LONG ASHTON RESEARCH STATION: ONE HUNDRED YEARS OF RESEARCH

Harry Anderson, Head of Scientific Liaison at Long Ashton – one of the three IACR sites near Bristol – describes the work of the station over the last 100 years, starting from its origins in cider-making research

Introduction

Long Ashton Research Station celebrates its centenary in 2003. It has its origins in a series of experiments on cider making done between 1893 and 1903 by Robert Neville-Grenville and Frederick Lloyd on the former's farm at Butleigh Court, near Glastonbury. The work led to Lloyd submitting a report to the Board of Agriculture emphasising the need for further research and recommending the formation of an institute for research and instruction in cider making and fruit growing. This eventually resulted in the establishment of the National Fruit and Cider Institute on six hectares of land leased from the Ashton Court Estate, near Bristol.

In 1912, the Institute became the Department of Agricultural and Horticultural Research of the University of Bristol and its name was changed to Long Ashton Research Station (LARS). Eight years later, the University purchased the whole of the one hundred hectare Fenswood Farm (of which the Station land already formed part) from the Ashton Court Estate.

Over the years, LARS gained a worldwide reputation for its work on fruit and cider so it came as a great shock when, on 14 December 1981, the Agricultural Research Council announced their intention to close the Pomology and the Food and Beverages Divisions. This decision caused widespread indignation and, for a time, the future of the whole Station came under threat. However, due to the untiring efforts of the then Director, Jim Hirst, and senior staff LARS survived, although the emphasis of the work changed towards research on arable crops.

Participants at one of the early Cider Tasting Days.

Two years later, the newly named Agricultural and Food Research Council decreased its investment in arable crops research and concentrated all such work at two centres, LARS and Rothamsted Experimental Station (RES). In 1986, the Institute of Arable Crops Research was formed with LARS and RES as the major sites.

A fatal blow was delivered to the Station in 1999, when the Biotechnology and Biological Sciences Research Council announced that they were withdrawing their research from the Long Ashton site, to be relocated to the renamed Rothamsted Research by 2003.

The original premises of the National Fruit and Cider Institute in 1904.

An aerial view of Long Ashton Research Station today.

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The track sprayer at Long Ashton, which is used for the experimental application of pesticides under controlled conditions.

Food and drink

During the early years, research into cider making was the main activity although work on cider orcharding expanded slowly. It was established that the foundation of the vintage quality of a cider apple cultivar lay in the chemical composition of the juice expressed from the mature fruit. Some two thousand juice analyses, done from 1903 to 1910, confirmed the broad classification of ciders into sharp, sweet and bittersweet. Disorders of cider, such as cider sickness and acetification, were also investigated and their causes identified.

Fruit samples from single cultivars from thirty-two experimental cider orchards established in south-west England were sent to the Station for standardised processing, bottling and tasting. The results helped determine the influence of such factors as soils, the environment and orchard management on cider quality.

The Station was also largely responsible for taking perry from near oblivion to popularising it as a drink and for rescuing perry orcharding from the verge of extinction.

By the early 1930s, the health giving properties of fruit juices were already known and biological determinations of their vitamin contents were made. Blackcurrant proved the most potent source of vitamin C which led to the commercial production of blackcurrant syrup (*e.g.*, Ribena) during the Second World War. Later, the quality of fruits and their juices was assessed by measuring the occurrence and metabolism of constituents contributing to aroma and flavour. Attention was also paid to factors controlling the production of important metabolic products.

In the years immediately following the First World War, large quantities of fruit were being wasted due mainly to a lack of knowledge of how to preserve these surplus supplies. This situation resulted in the establishment of the Fruit and Vegetable Preservation Research Station at Chipping Campden which, from 1921 to 1952, formed part of the same University Department as LARS, with much of the work being directed from the Station.

Investigations were also done to improve the presentation and storage of foods, including fresh and processed fruits, vegetables, meats and baked products. Important advisory and educational responsibilities were undertaken on subjects such as freezing, bottling and preserving.

Fruit

In practical top fruit growing the primary consideration is the cropping quality of the trees, the main objective being to obtain maximum yields for the life of a plantation. An investigation of the factors governing fruit-bud formation was initiated in 1910 and turned into a major programme spanning over forty years. The contribution of LARS to this field of knowledge was a particularly important one.

Studies of the levels of infection and sensitivity of fruit trees to viral diseases started after the Second World War. Healthy trees grown from material freed from viruses by heat treatment were released under the EMLA (East Malling – Long Ashton) scheme from 1965. The emergence of this material enabled growers to buy what was acknowledged as the best fruit planting material in the world.

One of the most fundamental advances in horticulture was the discovery in the mid 1940s of synthetic chemicals which could be used to modify and control plant growth. Early work with these chemicals was inextricably linked to work on fruit with their action and use in controlling vegetative and fruit growth, dormancy and abscission being investigated.

