

The Contribution to Agricultural Research of an Australian Woman Scientist

By NESSY ALLEN

Abstract

Agricultural science was not a discipline often followed by young women in Australia in the 1930s. An exception was Yvonne Aitken who specialized in the adaptation of agricultural species to climate through flowering responses. Encouraged by her mentor, Aitken stayed at the University of Melbourne after her graduation to work on her Master's degree. For several years thereafter she continued with her research on subterranean clover. Appointed to the full-time staff in the mid-1950s, she spent the rest of her working life at the university. Her work covered many continents and many climates: in the early 1960s she made a systematic study of temperature and daylength in early- and late-flowering varieties of nine agricultural species; in the early 1970s she began a breeding programme on maize, a programme she is still continuing nineteen years after her official retirement. Her achievement was to help plant scientists in selecting more rapidly varieties of a desired species with the appropriate growing period to match a specific climate in temperate or tropical zones.

DURING the early part of this century science was rarely regarded as a suitable vocation for women. Few entered the physical sciences,¹ more the life sciences,² though agricultural science in particular was very much a male domain. In Australia an exception was Yvonne Aitken, who specialized in the adaptation of agricultural crops to climate through flowering responses, to such good effect that in 1970 she was awarded the degree of Doctor of Agricultural Science, the first woman to be so honoured by her university. The citation for her degree reads in part: 'the results of her physiological studies have had important applications in plant ecology and genetics. They have enabled agricultural scientists to predict and explain the geographic and climatic limits of different plant species and genotypes and they have thus provided important guidelines for plant breeding programmes'.

This article deals with Aitken's life and work. It is derived from a major study of

eminent Australian women scientists active during and after the Second World War, concentrating at present on those who have retired and who are available to be interviewed. The major aim of the project, which draws on both personal interviews and archival information, is to clarify the achievements and document the contributions of women who have helped the advance of science.

I

Australia is usually regarded as an agricultural country, yet even in the early 1960s only 10.3 per cent of the population was employed in rural industries³ and this figure had dropped to 7 per cent by the mid-1970s.⁴ The farm sector was contributing a relatively small and declining proportion of GDP; in fact it fell from 21 per cent in 1948-9 to 7 per cent in 1979-80.⁵ The sheep industry was the largest though wheat

³ D H McKay, 'Agriculture in the economy' in D B Williams, ed, *Agriculture in the Australian Economy*, Sydney, 1967, pp 128-9.

⁴ A G L Shaw, 'History and development of Australian agriculture', in D B Williams, ed, *Agriculture in the Australian Economy*, Sydney, 2nd ed, 1982, p 19.

⁵ A Stoeckel and G Miller, 'Agriculture in the economy', in Williams, *Agriculture*, 1982, p 168.

¹ See Nessy Allen, 'Australian women in science - a comparative study of two physicists', *Metascience*, 8, 1990, pp 75-85.

² See Nessy Allen, '"The sea has many voices": profile of an Australian woman scientist', *Journal of Australian Studies*, 38, 1992, pp 41-50.

was Australia's major crop,⁶ but by the end of the 1970s wheat had overtaken wool as far as the value of agricultural exports was concerned.⁷ The export trade was the primary one; as an exporter of agricultural products Australia ranked second to the USA in the 1960s⁸ and fifth in the early 1980s.⁹

By the time Aitken started her university studies, the great period of agricultural expansion in Australia, between 1880 and 1930, had taken place and large areas of drier country had been opened up for wheat.¹⁰ One of these in Victoria, Aitken's home state, was the Mallee in the north-west, where she was to do much of her work; it is one of the driest areas ('a symbol of man's attack on the dry interior'¹¹), with sandy soil, eroded by wind¹² and subject to extreme droughts and very high temperatures.¹³ In Victoria, agriculture was the biggest industry even in the 1950s when its production averaged £Australian 290 m per annum.¹⁴ It had always contributed over 90 per cent of the total value of the state's exports.

The major role of the State Department of Agriculture, from its founding in 1872, had been 'to develop research of special advantage to Victoria's agriculture'.¹⁵ In the early part of this century, however, farmers generally were sceptical about science and scientific methods. It was not till the decade of the Depression that it was realized that scientific experimentation was

important and that the resulting technical knowledge could increase the fertility of the soil and the efficiency of production. In such a vast, and on the whole dry country as Australia, with widely varying climatic conditions, it is clearly of enormous economic as well as scientific significance to have knowledge of the factors underlying agricultural production. An example is provided by the study of the factors controlling the change from the vegetative to the reproductive stage in different crop species; some varieties of plants may flourish in one place but not in another, even when the climate appears to be similar.

In the circumstances outlined it is surprising perhaps that it was not until 1906 that the Council of the University of Melbourne created a Faculty of Agriculture and not until 1911 that a professor was appointed, when the state government agreed to meet the costs of his salary for five years.¹⁶ From the beginning there was a close connection between the State Department of Agriculture and the university. The founding professor was the former State Director of Agriculture; but when the government refused to renew the grant in 1916, his appointment was terminated. The connection was reinforced, however, by the appointment in 1917 of the man who had pioneered wheat breeding in Victoria, Dr A E V Richardson, Superintendent of Agriculture in the State Department, to teach two days a week and act as Director of the Faculty.¹⁷

The new Director of the State Department, Dr S S Cameron, who believed in teaching based on precise experiment rather than on informed opinion,¹⁸ was able in 1920 to persuade the government to pass the Agricultural Education Act

⁶ McKay, 'Agriculture in the economy', p 145.

