CSIRO Annual Report 1988–1989

REPORTING PHILOSOPHY

This Annual Report presents a selection of highlights to illustrate CSIRO's progress in achieving its principal goal of conducting research to benefit Australia. Our aims are to demonstrate the range of our work and to indicate how it can contribute to the nation's wealth or quality of life. A more comprehensive account of our research activities can be found in the annual CSIRO Directory of Research Programs, which is available both electronically (on the AUSTRALIS database) and as a book (CSIRO Bookshop, 314 Albert St, East Melbourne, Vic 3002). More detailed information is also published regularly by CSIRO Divisions. We also report on major policy decisions and operational activities that support the conduct of research.

Modern science is being transformed by exciting developments in molecular biology. Our growing understanding of the basic building blocks of life holds great promise for the future.

New agricultural products free of harmful chemical residues and new vaccines and medications against diseases that afflict people and animals are already a reality. CSIRO is at the forefront of this progress with the Gene Shears breakthrough, as well as advances in vaccine technologies.

The picture on the front cover shows a crystal formed by binding a fragment of DNA (deoxyribonucleic acid) with the antibiotic, Nogalamycin. Nucleic acids — DNA and RNA (ribonucleic acid) — embody the genetic code, thus playing a central role in the transmission of hereditary characteristics.

CSIRO
Annual Report
1988–1989

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The Honourable Barry O. Jones, MP
Minister for Science, Customs and Small Business
Minister Assisting the Prime Minister for Science and Technology
Parliament House
CANBERRA ACT 2600

We have pleasure in submitting to you, for presentation to Parliament, the forty-first annual report of the Commonwealth Scientific and Industrial Research Organisation.

The year has been one of major achievements, among them the completion of the Australia Telescope and the start of the commercialisation of our Gene Shears technology. Indeed, these two successes — one looking at the universe and the other at the building blocks of life — illustrate well the breadth of CSIRO's activities.

We also wish to report that we have made considerable progress in the development of our Human Resources strategy — a plan central to attracting and retaining the best scientific staff available.

Neville Wran
(Chairman of the Board)

N. Keith Boardman
(Chief Executive)

November 1989

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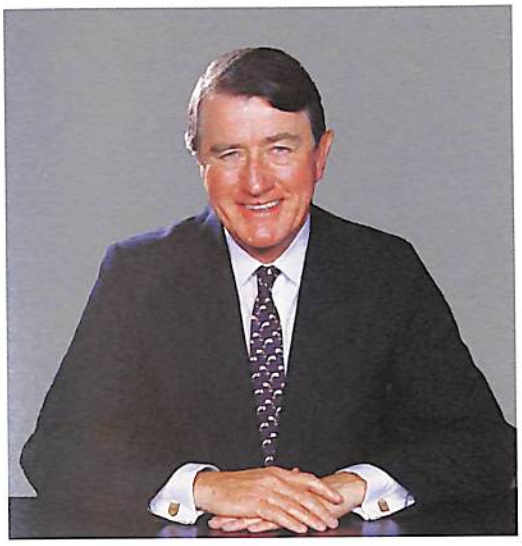


The Hon. Neville Wran AC QC

"Science and technology for Australia", the Government's May 1989 Science Policy Statement, marked the culmination of a period in which the issue of science and technology funding gained considerable prominence on the political and public agenda.

CSIRO — its Board and its staff — was at the centre of this debate, actively carrying it forward at all levels. The positive response by the Government has contributed to a notable rise in morale throughout CSIRO and, indeed, throughout Australia's science community.

Science and scientists have been accorded a status in Australia's present and future that is appropriate to the critically important role science and technology are destined to play as we move towards the 21st century. Intellectual capital — its recognition, growth and retention — is undoubtedly the key to Australia's future success as a player on the world stage.

The Government, by its May Statement, has recognised the fundamental importance of science and technology. It has established the Prime Minister's Science Council and appointed a Chief Scientist. This welcome recognition of the importance of science and technology has been backed by a substantial commitment of additional funding over the next five years.

There is no doubt that the May Statement represents a significant step forward. But there is a long way still to go. It is now up to all of us — government, industry, scientists, and the community — to ensure that science and technology are successfully integrated into the planning processes for Australia's future well-being.

