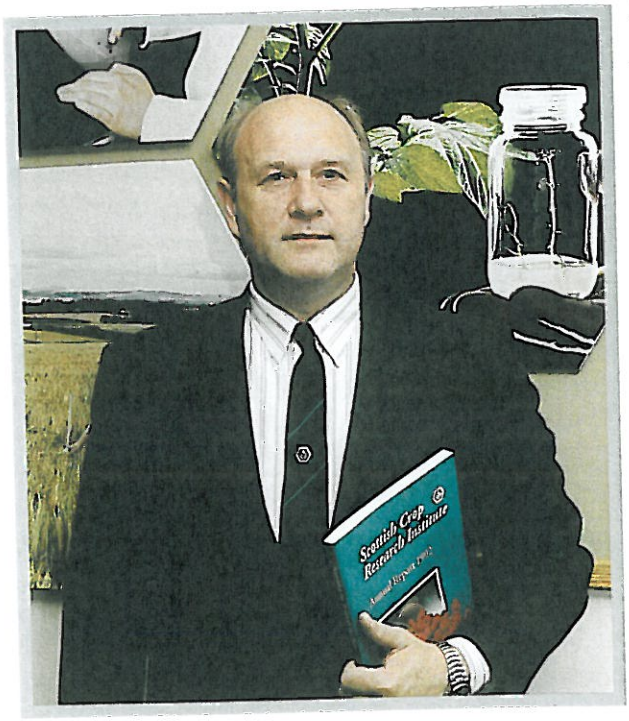
Report of the Director

John R. Hillman

Global perspectives influencing agricultural, biological and environmental sciences

International trends in 1993, the fourth year of the post-Cold-War era, were associated with increasing political instability and a tendency for certain countries to disintegrate. The reasons were typically ethnic, religious, tribal or economic. Hopes of multilateral international co-operation through the auspices of the United Nations to solve disputes and avert human tragedies were not realised in countries such as the former Yugoslavia, Somalia, Haiti, and various nation-states in the former Soviet Union. In contrast, internal pressures and initiatives in long-standing problem areas such as South Africa and the Middle East generated optimism for their future. Economic insecurity and unemployment arising from a wide-spread recession, pressures on public spending, and disillusionment with established political structures, seemed to permeate much of the world. Scientific research, however, transcends political boundaries in a common pursuit of knowledge and understanding. Major research institutions such as SCRI sustain wide collaborative networks, allowing nations to benefit from shared projects.



The year began with the inauguration of an open internal market in the European Community (EC), whereby the 12 nations of c. 350m people began to implement the first phase of a complex series of changes leading to the free flow of goods, information, currency and people. Later in the year, the UK was the final member of the EC to ratify the Treaty on European Union (EU), the so-called Maastricht Treaty, which took effect on 1 November 1993, developing from the original 1958 Treaty of Rome. Expressions of severe concern over the Social Chapter and pervasive Euro-dirigisme were not confined to the UK. The EU, however, has become one of the main sources of competitive grants for SCRI, partially funding large co-operative projects with European partners.

Peter Sutherland, Director-General of the General Agreement on Tariffs and Trade (GATT), declared that the protracted Uruguay round of negotiations begun in 1986 had reached a successful conclusion, meeting the 15 December deadline largely as a result of the USA and EU eventually resolving their differences on agriculture. This is the most important trade pact in history, and finally brought agriculture under international trade rules for the first time. Since the mid-1980s, there have been substantial increases in the costs of supporting domestic agriculture in the EU and the USA. In addition to domestic political problems, general subsidies, import restrictions, and export subsidies for surpluses have also created trade disputes and trading disharmony between and within trading blocs. The GATT Agreement should be seen as building on the 1991 "Dunkel Text" and the 1992 USA-EC "Blair House Agreement", leading to the formation of a market-reg-

ulated trading system. Nonetheless, domestic agricultural policies were virtually excluded from the early stages in the lifetime of the new GATT Agreement, given the socio-economic importance of agriculture and horticulture. Moreover, it was generally agreed that a government could apply overriding recognised sanitary and phytosanitary controls which could affect trade in livestock and plants.

The formal signing of the GATT Agreement was scheduled to take place in Morocco in April 1994, and the Agreement would take effect on 1 July 1995, fundamentally influencing trade in the 117 participating nations. Other important trade issues dominating international relationships included the acceptance of the North American Free Trade Agreement involving the USA, Canada and Mexico. Policies relating to national food security are tending to evolve into strategies for trading-block food security, thereby influencing the future direction of relevant research in agricultural, biological and environmental sciences.

