic procedure or regulations, and was often rather a rebel, but a likeable one. Nor did he take much part in meetings of scientific societies except the Grassland Society of which he was one of the founders and its first President: its first Congress was in 1937. 'Grass and grassland, and yet more grass and grassland' as he put it, were the subject of his labours; and gardening, golf, and later riding his relaxations. Yet he was no dull recluse: his love of the countryside, his vigorous enthusiasm for it, the visionary and poetic elements in his character with a touch of Peter Pan; his intense dislike of pretentiousness and injustice combined with his gift of racy description made him a good companion popular alike with students and staff in the College—'Stapes' he was to them—and brought him a wide and varied circle of friends outside.

In his 'Personal notes' he wrote: 'No obituary notice of myself would be complete without reference to the constant help I have received from my wife.' She was Doris Wood, only daughter of Thomas Wood Bourne and of Jessie Bourne. They were married in 1913. Having no children she was able to devote herself whole-heartedly to him and his work, which she equipped herself to follow; always, too, she sedulously guarded his uncertain health. They were inseparable companions. His extensive agricultural tours were almost invariably by car and she always drove, he never. Towards the end he estimated that she must have driven him some 700 000 miles, often over very difficult moorland trackways, to almost inaccessible places. In prefaces to his books he describes her variously as his dictionary, his ready reckoner, on occasion his Cahn Hill demonstrator. It is certain that without her aid he could never have achieved anything like what he did.

Science has its unsung heroes, and the world will never know what it owes to the mothers and wives of its scientists.

E. John Russell

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II. Papers.

Stapledon published a very large number of papers, most of them short, written for farmers, and published in the farming journals. Complete lists are filed in the Libraries of the Royal Society, The Welsh Plant Breeding Station, Aberystwyth, and the Commonwealth Bureau of Pastures and Forage Crops, Hurley, near Maidenhead, Berks. Those published between 1919 and 1941, Stapledon's most creative period, are listed in *Bibliography of the Welsh Plant Breeding Station* (1956).

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