⁷ Stoeckel and Miller, 'Agriculture in the economy', p 177.

⁸ S F Harris, 'Agricultural trade and trade policy', in Williams, *Agriculture*, 1967, pp 315-6.

⁹ S Harris, 'Agricultural trade and its international trade policy context', in Williams, *Agriculture*, 1982, pp 383-4.

¹⁰ Samuel Wadham, 'Development of agriculture', in G W Leeper, ed, *The Australian Environment*, CSIRO and Melbourne, 1966, pp 52-3.

¹¹ G W Leeper, 'Climate', in G W Leeper, ed, *Introducing Victoria*, Melbourne, 1955, p 10.

¹² G W Leeper, 'Soils and their productivity', in Leeper, *Victoria*, p 50.

¹³ R T Patton, 'Vegetation in Victoria', in Leeper, *Victoria*, p 63.

¹⁴ Australia's currency was the Australian pound until 1966, when the Australian dollar was introduced.

¹⁵ D S Wishart, 'A century of service to farmers', *The Journal of Agriculture*, Victoria, 70, 1972, p 214.

¹⁶ Ernest Scott, *A History of the University of Melbourne*, Melbourne, 1936, p 203.

¹⁷ Geoffrey Blainey, *A Centenary History of the University of Melbourne*, Melbourne, 1957, p 161.

¹⁸ K M Silcock, 'One man's vision, many men's work', *The Journal of Agriculture*, Victoria, 70, 1972, p 227.

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which provided the University of Melbourne with money for building, equipment and agricultural research. By this act, the university was to provide up to twenty free places a year within the faculty and the government was to appoint up to six graduates a year on a reasonable salary.¹⁹ Needless to say, the faculty began to grow. By the time Aitken began her studies in 1930 there were nearly seventy undergraduates; in 1919, before the passing of the act, there had only been two.

In 1924 Richardson resigned to take up appointment as Director of the Waite Agricultural Research Institute in Adelaide. By this time the faculty, though not large, was important enough for the university to secure the appointment of one of the best botanists of the University of Cambridge. Professor (later Sir) Samuel Wadham took up the chair in 1926 and occupied it for thirty years with the greatest distinction. He was not a conventional academic. Although, like others at the time, he thought universities were primarily teaching and examining institutions, unlike most he thought they should also engage in research and, in the case of agricultural faculties, promote agriculture in as many ways as possible. In fact agricultural research in Australian universities only became significant after the Second World War,²⁰ and Aitken was by then one of the scientists contributing to this effort.

Within weeks of his arrival in Melbourne, Wadham was touring the Victorian countryside, meeting farmers and examining crops; he was to continue his interest in the people on the land and their concerns for the rest of his life. His approach was informal, whether lecturing to his small group of students or discussing agricultural problems with farmers. He had done such good work in a few years that

in 1934 he was appointed a member of a Commonwealth Royal Commission to investigate the state of the wheat, flour and bread industries. In 1943 he was one of the four members of the Rural Reconstruction Commission set up to investigate the present and future position of Australian agriculture. He was a member of the Council for Scientific and Industrial Research (CSIR)²¹ and for some years a member of its executive. He sat on committees of various public bodies and was awarded many honours and distinctions. Altogether he exerted an enormous influence on the development of agriculture in Australia.²² Despite this very active public life, however, Wadham always had time for his students and he influenced and helped many of them, including Yvonne Aitken.

II

Aitken, the elder of two sisters, was born in 1911 in Horsham, a country town in Victoria. As her father was a bank manager, the family moved several times, but chose always to stay in country towns. No doubt this is why Aitken grew to love the countryside, though it does not explain her interest in science, an interest evident from an early age. Her parents were well aware of the value of education and her mother in particular was always encouraging. The Sisters of Mercy had an excellent reputation for their teaching, especially at high school level, in the many country schools which they had established. Aitken's mother ensured that her daughter was educated at the Convent of Mercy in whichever town the family was situated. By the time Aitken was nearing matriculation, however, the Depression was affecting even professional

¹⁹ H A Mullett, 'Scientific agriculture in Victoria', *Journal of the Department of Agriculture, Victoria*, 1955, p 339.

²⁰ J E Jessup and R B Dun, 'Organization and administration', in Williams, *Agriculture*, 1982, p 106.

²¹ The Council for Scientific and Industrial Research (CSIR) was an Australian government research organization, which was replaced in 1949 by the Commonwealth Scientific and Industrial Research Organization (CSIRO).

²² Sir Samuel Wadham: *Selected Addresses* (with a biographical study by Geoffrey Blainey), Melbourne, 1956, pp 9, 12-13; Blainey, *University of Melbourne*, p 162.

people; fortunately she won a scholarship for the last two years of schooling to the Sacred Heart College in Ballarat where the teaching was exceptionally good. Though Ballarat was a large town, the school did not teach physics or chemistry—very few girls' schools in Australia did at that time—but Aitken was able to study geology and botany, both of which were taught well by enthusiastic teachers. On matriculating, she won a Government Free Place to the University of Melbourne; these were state scholarships offered during the Depression in specified disciplines; the free place which Aitken won was in Agricultural Science. It was thus by chance that her career was established in agriculture.