Preliminary estimates in the Quarterly Bulletin of Statistics issued by the Food and Agricultural Organization of the United Nations (FAO) point to a decline during 1993 in total agricultural production, total food production and per capita food production. Declines in production were noted for coarse grains, rice, oilseeds, cocoa, cotton, and dairy products, whereas wheat and sugar production were little changed. Market conditions in the Far East, especially with the freeing-up of markets in China, were buoyant and contrasted with confused market conditions in the former Soviet Union. Civil warfare and its aftermath posed a greater threat to food security in 1993 than weather perturbations, pests, weeds, and diseases. FAO also released a wide-ranging analysis of the current state of, and future prospects for, the global food situation - *Agriculture: Towards 2010.* This study noted slow but steady overall increase in global food production and per capita food supplies over the past 30 years, and a modest decline over the past 20 years in the number of people chronically undernourished. Basing their estimates on an annual world population growth of 1.5% occurring mainly in the less-developed countries (LDCs), FAO projected that serious hunger is likely to continue over the next two decades at least. Sub-Saharan Africa would remain the largest and fastest-growing concentration of undernourished humanity (around 300m). A further slowdown is anticipated in total world agricultural production, reflecting reduced needs for enlarging production in developed countries and several LDCs, and reduced effective demand in the poorest LDCs.

Development assistance, from members of the Organisation for Economic Co-operation and Development to developing countries fell sharply from $60.8 billion in 1992 to $54.8 billion in 1993. Compounding this, was a decrease in the overall ratio of development assistance to Gross National Product from 0.33% to 0.29%, the lowest figure since 1973. On the other hand, there was an increase in emergency aid and distress relief, high-profile short-term areas of funding.

One scenario worthy of attention highlighted by Professor I. Carruthers is that the industrially underdeveloped world will become the primary source of manufactured goods, effectively reversing the trend in trade established since the Industrial Revolution. The economies of most of the countries of the Pacific Rim are expanding, and in Asia there are several countries with sophisticated, urbanised workforces able to operate effectively and compliantly with relatively low incomes. Multinational trading, communication networks, and rapidly improving higher education in these countries will ensure that invention, intellectual property and entrepreneurial service industries will not be the preserve of the present developed world. Moreover, agriculture in developing countries is no longer regarded as their engine of economic growth - witness the pressures on the Consultative Group on International Agricultural Research. Most of the world's food and industrial crop production could eventually take place in the temperate zones in which are located most of the developed countries, but whether there would be the means to pay for the food is a moot point.

Demand for capital throughout the year started to apply pressure on longer-term interest rates despite generally low inflation. Now that Japan, Germany and oil-rich Arab states are no longer large providers of international capital, there is growing competition for funding, favouring rapid-growth areas such as the Pacific Rim, Latin America and Eastern Europe. Unless there is an offsetting rise in savings, investments in Europe and the USA, most notably in their peripheral regions, may well be adversely affected.

With regard to the food industry in the developed world, consumers sought value for money, causing a general decline in brand loyalty. There was market growth for well-presented convenience foods, fruit

and vegetables. Food labelling detailing compositional and nutritional details was a popular issue. Food and retail profits tended to decline in a highly competitive market-place. White-meat consumption increased at the expense of red meat, and the interest in vegetarianism continued. The incidence of food poisoning rose throughout the world, prompting re-appraisal of food irradiation as well as high-pressure technology for sterilisation and pasteurisation. Scientific interest also extended to fat substitutes; reduced fat, salt and low-calorie diets; increased dietary fibre; and clear (non-coloured) beverages. Modified-atmosphere packaging to enhance shelf-life and the use of "environmentally friendly" packaging remain priority areas of development.

Throughout the world, public-sector funding supports most scientific research at the strategic and fundamental levels. Recession, competing high-profile health and social welfare funding obligations, and general ignorance of matters scientific, have universally driven research into the applied camp, essentially towards product or process development, making it capable of delivering easily understood objectives to those who arrange funding. Underpinning research and development (R&D) for policy, statutory and regulatory activities have, with few exceptions, been subject to much greater analysis than hitherto. Scientists in all countries face major changes in organisational and funding arrangements, sensitivity over intellectual property, the implementation of various mechanisms to assess their performance, and redundancies.