One practical application of growth retardants was in the meadow orchard system for the intensive production of apples. The system, which used the equivalent of seventy thousand single-stem trees per hectare, depended upon the use of growth retarding chemicals to encourage flowering on one-year-old wood to give heavy yields within two years of establishment.

Later work involved the extraction, purification and quantitative measurement of naturally-occurring growth promoters, such as gibberellins, auxins and cytokinins, and of growth inhibitors, especially abscisic acid, and their correlation with processes of agricultural importance. Work on plant hormones continues to this day with LARS being an international centre for the study of gibberellins.

Willow research started in 1922 in response to attempts to reverse the decline in willow hectarage following the First World War. Work was done on cricket bat willows and on the use of willows, and other species, as windbreaks to give protection to orchards at both pollination time and harvesting. More recently, the use of short-rotation coppiced willows as a renewable energy source using environmentally favourable technologies has been investigated. The Station holds the National Willow Collection of more than one thousand different willow 'clones' which is an important genetic resource used in willow breeding.

Nutrition

Arguably the most significant contribution made by LARS to agriculture is in the field of plant nutrition. Work started in the early 1920s with investigations into potassium; deficiency of which causes leaf scorch in fruit trees. Results from this work revolutionised fruit production in this country.

Work on mineral deficiencies continued apace, and in 1943 Tom Wallace's classic book *'The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms'*, which detailed mineral deficiencies of the more important arable, vegetable and fruit crops, was published. Wallace's work was continued by Eric Hewitt who carried out extensive systematic studies of mineral deficiency symptoms produced in intensive sand culture experiments and under conditions of controlled nutrient supply.

Concurrent with the publication of Hewitt's book *'Sand and Water Culture Methods Used in the Study of Plant Nutrition'* in 1952, the Agricultural Research Council Unit of Plant Nutrition (Micro-nutrients) was formed with Wallace as Honorary Director and Hewitt as Head. The Unit undertook comprehensive studies of important fundamental problems concerned with the nutritional processes of higher crop plants and of micro-organisms. On Wallace's retirement in 1939, the Unit was disbanded although the work continued as staff were absorbed into other sections engaged in related research.

Although nitrate is the principle form of inorganic nitrogen in the soil and in fertilizers it must be reduced enzymically to ammonia to be assimilated by plants. The factors controlling the induction and dehydrogenase activity of nitrate reductase, particularly the role of its molybdenum prosthetic group, and the unique biochemical properties of nitrite reductase were investigated.

Later work involved investigations of transport mechanisms at the molecular level, of metabolism which transforms inorganic ions to proteins, and of physiological relationships between mineral nutrition and other major plant processes such as photosynthesis, membrane transport and water relations. The practical value of this work may be to help plant breeders to select phenotypes with more efficient capture and use of mineral nutrients.

Spraying

The Station's long association with spraying research started in the early 1910s with experiments on the use and mode of action of the copper-based fungicide Bordeaux Mixture. By the 1920s, lime-sulphur and tar distillate washes were being experimented with to kill eggs of major pests such as aphids and red spider mites. Work with the latter led to the development of the 'Long Ashton Spray'.

The appointment of Howard Kearns in 1931 heralded the beginning of a particularly productive period in spray research. Not only was Kearns an outstanding scientist (he was Director from 1957–1967) but he was also a competent engineer being responsible for the design and construction of much spraying equipment. By the mid 1950s LARS was regarded as the leading national centre for the study of spray machines and equipment.

The effectiveness of pesticides depends on using them at the right time, in the right amounts, and at the right place. Research was done on the precise requirements for effective application and on developing new spraying methods aimed at achieving maximum biological effectiveness, whilst reducing the amounts of chemicals, labour and fuel used. Spraying efficiency was assessed by relating pest and disease control to measurements of pesticide deposition on plants and residues within crops and in the environment using sensitive analytical methods.

The Station also assisted the then Pesticide Analytical Advisory Committee in developing analytical procedures to define quality control guidelines for pesticide usage, and evaluated the physico-chemical properties of surfactants important in improving the deposition and uptake of spray chemicals.

Advice and expertise in spray application technology was offered overseas to improve disease control of tropical crops such as coffee and citrus. This service is now provided by the Tropical Weeds Unit which plays an important training, information and liaison role in weed research programmes for developing countries. In addition, work at the Station's Centre for Aquatic Plant Management, located near Sonning-on-Thames, aims to improve techniques for managing vegetation in aquatic ecosystems whilst enhacing the conservation value of the habitat.

'Pest' control strategies

Work on the control of pests and diseases increased rapidly after the end of the First World War. Between the World Wars, the study and control of numerous pests and diseases of several fruit and vegetable crops were done.