The May Statement provides a framework and a funding baseline for the oft-stated goal of the Minister for Science, Barry Jones: namely, that Australia's research and development expenditure should be 2 per cent of GDP by the year 2000.

Of course, it goes without saying that it is in the interest of every Australian that this goal should be achieved and indeed that it should be surpassed. However, the task is not easy. Industry will have to double its current effort, and present Government investment in R&D will have to be increased by 25 per cent over the next 10 years.

Whilst the goal is by no means impossible of achievement we should be spurred by the solemn certainty that our living standards are imperilled unless it is achieved.

For CSIRO, the funding gains from the May Statement complemented progress earlier this year when the Government affirmed three-year funding for CSIRO and allowed the Organisation to retain all its external funds. All in all, although CSIRO's financial position has not been fully restored, these considerable gains represent significant improvement in our position.

Regrettably, two committed contributors, Graham Spurling and Bill Mansfield, left the CSIRO Board during the year. On behalf of everyone in CSIRO I take this opportunity to acknowledge publicly their valuable contribution to the Organisation. I am also pleased to welcome Laurie Carmichael and Ralph Ward-Ambler to the Board. Their skills, experience, and commitment to Australia's future will be valuable assets as CSIRO moves into the 1990s and addresses the

increasingly important scientific and technological issues that affect all our lives.

Recently a Staff Bonus Scheme has been put in place. Its purpose is to share some part of the revenue from commercialised CSIRO research with the scientists responsible for the research. The Scheme also enables the Organisation to reward researchers in fields that do not attract commercial development but do contribute significantly to the social or environmental quality of life for all Australians.

This year, CSIRO's expertise and reputation have brought it to the forefront of what is arguably the greatest challenge facing Australia and the world today — the challenge to the environment. Conflicts between demands for growth and environmental conservation pose crucial and difficult questions. CSIRO has been required to assume a vital role in helping Australia provide the right answers. Global climate change and land degradation are just two examples of fields in which CSIRO is now recognised as an international leader.

In Australia itself, CSIRO's expertise, whether as an honest broker in the debate over a proposed new pulp mill or as a source of new technologies to resolve environmental problems, has ensured that government, industry and the wider Australian community have been fully informed when difficult and contentious decisions have been made. I think there is little doubt that CSIRO's participation in this kind of decision-making process will become more widespread in the future.

The men and women who make up the Organisation — who provide our skill base and whose knowledge and drive underpin all CSIRO achievements — are our greatest resource. It is essential, especially after a period of organisational restructuring, that they be supported and motivated by their professional environment.

CSIRO's human resource strategy is creating this environment. The strategy is dedicated to increasing tenure and training opportunities for staff and to providing positive incentives for excellence in research. A commitment to improving CSIRO's and Australia's skill must become a major investment in both the private and public sectors.

Finally, I should like to say that a lesser organisation than CSIRO would not have been able to withstand the uncertainty and the pressures of recent years. My hope — and my conviction — is that those pressures and that uncertainty are things of the past, and that in the result CSIRO will now be able to do what it does best — practise excellent science and technology in the interest of Australia and Australians.

CSIRO's Chairman, Mr Neville Wran, opened a major exhibition called "Flora — the art of Botany" at the National Library of Australia on June 22, 1989. The exhibition contained rare prints, reproductions and original watercolours of Australian plants and traced European artistic records of Australian flora through three centuries. The Australian National Herbarium within CSIRO's Division of Plant Industry supplied historic plant specimens collected by botanists visiting Australia during the previous century. Viewing some of the exhibits are Mr Neville Wran (left) and Mr Ken Myer.

Chief Executive's Review

Dr Keith Boardman

'Profound change' has been the major theme of CSIRO annual reports for most of this decade.

In my five years as senior executive of CSIRO the magnititude of change within the organisation has been unprecedented.

These real shifts in direction and emphasis have not come easily but they are delivering manifest benefits: CSIRO is now more successful in fulfilling its charter than ever before.

This success has most importantly been in —

- closer links with industry
- developing research results.