United Kingdom perspectives Conventional agriculture, horticulture and forestry suffered in 1993 from pressures on profitability, which together with improved efficiency led to a continuing decline in the numbers directly employed, and an increase in the size of production units. These areas of activity have been paradigms of technology transfer to the point that planning targets and expectations of governments rarely allow for declining performance or catastrophe.

Since the 1960s, public-sector science and technology has been shaped by a tranche of policies aimed at improving efficiency and reassessing priorities. Key modifications in direction came with the 1965 Science and Technology Act, the 1968 Fulton Report, the 1971 Dainton Report, the 1972 Rothschild Report, the 1980s Financial Management Initiative, the development over the past five years of bureaucratically heavyweight ROAME (Rationale, Objectives, Appraisal, Monitoring, Evaluation) procedures, the 1989 Next Steps (Fairclough Guidelines) initiative and the formation of Executive Agencies, cessation of public funding to support near-market R&D, the Citizen's Charter, and piecemeal privatisation through Market Testing and Prior Options reviews, creation of the Office of Science and Technology, and operation of the Cabinet Office Efficiency Unit. Together with institutional amalgamations and closures, there are now unprecedented pressures on those organisations reliant to varying extents on public funding in the UK, with a constant need to scrutinise every activity and to adapt to policy reversals. Regardless of its role in quality of life, raising intellectual standards, creating wealth, upgrading the processes and resources of civilisation, and understanding the natural world, scientific research fits uneasily within the time-frames of conventional accountancy, legal systems and political priorities. Policy and re-organisational turbulence, the peculiarities of governmental annuality of funding with its associated cash limits and inflexible management practices pitched at nanolevel detail, a phenomenal range of auditing exercises, perpetual reviews and competition for shrinking resources collectively are discomforting to the point of hostility for public-sector research and development. Perhaps fortunately for those with responsibility for effecting change, the impacts of present-day decisions affecting R&D institutions will only become manifest in the years ahead. A life-time career in public-sector or private-sector science is no longer a proper expectation for most young graduates; perhaps this is strategically correct for there are not enough posts or resources to meet the rapid expansion in graduate output and employment demand. Trained scientists should be encouraged to pervade all sectors of society and industry. It is clear, though, that there is no room for under-achievers in respect of quality scientific output and ability to attract diverse sources of funding. Overhead costs will be driven down even further. Altogether, there is an increasingly high price to be paid in terms of lifestyle for accessing the public purse and for having scientific aspirations.

In the UK private sector, particularly the leading companies, R&D cannot thrive if there are inflationary-stoking expectations of short-term huge returns on R&D-related investments. Policies on company dividends, R&D taxation treatment, and Stock Exchange rules merit close examination and comparison with other countries, but realistically the likelihood of a change in culture is small at this juncture. R&D, and

ownership and exploitation of the consequent intellectual property, can be readily displaced outwith the UK.

SCRI is a special organisation for several reasons. Through its own efforts, it bridges the public and private sectors, it enjoys an unrivalled global reputation for its scientific quality and productivity, it has grown steadily in a competitive market whilst most similar bodies have contracted or merged, and wholly innovative lines of research cover nearly all our work which integrate laboratory and field experimentation. The mission of the Institute is to undertake research of the highest international scientific standards on agricultural, horticultural and industrial crops and on the underlying processes common to all plants. It aims to increase knowledge of the basic biological sciences, to improve crop quality and utilisation, to improve agricultural sustainability and diversification and to develop environmentally benign methods of protecting crops from depredation by pests, pathogens and weeds. A broad multidisciplinary approach is a special strength of the Institute, employing and fostering the disciplines of genetics and breeding, molecular and cellular biology; pathology (virology, bacteriology, mycology, nematology and entomology); physiology (metabolic, environmental and developmental); chemistry and biochemistry; agronomy; ecology (molecular ecology, vegetation dynamics, bioremediation); serology; physics; mathematics and statistics. The range of skills from fundamental studies on genetics and physiology, through agronomy and pathology to glasshouse and field trials with exploitation of genetic resources is unique within the UK research service. Close liaison with other research organisations, universities and colleges in the UK and abroad is an integral part of the scientific development of the Institute; such links are continually being developed and strengthened. SCRI actively seeks research contracts from Government Departments and agencies, levy boards, grower organisations, international agencies, commercial companies, local government and trusts.