Her interests at school had been wide and continued to be so all her life. She was fascinated by English, by history, by French, and had the scholarship been in any of those subjects, she would have accepted it. As it was, her natural curiosity propelled her along the scientific path and though the scholarship may have dictated her choice, she was more than happy to accept it and be able to go on to university.

Her sex, however, almost put a stop to her aspirations at their inception. None of the nuns at the college had ever heard of a girl doing agricultural science and her parents were dubious about giving her permission to go. Chance again favoured her. The brother of one of the nuns was in the Department of Agriculture. A broad-minded man, he assured his sister that not just one but two girls had already undertaken the course: it was a suitable subject of study for a lady and the department needed more scientists. The nuns, persuaded, were able to reassure Aitken's parents that agricultural science would in fact be a suitable course for their daughter to follow.

The course, which had been started before Wadham's arrival, was designed to train students in science as it applied to agriculture, the first year consisting of

botany, zoology, physics and chemistry.²³ Aitken started at the university in 1930, very much handicapped by the fact that she had no background in physics, chemistry or zoology. She caught up though, with the help of some women demonstrators whom she describes as 'pure gold'.²⁴ Unlike some of her female contemporaries who were intimidated by being the only girl in their class, she found herself one of four girls in a class of seven. But her good luck ran out at the end of her second year. She became extremely ill and was unable to return to the university for two years. Fortunately – for her parents would not have been able to afford to send her back – the free place was still available to her and she continued her course, now one of only two girls in the class. She was undaunted by this, partly perhaps because, most unusually for those days, there was a woman lecturer on the staff who was generous in her support of all the students. In addition, in a small and friendly school, her professor was very encouraging.

Aitken graduated in 1936 and was keen to start research training in preparation for her Master's degree. (There was no doctorate offered in Australian universities until after the war.²⁵) While recuperating at home after her illness, she had had the opportunity to meet a few farmers and had become interested in their difficulties. The question now was, which of the many problems needing investigation – every one of which she found fascinating – should she tackle? And what would she live on?

Wadham solved both problems. It was not the first, nor the last, time he helped her. When she first won the free place to university, the dilemma of where to live loomed large; without suitable accommodation, she could not have accepted the

²³ Wadham: *Selected Addresses*, p. 6.

²⁴ From an interview with Yvonne Aitken. Unless otherwise stated, all the statements made by her are from interviews conducted by the author.

²⁵ Farley Kelly, 'Learning and teaching science', in Farley Kelly, ed. *On the Edge of Discovery*, Melbourne, 1993, p. 43.

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scholarship. Wadham personally phoned the principal of one of the women's colleges, Janet Clarke Hall, in order to get her accepted. He had a very great and positive influence on her career, acting as a mentor from the time she first went to the university right up till his retirement. He made her feel she was a member of a small family and that therefore there was no difficulty in approaching him when something special was required. ('He gave me all that was needed'.) Although he clearly had a sense of responsibility, for example telling his women students early in their course that they had very little chance of getting a job on graduation, and that farmers would be prejudiced against them from the beginning, he must have thought very highly of Aitken because he singled her out immediately on her graduation. It is likely that some of her success can be attributed to his influence – the literature on mentoring shows that those who have had mentors, whether in business²⁶ or in academia,²⁷ have more successful careers than those who have not.

Now, to enable Aitken to stay at the university and go on with her research, Wadham offered her a small research grant, which was renewed yearly. It was not enough to live on, but fortunately her parents had by this time decided to settle in Melbourne and she was able to live at home; she also supplemented her meagre income by demonstrating both in the Botany Department and the Faculty of Agricultural Science.

The question of her research training was also answered. 'Nitrogen is the primary limiting nutrient for pastures. Australian pastures rely heavily on the fixation of atmospheric nitrogen in the root nodules of legumes to meet their needs. Indeed the

function of phosphatic fertilizer is largely to promote the growth of the nitrogen-fixing legumes, rather than to meet the usually lower needs of grasses for phosphorus'.²⁸ Before chemical fertilizers were widely used, rotations using legumes were introduced as a means of restoring soil nitrogen, but a vigorously growing legume had to be found.²⁹ The legumes being introduced in Britain were not suitable, as growing seasons in Australia were much shorter.

The Department of Agriculture had become interested in subterranean clover (*Trifolium subterraneum*), the advantages of which had already been pointed out in the late nineteenth century. This plant, which is native to the Mediterranean area where the climate is similar to that of large parts of Victoria and 'which was to make so great an impact in subsequent decades',³⁰ had been introduced accidentally. It is a reseeding winter annual and can therefore be grown in areas which receive less than 500 mm of annual rain,³¹ a great boon in the generally dry Australian climate. There had been difficulties about harvesting the seeds, however, and it was not till the 1920s that it was found that top dressing with superphosphate resulted in increased yields.³²

By the 1930s the clover was beginning to be commercialized because it had shown some promise in South Australia, though it was not till the 1950s that subterranean clover pastures were used on a large scale in Australia.³³ Since 1928 the Victorian Department had been collecting a range of samples of subterranean clover from dairy areas of the state and from botanical gardens in several countries in Europe. This pion-

²⁶ Gerard R Roche, 'Much ado about mentors', *Harvard Business Review*, 57, 1979, pp 14–16, 20, 24–28.