This is happening at the Divisional level, between people working in CSIRO research and people working in industry. It reflects CSIRO's restructuring as well as attitudinal changes within both CSIRO and industry.

Key changes underlying this development are the operation of Divisional Advisory Committees and the identification of research priorities. The first promotes operational interaction between science and industry; the second provides direction in terms of national objectives and funding priorities.

The reorganisation of Sirotech also took place in the past year. By attuning CSIRO's commercial arm closer to industry sectors and research managers, the speed and frequency of technology transfer from CSIRO to industry have been enhanced.

Increased satisfaction for researchers and more visible value for investment in CSIRO by the Australian community are starting to flow from this progress.

The evidence is there: direct external funding to CSIRO is growing fast. Last year I reported that cash expenditure in 1987–88 of funds provided for sponsored research by Australian companies totalled $16·5 million. For 1988–89 the figure is $20·1 million, a rise of over 22 per cent. This healthy growth reflects the success of CSIRO's conscious efforts to attract more direct R&D funding from Australian industry.

Fundamental changes to research management in CSIRO have been directed to this end. The past year saw consolidation of a research management strategy that evaluates research projects broadly in terms of national objectives, CSIRO resources, and Australian industry's needs and capacities.

Managing science — where outcomes are never certain — is a particular challenge. The twin imperatives of organisational management and individual freedom must be reconciled. This is a necessarily flexible process over time and across research areas.

CSIRO accepts that research management strategies supply information to enable managers to assess the nature of risks; they do not supply immutable matrices that eliminate the need for human judgement. Their most worthwhile and permanent outcome is a cultural endorsement within CSIRO of research management as an essential part of scientific research.

The pressure on research management has been all the greater due to reduced appropriation funding levels, compounded by research costs rising faster than inflation and an Australian dollar falling in buying power. This squeeze on CSIRO's capacity has been a source of great concern, especially in the immediate term when R&D expenditure has never been more crucial.

Australia's two largest scientific organisations, CSIRO and the Defence Science and Technology Organisation (DSTO), have agreed to collaborate in scientific and technological areas where they share expertise. CSIRO's Chief Executive, Dr Keith Boardman (left) and the Chief Defence Scientist, Mr Henry d'Assumpcao, are here seen signing the Memorandum of Understanding between the two organisations in Canberra on May 31, 1989.

CSIRO has taken on the challenge of selling science to industry. It is an important challenge because Australia's economic well-being depends on industry's accepting a far greater role in research and development of new products and processes. It is a most difficult challenge because of Australian manufacturing industry's much-chronicled reluctance to accept its responsibilities and realise the opportunities available to it.

This reluctance remains the cultural norm. Despite CSIRO's success in attracting a higher proportion of direct industry funding, the rate of increase in private Australian investment in R&D is unfortunately slowing in comparison to past years. This trend — and the public sector's incremental rather than visionary approach to science funding — underline the immense effort needed for Australia to boost competitiveness in existing capacity and develop new industries.

This is essential if Australia is to earn the prosperity levels currently maintained by debt. The simultaneous challenge of creating this industrial growth while conserving our unique and fragile environment can only be met through science and technology.