Three pivotal documents directly influencing SCRI were released during 1993. Firstly, the White Paper *Realising our Potential: A Strategy for Science, Engineering and Technology* (Cm 2250, May 1993) heralded an enhanced role for the Office of Science and Technology and a series of initiatives that will alter the science landscape of the UK. Thus, the Research Councils were scheduled in April 1994 for restructuring with revised missions; Forward Looks were started; the Technology Foresight Programme began to take shape; and the ownership options for public-sector research establishments were to be subject to an Efficiency Unit scrutiny exercise in 1994. Implicit in the paper was the forging of a new partnership between industry, scientists, engineers, and science policy-makers. Secondly, the *Review of Allocation, Management and Use of Government Expenditure on Science and Technology* (The Levene/Stewart Report) was released at the same time.

Thirdly, the Scottish Office Agriculture and Fisheries Department (SOAFD) published in December its *Policy for Science and Technology.* This built on the successful framework of supporting agricultural, biological, aquatic, environmental and engineering science and technology, mainly in nine Scottish organisations (the "Scottish System"), and took into account the Science White Paper and the 1993 White Paper *Scotland in the Union: A Partnership for Good* (Cm 2225). The SOAFD paper signalled reduced core grants, a more arms-length relationship with contractors, greater monitoring, open competition, and a focusing on the importance of science and technology to wealth creation, all coupled to improved co-operation between the various constituent bodies. Regarded as timely and entirely consonant with the current situation, it was well received in the nine organisations (the five Scottish Agricultural and Biological Research Institutes, the Scottish Agricultural College, the Scottish Agricultural Science Agency, the Fisheries Research Service, and the Royal Botanic Garden, Edinburgh). The Scottish System is unique for its breadth and depth of science, horizontally and vertically integrated, engineering and technology carried out in internationally renowned bodies, rigorously overseen, encouraged and funded by SOAFD.

For SCRI it was reassuring to note that the conclusions of these three documents confirm the wisdom of the long-standing initiatives we have taken in redirecting our science, setting up effective technology transfer through the highly regarded Mylnefield Research Services Ltd. (MRS) and CAROS International Ltd., addressing the needs of industry and society, linking formally with universities and institutes at home and abroad, and becoming a widely recognised Centre of Excellence in international science. There are various mechanisms to ensure that the quality and standing of the science conducted in the UK Research Institutes are regularly and rigorously monitored. Additional to the internal reviews (operated at SCRI by individual scientists, Working Groups, Heads of Science Departments, the Director, and the Governing Body),

there are numerous external reviews. Foremost of these are the periodic Visiting Groups, reinforced by other frequent assessments carried out by research sponsors and government departments, associated scientific bodies, visiting scientists, international comparisons and peer evaluation of scientific submissions. In April 1993, SCRI received a Visiting Group ably organised by the Agriculture and Food Research Council (AFRC, now the Biotechnology and Biological Sciences Research Council) and forming part of the regular four-yearly inspections with intermediary two-yearly reports.

The Institute was visited from 19 to 23 April 1993 by a Group comprising Professor E C D Cocking FRS (Chairman), Professor N Atherton, Dr J T Braunholtz, Professor R Coffman, Professor E Griffiths, Dr M Hornung, Dr K Hummer, Professor J L Monteith FRS, Professor K Richards and Professor K Vickerman FRS. The Group was accompanied by Dr J N Wingfield, the late Dr I M Reid, Dr P Maplestone, Dr D Rawlins and Mrs M Pringle of the AFRC's secretariat, and by Dr K W Moore and Mrs L A D Turl (SOAFD). The Visiting Group conducted a scientific audit of the quality and conduct of research at SCRI. The emphasis of its audit was on the national and international standing of the research programme, its relevance to the remit of the Institute, progress made towards objectives, and the plans for future work. The Group also considered the scientific organisation and management of the Institute, the facilities and resources, interactions with other organisations nationally and internationally and links with industry.

The Group's assessment was based on discussions with the Director, the Deputy Director, Heads of Departments, and other scientific staff of the Institute. Although the Institute's programme is formulated as a series of ROAME projects, agreed with SOAFD, for the purposes of this visit, projects were grouped together into 28 scientific themes and the scientists involved in each were interviewed collectively. This allowed the Group to see the research programmes in cohesive units and to explore the interactions within research groupings.