²⁷ William Lyons, Don Scroggins and Patra Bonham Rule, 'The mentor in graduate education', *Studies in Higher Education*, 15, 1990, pp 277–285.

²⁸ Tim Anderson, ed, *CSIRO Research for Australia: Agriculture*, 16, CSIRO, Canberra, 1987, p 38.

²⁹ Bruce R Davidson, *European Farming in Australia*, Amsterdam, 1981, p 26.

³⁰ Samuel Wadham, *Australian Farming, 1788–1965*, Melbourne, 1967, p 33.

³¹ Anderson, *CSIRO Research*, p 36.

³² Davidson, *European Farming*, p 322.

³³ *Ibid*, p 337.

earing selection work was being undertaken by the Pasture Branch of the Department at Burnley Gardens, a plant research laboratory in Melbourne. At Wadham's suggestion, the pasture scientist in charge of this research invited Aitken to help with the listing of inherited characters obvious in the various samples, a project which extended in several ways from 1936 to 1955.

In addition to ranking the characters, two were selected for special study at the School of Agriculture. The first was the variability in plants in relation to the time taken to reach maturity and the relationship of that to the time of sowing; the second was the high level of 'hard' seeds. Farmers were finding that only about 1 per cent of the seeds would germinate because they were hard. Softening was being achieved by scratching the waxy surface of the seed-coat with sandpaper and by the roughened internal surface of commercial seed harvesters. Aitken began to investigate that character of the hard seed which made the seedcoat impermeable to water and which therefore prevented germination. Experiments showed that several treatments changed hard seed to soft - widely alternating temperatures, freezing and thawing, and percussion (bouncing or shaking the seed). She was able to confirm two major points: first, that the natural softening of hard seed, in or on the soil, could result from alternating daily temperatures, especially over summer, and secondly, that the commercial softening by machine harvesting was much more the result of 'bouncing' than of scratching the seedcoat surface.

The hard seed problem was selected as the theme for her Master's degree (awarded in 1939) and became the subject of the first paper she gave to the Royal Society of Victoria.³⁴ The other study, on variability

in plants, was carried out with another postgraduate student and resulted in a joint paper, also published by the society two years later.³⁵

III

Aitken continued to work on aspects of subterranean clover for many years. The species is now a major one in Australia, grown over about 16 m ha. It was her work in cooperation with many other colleagues which showed the importance of genetic differences in the plant's flowering response to climatic factors, temperature and photoperiod (that is, length of daylight). These differences are the basis for the range of early to late varieties and explain their development rates in different climates.

In 1938 Aitken's research programme was enlarged to include another legume. The results of crop experiments on wheat in Victoria over the previous fifty years had shown a very disturbing trend. Carl Forster, a former student of the faculty and now an Agricultural Research Officer in the Cereal Branch of the Department of Agriculture, had discovered that yields were decreasing despite the introduction of higher yielding varieties, and despite the use of improved fertilizers. He and Professor Wadham suspected that the amount of nitrogen in the soil was inadequate. A possible way to reverse the trend was to include a rotation crop in which a vigorous legume with an efficient association with *Rhizobium* nodule bacteria on its roots would raise the nitrogen status of the soil.³⁶ Subterranean clover was showing promise as the vigorous pasture legume in the wheat country with longer growing seasons, but not in the drier country like the Mallee with its short and erratic grow-

³⁴ Yvonne Aitken, 'The problem of hard seeds in subterranean clover', *Proceedings of the Royal Society, Victoria*, 51, 1939, pp 187-213.

³⁵ Yvonne Aitken and F R Drake, 'Studies on the varieties of subterranean clover', *Proceedings of the Royal Society, Victoria*, 53, 1941, pp 342-393.

³⁶ Wadham, *Australian Farming*, p 90.

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ing seasons. It was decided to test higher yielding, early maturing varieties of field peas as a rotation crop in the drier areas of the Victorian wheat belt,³⁷ and to establish whether the customary period of fallow which preceded the wheat crop could be dispensed with. The peas could supply a high protein seed crop and also raise soil fertility through the manurial value of the pea stubble from sheep grazing and from the nitrogen-fixing activity of the *Rhizobium* nodules on the pea roots.

Forster approached Wadham for help in the study, and the latter had no hesitation in recommending Aitken. Initially her interest was caught by the dry Mallee district of northern Victoria because this area has a limited rainfall and plants have to develop quickly in a short growing season. It was the practical problem of developing plants which could do that to which she applied herself for so long and which she so successfully solved.

Wadham also arranged for her to have some research assistance on the pea project, an undertaking which developed in several directions. Over many years she studied the possibilities of improvement of the pea crop for increased grain protein in the wheat areas of Victoria. In fact Aitken herself bred a commercial variety of field pea which is particularly well suited to northern Victorian conditions, a variety named 'Derrimut' after the University Field Station. (It was during this period that officers of the Dookie Agricultural College christened her 'Miss Peabody' – she was out in the sun all day with her sun hat on working with students on field peas.³⁸)

By now she had spent some nine years working on her research and demonstrating at the university, continuing on the small annual research grant that Wadham

arranged for her. It was just after the war and again a series of events came together to favour her progress. Wadham was deeply involved with the Rural Reconstruction Commission and the time he could devote to lecturing was limited. Furthermore, the university was trying to cope with the influx of returned servicemen and needed extra staff. Wadham therefore arranged for Aitken to be appointed to a lectureship and she thus joined the full-time staff of the university in 1945.