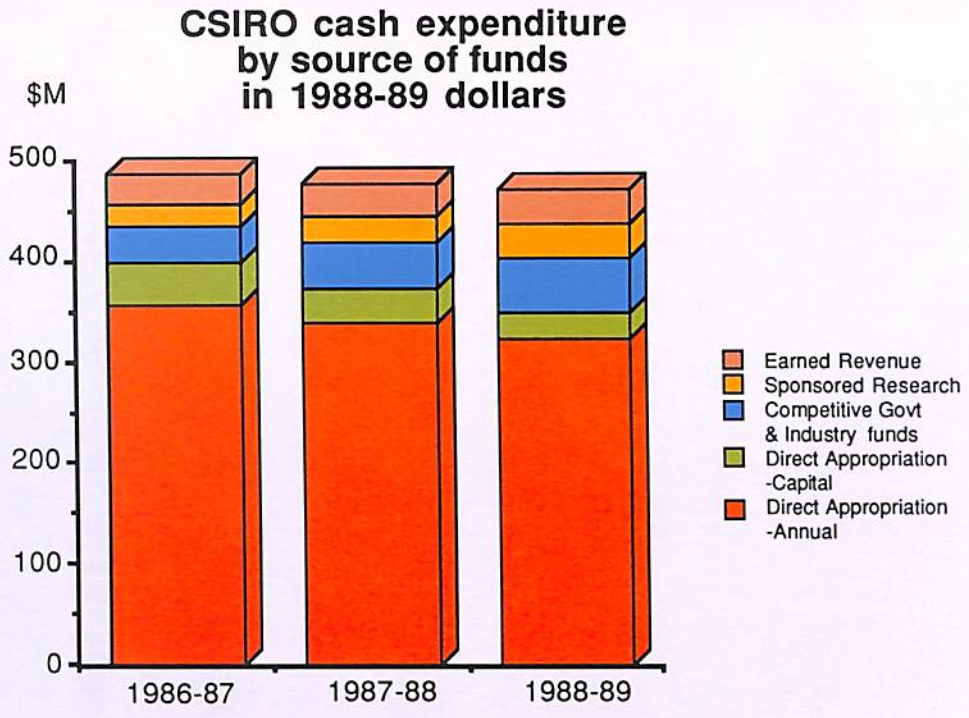
The latest figures available on R&D investment show an increase in real terms but a decrease as a proportion of GDP. In 1987–88, Australia spent 1·2 per cent of GDP on R&D, down from 1·25 per cent the previous year. However, the absolute amount spent on R&D increased by 2 per cent compared to the previous year. This apparent contradiction mainly reflects the rate of growth of the Australian economy during 1987–88.

Some consolation may be gained from the fact that these results were achieved despite a real reduction in Government funding of R&D. Private sector investment in R&D is still rising, but at a slower rate than during the early years of the 150 per cent tax deductibility scheme for R&D.

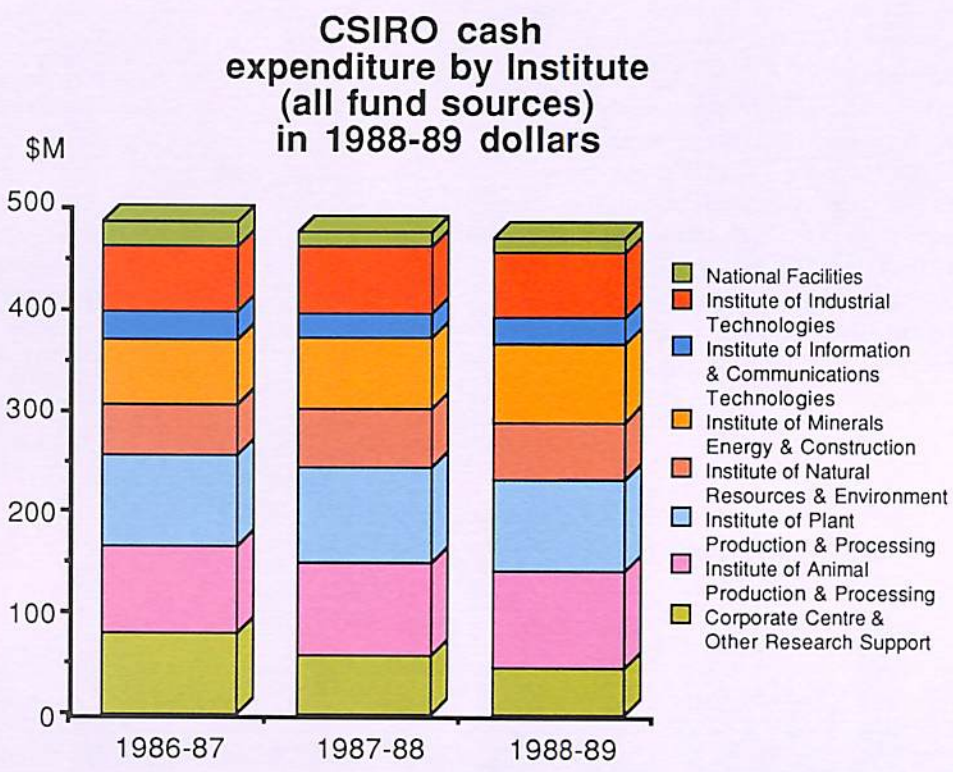
Overall, these figures show that Australia has not really committed itself to a higher level of R&D. In a world where successful countries are spending almost 3 per cent of GDP on research, Australia has yet to display a strong trend towards that level. Only when we see that trend emerge can we be confident that a cultural maturity and confidence has been achieved that will generate a momentum of its own.