The Visiting Group was provided with a comprehensive submission from the Institute. It was also provided with detailed comments from 50 eminent overseas referees who were asked to review aspects of the Institute's science programme, based on the information provided in the written submission. The referees were asked to comment on the: quality of science in relation to international standards; relevance to the Institute's remit; research output; and future direction of the programme. They were asked to assign the programme to one or more of the following categories: (i) internationally recognised science of the highest quality; (ii) good quality science worthy of continued support; (iii) research which is mundane or derivative of other, more innovative work, or which is unsatisfactory in its execution. The names of the referees were not disclosed to the Institute. During its visit the Group also met the non-science-group staff of the Institute; the post-graduate students, post-doctoral research fellows and visiting workers. It also toured the estate and laboratories, visited the Data Processing Unit and held discussions with representatives of MRS and CAROS International Ltd.

The Group reported that it was impressed by the high standard and productivity of science at SCRI, verified by the external referees, and by the quality and commitment of the staff and strong sense of community at the Institute. It was also impressed by the very high standard of the research facilities and instrumentation, reflecting the sustained support from SOAFD, and by the establishment of first-class groups carrying out innovative basic research alongside other scientists who were conducting applied research of more obvious application. It considered that the research programme was well designed to fulfil the Institute's remit. Several project teams and individuals were regarded at the international forefront of their area of science, confirming the views of other internal and external assessments. None of the work at SCRI was regarded as mundane, derivative, or unsatisfactory.

The Visiting Group recognised that the wide range of scientific expertise was crucial in maintaining the continuum of research. It was pleased to note that modern technologies were finding application throughout the research programme. SCRI was seen to have an excellent record in the commercial exploitation of science and to provide very good research training and supervision. Valuable links had been built up at home and abroad, attracting many eminent visiting scientists. Constructive recommendations were made aimed to strengthen our position and provide guidance for future development. In summary, the Visiting Group Report was outstanding; Professor Cocking and his Group members, and the accompanying AFRC and SOAFD staff are thanked for their penetrating, professional and courteous review.

SCRI acts as a parent body for the Scottish Agricultural Statistics Service (SASS) which operates as a unit of SCRI under the directorship of RA Kempton. SASS was reviewed separately by a Visiting Group in 1991 and received an excellent Report which regarded SASS as an extremely good organisation. The SASS Visiting Group Interim Report was considered by the AFRC Plants and Environment Research Committee in September 1993. With the advent of BBSRC, it was thought that it would be timely to reassess the potential to develop the highly successful SASS model south of the border.

This Annual Report details a small selection of the research achievements of the Institute and SASS, incorporating advances in fundamental and strategic science, contributions to the protection and understanding of the environment, and discoveries of both direct and indirect benefit to agriculture, horticulture, forestry and various biologically based industries. The outstanding performance, independently validated, of SCRI and SASS in respect of publications, reports, new cultivars, patents, contracts, reputation and influence, supervision of students, teaching, and value-for-money reflects not only the range of facilities and resource capacity of the Institute but most notably the dedicated commitment of talented staff in every department and section. Reports on the remarkable success of MRS and CAROS International Ltd. are included.

On behalf of the staff and Governing Body it is a pleasure to acknowledge with gratitude the staff of SOAFD for their continuing support of our research. They function as always at the highest professional standards of public service. Grants, contracts, donations and advice from the Scottish Society for Crop Research, governmental and non-governmental agencies, sister organisations, grower levy boards, local and regional authorities, commercial companies, farmers and other individuals are also warmly appreciated. In all respects, SCRI justifies its existence and flourishes.

People and Events

Retirements Two long-standing colleagues left during 1993. Dr A F Murant FRSE, UG6 in the Virology Department, retired in April after 33 years' service. His long and illustrious career in plant virology has provided sound biological, taxonomic and epidemiological foundations for many current molecular programmes. Never one to avoid a scientific challenge, he conducted a series of pioneering investigations of virus complexes in which the component viruses depend on one another for their ability to be spread by insects and to cause damage. He became an international authority in this area, and especially on the devastating groundnut rosette disease complex from Africa. This study attracted considerable funding from the ODA. His professional stature, reputation for precision, and the breadth of his contributions to the discipline of plant virology remain unparalleled. For many years he has edited the CMI/AAB series 'Descriptions of Plant Viruses' which is an invaluable resource to virologists throughout the world. He was elected a fellow of the Royal Society of Edinburgh in 1986.