By 1949 she was testing crossbreds of field peas at several stations in Victoria and at the Waite Institute in South Australia, and by 1952 was getting encouraging results in higher yielding varieties in both drilled and handsown plots. Wadham had suggested that the pea breeding programme be extended because the Horticulture Branch of the Department of Agriculture and the Heinz Company were interested in the potential for increasing the yield of commercial canning pea crops. This research project lasted from 1949 to 1968 and laid the foundation of knowledge on the yield characters of both the canning pea and the fresh vegetable pea, in the southern Victorian climate, when sown in spring for summer cropping.

In the meantime Aitken was continuing her work on subterranean clover and in 1953 could report: 'It has been found that late varieties [of subterranean clover] like those of some other plant species require an exposure to cold for some months before flower initiation occurs. The length of day affects the length of cold requirement... In early varieties, long daylight can substitute for low temperature. These differences between the early and the later flowering forms can be related to the potential use of the varieties in different parts of Australia'.³⁹ In other words, her aim now was to be able to predict where

³⁷ Thomas Cherry, *Australian Settlement*, Melbourne, 1935, p. 162.

³⁸ This story was told to the author in February 1994 by Dr Jack Meagher, who became Chief of Plant Research and Development in the Victorian Department. Aitken had lectured to him on subclovers and legumes when he was a student.

³⁹ N H Olver, ed, *University of Melbourne Report of Research and Investigation 1953*, Melbourne, 1953, p. 1.

the species could be successfully introduced. By 1957 she had determined that the nature of early and late flowering varieties was due to genetic causes and that these were greatly affected by the environmental factors of photoperiod and temperature. She then began to widen the research to a perennial pasture legume, several ryegrass species and the four annual cereals, especially oats.

Dr L T Evans describes her early work as follows:

At its outset, Aitken's work was shaped by the views on variation of the great Russian plant geographer, N I Vavilov, by the methods of the Carnegie group under Clausen at Stanford, and by the findings of Garner and Allard on the importance of daylength in the control of flowering time. Her first paper on this subject (with F R Drake, in 1941) exploited the technique of serial sowings of many subterranean clover strains at many locations and showed convincingly that the first step in the reproductive process, flower initiation, was predominantly responsible for the great variations in flowering time between strains and between environments. This sharpened the attack and Aitken went on to show, in her classic papers of 1955,⁴⁰ some of the ways in which inductive cold (vernalization), daylength and temperature interacted in the control of flower initiation. Other investigators working with other plants had found comparable interactions but, for myself at least, Aitken's findings were the most powerful example at that time of the adaptive flexibility of environmental control of flowering time.⁴¹

When Wadham made the decision that he would retire in 1956 (partly because of ill health), he arranged that Aitken should take the calendar year of 1955 as a sabbatical year, during which he generously took over her teaching. He arranged for her to go to the University of Cambridge to his former teacher, Professor F Engledow. There she grew a range of pea varieties in

spring and summer and found that 'later flowering varieties were accelerated in "flower initiation" by the lower temperatures and longer day of the English latitude compared with the same factors in Melbourne'.⁴² She spent most of that year in England but also visited many agricultural institutes in various countries of Europe. These visits enabled her to collect information 'on the type and yield of pea crops in a range of growing seasons: for example, that at Larissa in Greece, where the crop is autumn sown and spring harvested, and that at Lannas in northern Sweden, where the crop is summer sown and harvested'.⁴³ On her return she was able to report that 'in general, the problem of yield in crop and pasture in Europe was found to be much like that in Australia, and the methods of attacking the problem the same'.⁴⁴

When she returned to the university, Wadham made arrangements for her to be promoted to senior lecturer. The promotion took effect in 1957 shortly after his retirement and under a new professor, H C Forster.⁴⁵ Now Aitken no longer had the kind of personal support that Wadham had provided. But she had begun establishing her networks early. She had given her first conference paper in 1939 to a meeting in Canberra of the Australasian Association for the Advancement of Science on the control of flowering in subterranean clover. There she first established relations with many other Australian as well as overseas participants; as a result she was able to ask colleagues from the CSIRO and the Queensland Department of Primary Industries to sow the clover varieties she was working on in Western Australia and

⁴⁰ Yvonne Aitken, 'Flower initiation in pasture legumes I-III. I. Factors affecting flower initiation in *Trifolium subterraneum* L; II. Geographical implications of cold temperature requirements of varieties of *Trifolium subterraneum* L; III. Flower initiation in *Medicago tribuloides* Desr. and other annual medics.', *Australian Journal of Agricultural Research*, 6, 1955, pp 212-64.

⁴¹ Dr Lloyd T Evans, former Chief, now Hon Fellow, Division of Plant Industry, CSIRO, in a letter to the author, February 1994.

⁴² N H Olver, ed, *University of Melbourne Report of Research and Investigation 1955*, Melbourne, 1955, p 6.

⁴³ Yvonne Aitken, 'Report on sabbatical leave 1955 to Melbourne University Council', 1956, p 3.

⁴⁴ Yvonne Aitken, 'Overseas research in crops and pastures', *Seed and Nursery Trader*, 54, 1956, p 17.