The difficulties in this area were highlighted by a spectacular scientific success of the Gene Shears technology and the need to eventually look overseas for a commercial partner to develop the huge potential of this discovery. Groupe Limagrain, the French firm who took up the project, is a valuable and powerful partner. The lack of an Australian firm with vision, expertise, and resources to match Groupe Limagrain epitomises our national dilemma when it comes to gaining full value for our science.

While regretting this, we must also be proud of the scientific achievements — such as Gene Shears — that CSIRO generates. This productive creativity — more than anything else — underscores my confidence that CSIRO is now well positioned not only to contribute to an increase in R&D effort but to provide a greater lead to industry in some sectors. This confidence is based not only on what



The figures show a continuing decline in CSIRO's funds, especially those appropriated directly from the Government. However, there is a sizeable increase in external resources gained from competitive government and industry funds.



The growing amount of external funding has lessened the impact of reductions in appropriation over the three-year period.

The significant reduction in expenditure on research support is a result of devolution and streamlining of corporate services in 1988.

CSIRO operates two National Facilities on behalf of the Australian scientific community: the Australia Telescope and the oceanographic research vessel "Franklin".

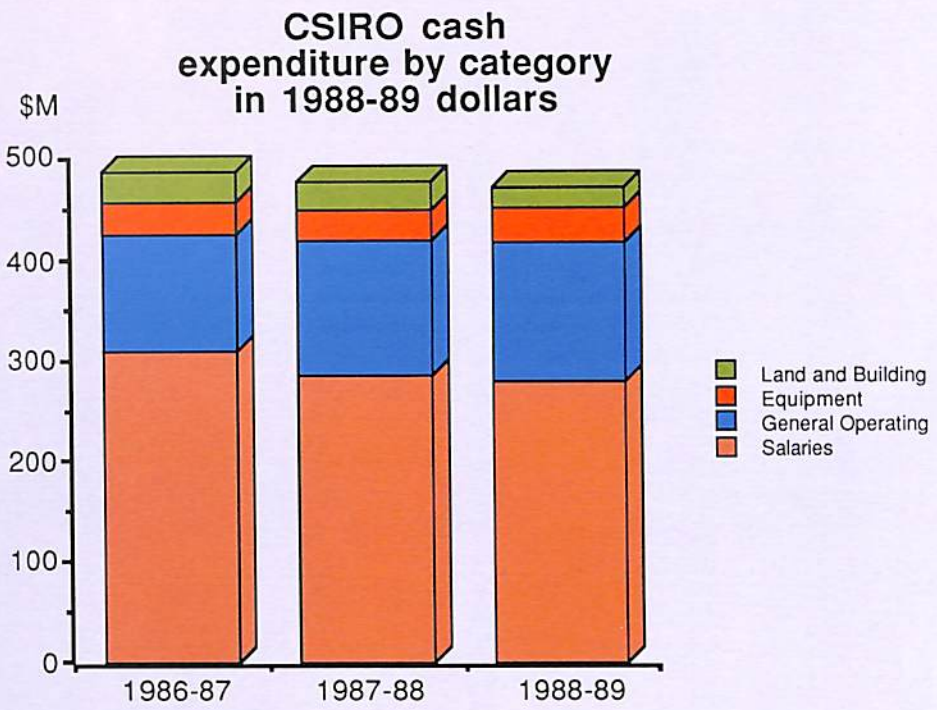
has changed in CSIRO, but on what has stayed the same.

The restructuring of CSIRO has brought the organisation into close and active relation with the needs and aspirations of the community it serves. It has not changed the skills, dedication and creativity of CSIRO researchers. It has not changed their devotion to the pursuit of excellence in science nor their commitment to the economic, social and environmental objectives of Australians.