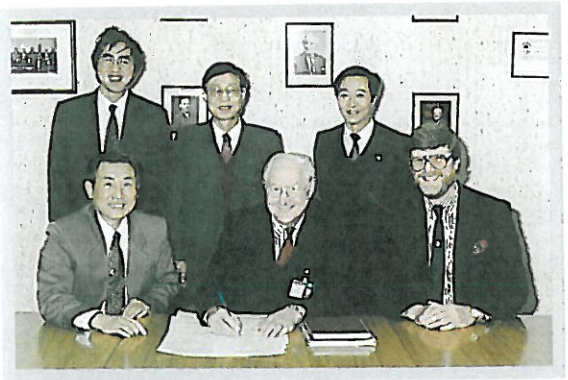
Pat Dashwood took early retirement in March after 27 years in the Mycology and Bacteriology Department. She was renowned for her experience in fungal diseases, and her expertise in the identification of microfungi, fungal ecology and blemish diseases of tubers will be missed throughout that sector of the scientific community.

Visitors In March 1993 the Virology Department welcomed 24 visitors from Africa, Asia, The Americas and Europe to a 2-week intensive training course, sponsored by the British Council, on modern techniques and approaches to plant virology. Members of the Virology Department also organised a

His Excellency Mr Ivan Stancioff, the Bulgarian Ambassador, and the Director, Professor J R Hillman.

2-day informal workshop on the topic of "Exploitation of plant viruses in biotechnology". This workshop, held in August just prior to the International Congress of Virology in Glasgow, was attended by approximately 140 plant molecular virologists and biotechnologists from around the world, many of whom also toured the facilities of the Institute. Both these events raised the international profile of the Virology Department and SCRI and are expected to stimulate future exchanges of scientists.

Dr Bernard Goodman, Head of the Director's Spectroscopy Group, was a member of the organising committee for the First International Conference on Oxygen and Environmental Stress in Plants. This Conference was held at the University of St Andrews under the auspices of the Society for Free Radical Research and the Royal Society of Edinburgh in September 1993. It was attended by over 100 scientists who took the opportunity to visit the Institute as part of the programme.



A Memorandum of Understanding between SCRI and Zhejiang Academy of Agricultural Science being signed.
Front l to r: Professor Yang Jizhong, Professor N L Innes, Professor T M A Wilson,
Back l to r: Mr Jianping Chen, Professor Chen Shengxiang, Professor Shen Pei Pei.

Professor Hillman was invited to present the prestigious Twentieth Bawden Lecture at the Brighton Crop Protection Conference in November. He chose as his theme 'Bio-engineering - Intellect, Enterprise and Opportunity'.

During the year many individual and groups of visitors from abroad and the UK were hosted at the Institute, ranging from eminent scientists, agricultural administrators and foreign delegations, through to student parties, members of the Scottish Society for Crop Research and local club organisations. As in 1992, there were several groups from the former Eastern Bloc countries, including trade missions from Czechoslovakia, Poland and Hungary.

Distinguished visitors included His Excellency the Ambassador Extraordinary and Plenipotentiary, Mr Ivan Stancioff, Bulgarian Ambassador to Britain. Mr Stancioff, accompanied by his wife, and two colleagues from the University of Sofia, visited SCRI on 17 August. Steps are being taken by the Ambassador and his colleagues from Sofia to draw up a Memorandum of Understanding between SCRI and an appropriate complementary Institute in Bulgaria.

A second ambassadorial visit took place on 3 September, when four members of the Commercial Office of the London Embassy of the People's Republic of China met the Director, and toured the Institute. In addition there were three delegations of senior scientists from China during the year, including a group from the Zhejiang Academy of Agricultural Science (ZAAS) in December. During this visit, Professor Yang, the Deputy Director of ZAAS, conferred an Honorary Professorship on Professor T M A Wilson, Head of Virology Department, and signed a Memorandum of Understanding to facilitate future applications for co-operative funding between the two Institutes.

In October, four new raspberries and a new strawberry were formally launched at Scotgrow, Scotland's National Horticultural Trade Exhibition held at Ingliston, Edinburgh. An agreement was signed with NSA Plants Ltd granting them the rights to propagate and sell the raspberry cultivars Glen Magna, Glen Ample, Glen Shee and Glen Rosa. An agreement was also signed with Commercial Fruit Plants Ltd, granting them the rights for the marketing of the new strawberry cultivar, Symphony.