⁴⁵ Forster had been a pioneer of statistical plot work in the Victorian Department of Agriculture. Before his appointment to the chair, he was an assistant executive officer in CSIRO.

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Queensland, climates which are much hotter than that of Victoria.

In 1962 the cereal research project included a special experiment (in conjunction with the Department of Agriculture at the University of Sydney) with wheat varieties to provide evidence on the flowering character of the first wheat grown in Australia, commonly assumed to have been the 'Lammas' varieties of the English late winter wheat group. In fact the findings suggested that the first wheats must have been of the early type, probably introduced from Mediterranean stocks via Rio de Janeiro, Brazil, after failure of the seed brought from England and South Africa and sown in 1788.

Another project established that the early maturing varieties of wheat, barley, oats and rye used in the cereal belt of southern Australia had very similar development rates to one another, in contrast to the very late varieties. The fast development of the early group suggested that these varieties would be early maturing when sown in winter in northern Australia, and this was found to be so. Aitken stated in 1962 that 'such a genotype should be of use in a short growing season whether at low or high altitudes'.⁴⁶

The conference at which Aitken made her most valuable overseas contacts was the Canberra Symposium on Environmental Control of Plant Growth, to mark the opening of the CSIRO 'Ceres' phytotron in 1962. Here she met Dr William M Hiesey from the Department of Plant Biology in the Carnegie Institute of Washington at Stanford, California, Professor D Chilcote from the State University of Oregon, Corvallis, and Dr J P Cooper from the Welsh Plant Breeding Station at Aberystwyth in Wales. As a result of these contacts and her acquaintance with Dr E Britten of the School of Agriculture

at the University of Hawaii, who was working in a similar field and had spent a study leave in the Melbourne Faculty, she was able to spend most of her 1963 sabbatical in California and Wales, together with a week in Hawaii. In North America, she carried out her research not only at Corvallis and the Carnegie altitude plots (at Stanford, and at their centres in the Sierra Nevada Mountains at altitudes of 4600 ft and 10,000 ft) but also at the University of Saskatchewan in Saskatoon, Canada. The comparative development project she was involved in concerned a systematic study of the effect of temperature and daylength on early and late-flowering varieties of nine agricultural species, including cereals, rye grasses, clovers and peas. Again she found that the flower initiation of early-maturing varieties was less affected by climatic factors than the late ones. Temperature, not daylength, was the main factor affecting the growing period (sowing to ripe seed) of both types of varieties in each of the cereals.⁴⁷ Unexpected genetic variation within varieties of cross- as well as self-fertilized species was also found.⁴⁸ During that year she also visited research centres at Iowa State University, Harvard University, Boulder University, Colorado, and several research institutes in the USA, and attended conferences in her speciality.

Aitken continued this work throughout the 1960s. She also began a study of the rate of leaf appearance in a range of agricultural species in relation to genetic and environmental variation. Her finding was that there was a high positive correlation with temperature except under conditions of moisture stress.⁴⁹

⁴⁷ Yvonne Aitken, 'Report to the Victorian Wheat Research Committee on study leave, May 1963 to June 1964', 1964, p 2. The Victorian Research Committee gave Aitken a grant of £Australian 400 towards this research.

⁴⁸ *University of Melbourne Report of Research and Investigation 1964*, Melbourne, 1964, p 6.

⁴⁹ *University of Melbourne Report of Research and Investigation 1969*, Melbourne, 1969, pp 9-10.

⁴⁶ *University of Melbourne Report of Research and Investigation 1962*, Melbourne, 1962, p 6.

Her 1970 sabbatical extended her range of observation even further – to Peru, to the highlands of Mexico, to Alaska. In the highlands of Mexico at an altitude of 7200 ft, latitude 20°N, the mean temperature in the winter is similar to that of the Victorian spring, but daylight is a little less than twelve hours. The centre of Alaska at 500 ft elevation, latitude 65°N, has twenty-four hours of light in the three months of summer but the mean temperature is also similar. Aitken took advantage of the opportunity to spend several months partly at the Postgraduate College, Chapingo, Mexico, which had connections with CYMMYT (the International Maize and Wheat Improvement Centre), and partly at the University of Alaska, Fairbanks, growing the same varieties of the temperate species as were used in the 1963 tests. The outstanding result of her comparative studies was the evident importance of photoperiod to plant development in sensitive genotypes: she found that the genotypes most sensitive to photoperiod took three times as long to reach flowering in Mexico as they did in Alaska. The basic importance of temperature to the rate of reproductive development was also confirmed.⁵⁰ During this leave, she also travelled to universities and agricultural research institutes in the USA, South America and Europe for discussions with scientists working on the physiology of plants suited to short growing seasons.⁵¹

During her last overseas leave in 1975, which she took once more in Mexico, at CYMMYT, she continued her study of the reproductive development of maize varieties of different maturity groups. After her return she was able to report, 'Studies of maize over a wide range of latitudes have shown that, to be suitable for short

growing seasons, varieties should have intrinsic earliness and should be insensitive to daylength both before flower initiation and between flower initiation and flowering'.⁵² Again she took the opportunity to visit scientists working in her areas of interest in the USA, Canada, South America and Europe.