The Australia Telescope, opened by the Prime Minister in September 1988, is a fine example of excellent and comprehensive CSIRO expertise. The technologies of its construction and operation showcase world-beating CSIRO innovation working in collaboration with Australian industry; its completion on time and within budget is a tribute to all involved and to the management skills guiding the $50-million project.

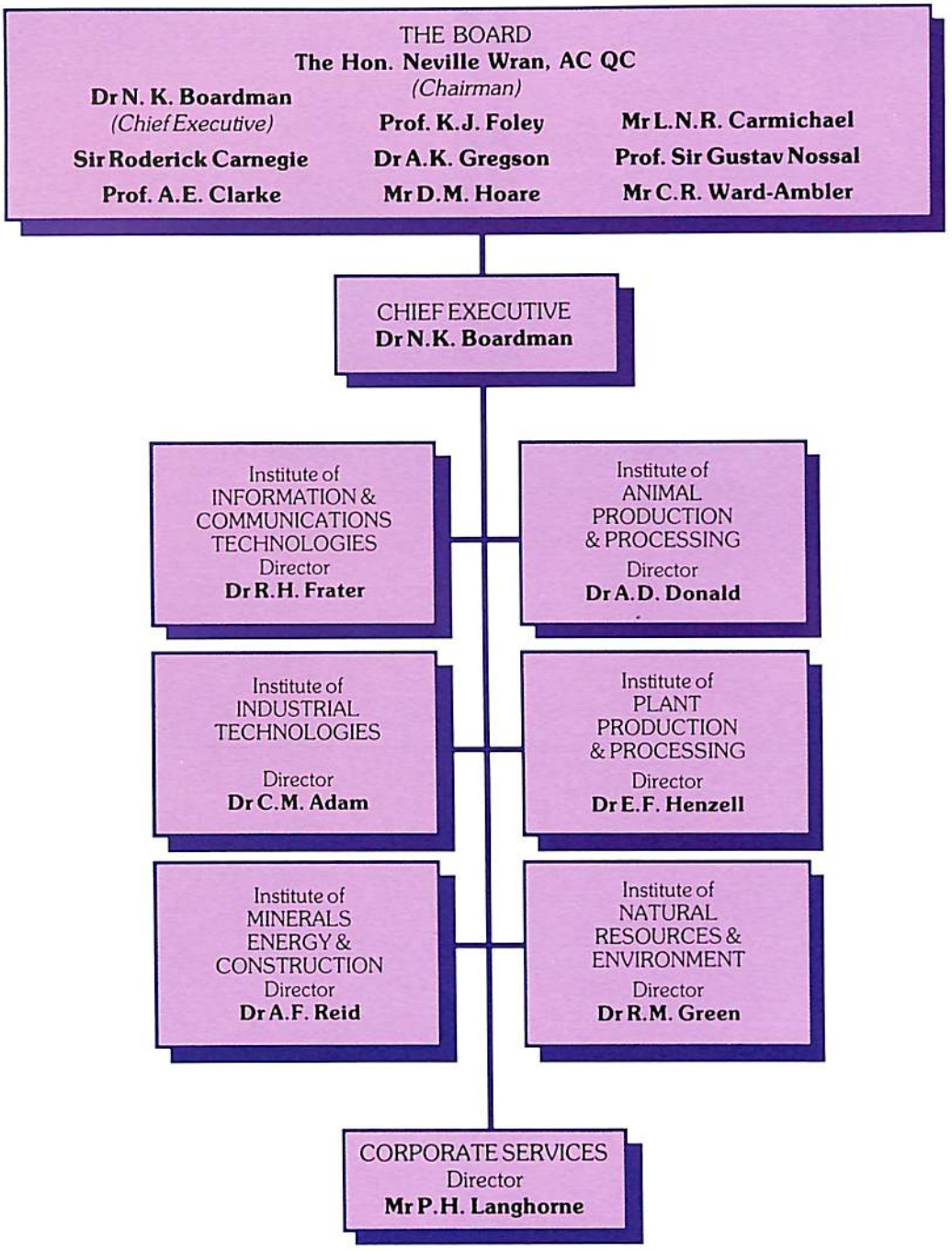
This and other research highlights in this report chronicle another year of fine achievement in the best traditions of CSIRO.