As pesticides seldom act simply, the wider ecological implications were examined. For example, since earthworms are susceptible to certain fungicides, studies were made of how these chemicals acted and of the general recovery of worm populations in orchard soils after spraying ceased. The behaviour and control of slugs and snails were also investigated including the use of a novel nematode biological control agent.

In the late 1980s, by which time European agriculture was over-producing and environmental concerns were increasing, LARS took a lead in initiating research on integrated crop management in arable crops. This approach involved reducing chemical and energy inputs to the minimum whilst maintaining, or even increasing, profitability and enhancing biodiversity.

A large-scale, long-term field experiment, the LIFE (Less Intensive Farming and Environment) Project, led by Vic

Jordan, was established in 1989. This attracted much interest and stimulated the development of several other major integrated crop management research programmes in the UK.

Coupled with the integrated approach, research on pest and disease forecasting was done to enable farmers to predict the risk of crop damage through attack by pests and diseases, and hence to apply selected pesticides according to need rather than on a routine basis. Studies concentrated particularly on foliar and leaf-sheath diseases to provide a scientific foundation for decision support systems.

Fundamental aspects of farmland ecology were also studied, the aim being to improve basic knowledge and understanding of how populations and spatial dynamics of crop pests and weeds, and the many beneficial species that feed on them, are affected by, or depend on, the density, size and proximity of semi-natural habits such as field margins and hedges. Weed research included studies on the dynamics of weed populations, crop/weed competition, herbicide resistance and effective weed control with low doses of herbicides. Factors affecting weed seed production, germination and dormancy of pernicious weeds, such as barren brome, are currently being researched.

The last 15 years

The last fifteen years has seen a massive expansion in plant science research at LARS, working on the model species *Arabidopsis* as well as on arable crops. The use of molecular biology has become pervasive in these studies, combined with more classical biochemical and chemical approaches.

Seeds are the major crop products with wheat becoming the dominant species. Studies of wheat have focused on understanding the molecular basis for bread-making quality, which is determined by the visco-elastic properties of the gluten proteins. This work has included the production of transgenic wheat lines with altered storage protein composition, and the trialling of these over four seasons in the field. Other work on wheat has elucidated the molecular basis for pre-harvest sprouting, which is a major problem for UK farmers in wet summers.

The Station continues to have a major programme on gibberellins, including molecular cloning of enzymes catalysing their biosynthesis and breakdown. This has allowed the manipulation of these processes in transgenic plants, to alter the stature and other aspects of crop architecture as an alternative to the use of plant growth regulators.

Work on plant pathogens has also included molecular studies, particularly on *Mycosphaerella graminicola,* the pathogen of leaf blotch of wheat. More strategic studies have included measurements of variation in pathogen populations to maximise the benefits of using host resistance in control strategies and the rational design of fungicides based on the analysis of fungal metabolic pathways.

In conclusion

It has only been possible in the space available to give a very brief overview of some aspects of the research done at Long Ashton Research Station over the last one hundred years. It is incomprehensible that a Station of international repute which has served the horticultural/agricultural industry for a century is to close. The only small consolation is that some research programmes, together with associated staff, will transfer to Rothamsted Research where, it is hoped, research into arable crops will continue for many years to come.

The Long Ashton Centenary Symposium

To commemorate the centenary of Long Ashton Research Station in 2003, a symposium *Science for Sustainable Agriculture* was held at the Station on 16–17 September 2002 highlighting scientific advances and opportunities underpinning the agricultural industry.

The meeting provided a forum to discuss the challenges that lie ahead for the development of sustainable agriculture over the coming decades, including the impact of new technologies, the socioeconomic background and environmental issues. The meeting also looked forward to the scientific opportunities afforded by the Institute's restructuring.

The presentations, by world leaders in their respective fields, were aimed at policy makers and opinion formers as well as research scientists.

For more information

If anyone is interested in reading a fuller account of the work of Long Ashton Research Station, a book entitled *Long Ashton Research Station: one hundred years of science in support of agriculture* is currently being written and will be published early in 2003. Further information on this book can be obtained by contacting Harry Anderson at Long Ashton Research Station, Long Ashton, Bristol, BS41 9AF until the end of March 2003 and thereafter Professor Peter Shewry at Rothamsted Research, Harpenden, Hants, AL5 2JQ.

SOME PAST *PESTICIDE OUTLOOK* ARTICLES FROM LONG ASHTON

GM crops. Is here a future? (N Halford)	*Pesticide Outlook*, 1999, 10(6), 246
Control of rust diseases in willows (M Pei)	*Pesticide Outlook*, 2000, 11(4), 145
Herbicide safeners (J Davies)	*Pesticide Outlook*, 2001, 12(1), 10
Diagnostics in crop protection (S Kendall)	*Pesticide Outlook*, 2001, 12(2), 75
Exploiting the maize genome (K Edwards)	*Pesticide Outlook*, 2001, 12(6), 219