Eighteen years after becoming senior lecturer and in the year before her retirement in 1976, Aitken applied for promotion to reader. Although from early in her career she was forming contacts with other researchers and collaborating with many people all over the world, there were certain aspects of academic life of which she was not even aware. It was not until a colleague in her department urged her to stop writing papers and put her work together in book form that she thought of doing so. She was also influenced by the sudden realization that a former student had been promoted to reader. Shortly after, another younger man was also promoted. No-one had ever told Aitken it was necessary to apply for promotion. She decided to enquire how such promotions took place and only then discovered that in order to be promoted it was necessary to apply. After her book, *Flowering Time, Climate and Genotype*,⁵³ the outcome of her research up to 1974, was published, Aitken did apply and in 1975 was promoted to reader.

At the age of 84, she is still continuing in Australia the breeding programme on maize which she began in Mexico in 1970, when she had access to the Maize Bank for seeds from the collections of maize varieties in Mexico and the South American countries. She has also made three visits to China (in 1980, 1982 and 1985) to study the relationship between the climate, the natural vegetation and the agricultural use of land. She found surprising similarities to Australia in the range of

⁵⁰ Yvonne Aitken, 'Report to the Wheat Industry Research Council on study leave, June 1970 to May 1971', 1971, p. 1. Aitken received financial assistance from the Wheat Industry Research Council towards this research.

⁵¹ Yvonne Aitken, 'Report on study leave, May 1970 – May 1971 to Melbourne University Council', 1971, p. 2.

⁵² *University of Melbourne Research Report 1976*, Melbourne, 1976, p. 10.

⁵³ Yvonne Aitken, *Flowering Time, Climate and Genotype*, Melbourne, 1974.

climate – from tropical in the south to cold temperate in the north, and from a continuous growing season to a very short one. During the 1980 visit she was given seeds of millets from two communes several hundred miles apart and with differing lengths of growing season. When grown at the University of Melbourne in the Australian summer, these two samples proved to be different in flowering time – that from the shorter drier growing season flowering earlier. The relationship between early development and shorter growing season is now an essential principle in agricultural teaching in Australia, although it is usually related to different crop and pasture species, such as subterranean clover. That her research is still considered important is shown by the fact that, despite her retirement, reports on her work in progress continue to appear in the Melbourne University Research Reports.

IV

Aitken's passionate interest in her subject is obvious at the first meeting with her. She is a pure scientist in that she really wants to *know*. Her eyes sparkle as she talks, the words pour out as she explains to the visitor what she is doing. When describing her first visit to California, to a climate somewhat different to that of Victoria, and her experiments there, she says, 'It lit me up'. To the observer, it is obvious that this must certainly have been the case. But knowing is not enough for her. She wants the knowledge to be applied – 'I like the practicality of doing something that's worthwhile' – and her work has certainly demonstrated that. For example, a practical outcome of her studies on maize is that the concept of development analysis can be used to unify information on maturity genotype in both temperate and tropical groups of agricultural plants. The purpose of her book was to help plant scientists in selecting more rapidly varieties

of a desired species with the appropriate growing period to match a specific climate in temperate or tropical zones. Before her work there was no knowledge of the comparative performance of an array of standard, established agronomic varieties of both legume and grass species, grown under comparable cultural practice over a wide diversity of the world's climatic zones. She has begun to fill this gap in knowledge, doing so with critical observations on seasonal development. It is no wonder that one of the reviewers of the book wrote: 'Dr Aitken's command of her subject, as expressed in her book, ensures that it will be the authoritative text in its field for years to come'.⁵⁴

In 1962 she had also co-authored an introduction to agricultural science,⁵⁵ which was revised a few years later and re-issued in 1975 in a metric version. Other publications during the course of her very active life included a chapter in another book⁵⁶ and some forty research papers. Most of her work is published under her name alone. This is not because she is a 'loner' but because her colleagues were working in areas related to other aspects of crop and plant physiology, whereas she remained interested in understanding the factors which control plant reproductive development from sowing to harvest.

Aitken's range of contacts was, and is, very wide and she has had generous cooperation from researchers at other universities within Australia and overseas, from State Departments of Agriculture, from research organizations such as CSIRO and equivalent bodies overseas. She is very appreciative of the help given by her colleagues during

⁵⁴ John Lovett, *The Journal of the Australian Institute of Agricultural Science*, 41, 1975, p 129.

⁵⁵ Yvonne Aitken, D E Tribe, N M Tulloh and J H Wilson, *Agricultural Science – An Introduction for Australian Students and Farmers*, Melbourne, 1962.

⁵⁶ Yvonne Aitken, 'Temperate herbage grasses and legumes', in Abraham H Halevy, ed, *CRC Handbook of Flowering*, vol 1, Florida, 1985, pp 185–202. Dr Aitken welcomed the opportunity to add her research to the broad but little explored field of flowering controls in the many species in these two plant families.

the many years of research, especially through their shared experience in similar fields.⁵⁷ The amount and range of the work that she achieved was, however, extraordinary – and it was unique, as her publications show.

For almost the whole of her career she was the only woman member of the academic staff of the School of Agriculture. She enjoyed her students and she enjoyed teaching. She often became a friend to the women students 'simply because there were so few of them'; indeed many must have turned to her as a mentor and a role model. The students of the school spent their second year at Dookie Agricultural College and usually several would be allocated to help with the sowing of the pea plots and the collection of data at harvest time; one such was Nancy Millis, an eminent industrial microbiologist, now Chancellor of La Trobe University. Aitken taught from second year to postgraduate level and even after her retirement co-supervised several PhD students. A former Professor of Animal Production in the faculty speaks of her extraordinary patience with both undergraduate and postgraduate students.⁵⁸ A former student says, 'she never appeared to be lecturing at the limits of her knowledge. In fact her knowledge then and now seems almost endless although the state of her office was such that no-one could comprehend how the retrieval system worked! I believe this knowledge and her readiness to give it to anyone interested was her great strength as a teacher'.⁵⁹

Aitken believed in the value of plant experiment and dissection in teaching and used these techniques as much as possible.

When overseas she made a point of visiting high schools as well as university departments of agricultural science; during her 1963 leave she did so, for example, in California, in Massachusetts, in England and in Wales. She devised a special course, the only one of its kind in Australia at the time, for students in agricultural engineering, based on direct learning from experiments with biological material. 'The special problems of the bored agricultural undergraduate, the biologically ignorant engineer and the unacademic school student have concerned me most.' Even today she still accompanies students on excursions and helps them with their practical work, 'because it is my pleasure'.

She has been in touch with students since she was one herself. For a short while after the war she shared with some friends a flat reasonably close to the university. But when members of the group dispersed, she became a resident tutor at Janet Clarke Hall and lived there for twenty-five years until her retirement, under three different principals. She watched the change of attitude towards female students, the growth of student committees, the gradual unwinding of the kind of strictness enforced when she herself was a student (one late leave per month), until now when students come and go as they please. She obviously enjoyed this association and says it was fascinating. She must have contributed greatly to college life because in 1966 she was made a Fellow of the College. On her retirement she bought an apartment close to the university and although she no longer has any formal teaching duties her life has not changed very much.

But in no way has it been narrow. She has always had a wide variety of interests beyond her work. That she is interested in gardening, the environment and all aspects of biology is hardly surprising. What is a surprise is that she paints, and extremely well. She is also interested in music, in various crafts, in history.

⁵⁷ Aitken pays tribute to the many colleagues with whom she worked in the course of her long career in the acknowledgments in her book (see footnote 53).

⁵⁸ Professor Norman Tulloh, former Professor of Animal Production in the Faculty of Agriculture, University of Melbourne, in a conversation with the author, February 1994.

⁵⁹ Dr W M Lush, School of Botany, University of Melbourne, in correspondence with the author, March 1994.

She never married, but then few women scientists of her generation did.⁶⁰ Had the right circumstances arisen she would have liked to marry but she knows that she would have had less time to devote to her work and perhaps her travel opportunities might have been restricted. She is aware of the problems that face professional women with children and admires those who have managed to combine the responsibilities of both family and career. She does not consider herself to be a feminist but 'I'm all for equality'. Her generation knew too well that in order to get a job a woman had to be better than a man; but this never posed a problem for her. She would and did encourage girls to go into science but 'it's the keen mind that matters'. In any case, there are now many women in the faculty.

There is no doubt that Aitken has received and continues to receive from her peers the recognition due to her. The fact that she is still producing results which are acknowledged by her university, that she is still in contact with colleagues both in Australia and overseas, attest to that. Some of her former associates are more than happy to talk about her. Dr John Wilson, formerly Reader in Plant Sciences, Faculty of Agriculture, says she was well ahead of her time – in fact the first – in recognizing and formulating the ways plants develop.⁶¹ Dr L T Evans states that 'her research contributed greatly to our understanding of the variation and control of flowering time, the great significance of which was

recognized for wheat by William Farrer'.⁶² Dr Mary Lush speaks of her 'great gift of curiosity' and her 'legendary dedication'.⁶³ In support of the latter, she cites her experience of several times seeing Aitken at work (after her official retirement) at the CSIRO Phytotron in Canberra where she was growing lines of maize from South America. Another colleague talks among other things about her 'sheer courage and determination'⁶⁴ – qualities which she does clearly possess.

Her book established her international reputation. One of her referees wrote to her: 'I do want to congratulate you on having done such a masterful job in planning and seeing through to completion such an extensive undertaking. Undoubtedly your contribution will be recognized by plant scientists everywhere for a long time to come'. Talking to many of her former colleagues and students has confirmed that his words were prophetic. It is as true today as it was when Australia was first settled that 'any attempt to introduce a new crop into a new land, or even a new district, is not likely to be a complete success until the proper technique has been devised, whether that technique be the selection of suitable species and varieties of plants or the knowledge of how best to cultivate the crop under the local conditions of soils and climate.'⁶⁵ Aitken has certainly contributed her share to knowledge of plant ecology. It is more than fitting that her contributions to agricultural science were recognized publicly by the award in 1989 of the Medal of the Order of Australia.

⁶⁰ See, for example, Nussy Allen, 'Australian women in science: two unorthodox careers', *Women's Studies International Forum*, 15, 1992, pp 551–62.

⁶¹ Dr John H Wilson, formerly Reader in Plant Sciences, Faculty of Agriculture, University of Melbourne, in a conversation with the author, February 1994.

⁶² See footnote 41.

⁶³ See footnote 59.

⁶⁴ Personal letter to Aitken, 19 June 1973.

⁶⁵ Wadham, 'Development of agriculture', p 46.