I am proud to have been able to contribute to maintaining these traditions in this great organisation.



The decline in funding has led to a readjustment of expenditure in the broad categories shown. A growing increase in the salary to operating ratio gave concern some years ago. The figures show that the policy introduced to reverse this trend is working.

Organisation Chart



Board Members

The Board is committed to maintaining and enhancing CSIRO's vital role in research for Australian industry and the community, and its tradition of scientific excellence.

The CSIRO Board, from left to right: standing, Sir Roderick Carnegie, Professor Kevin Foley, Dr Tony Gregson, Professor Sir Gustav Nossal, Mr David Hoare, Mr Ralph Ward-Ambler and Mr Laurie Carmichael; seated, Professor Adrienne Clarke, the Honourable Mr Neville Wran and Dr Keith Boardman.

Members and Terms of Office of the CSIRO Board

Chairman
The Hon. Neville Wran AC QC
Chairman of Whitlam Turnbull & Co. Formerly Premier of New South Wales (1976–86)
5 Dec. 86 — 4 Dec. 91

Dr Keith Boardman PhD ScD FTS FAA FRS
Chief Executive of CSIRO
5 Mar. 87 — 4 Mar. 90

Sir Roderick Carnegie BSc MA(Oxon) MBA FTS
Company Director
5 Dec. 86 — 4 Dec. 91

Professor Adrienne Clarke BSc PhD
Director, Plant Cell Biology Research Centre, University of Melbourne
5 Dec. 86 — 4 Dec. 89

Dr Kevin Foley MCom PhD
Managing Director, Kevin Foley and Associates Pty Ltd, and Chairman, Wine & Grape Industry Advisory Council
5 Dec. 86 — 4 Dec. 89

Dr Tony Gregson PhD DSc FRACI
Primary producer, formerly Associate Professor of Chemistry at the University of New England
5 Dec. 86 — 4 Dec. 90

Mr David Hoare BEc AASA ASIA
Chairman, Bankers Trust Australia Ltd and AUSSAT Pty Ltd
5 Dec. 86 — 4 Dec. 90

Mr Bill Mansfield LLB
Assistant Secretary of the Australian Council of Trade Unions
5 Dec. 86 — 4 Dec. 90 (resigned Dec. 88)

Professor Sir Gustav Nossal AC CBE MB BS BSc PhD FTS FAA FRS
Director of the Walter and Eliza Hall Institute of Medical Research
5 Dec. 86 — 4 Dec. 91

Mr Graham Spurling ED BTech MAE FIEAust
Managing Director, Pacific Dunlop International Battery Group
5 Dec. 86 — 4 Dec. 89 (resigned Nov. 88)

New members

Mr Laurie Carmichael
Assistant Secretary of the Australian Council of Trade Unions
13 Mar. 89 — 12 Mar. 93

Mr Ralph Ward-Ambler BMechE
Company Director
8 Feb. 89 — 7 Feb. 93

Mission, Goals, Objectives

CSIRO's Mission

To contribute to Australia's quest for enhanced economic performance, living standards, environmental quality and community understanding of science and technology, through excellence, leadership and teamwork in research.

Corporate Goals

- To strengthen mechanisms for determining research priorities and resource allocation across the Organisation in order to maximise the contribution of CSIRO research to national economic and social welfare.
- To enhance the efficiency, international competitiveness and growth of Australia's
  - — information and communications industries
  - — manufacturing industries
  - — minerals and energy industries
  - — rural production and processing industries
  - — construction industries.
- To provide the scientific knowledge required for the effective management and conservation of Australia's natural resources and environment.
- To improve human well-being and community health in Australia.
- To provide support to facilitate the conduct of efficient and effective research by the Organisation.

Research Objectives

Each Institute and Division has a set of objectives to support the corporate goals. The objectives for the six Institutes are:

Information and Communications Technologies

— to be a leader in strategic research on information and communications technologies for the benefit of Australia;

— to help increase the international competitiveness and export orientation of the Australian information, telecommunications and space industries; and

— to assist other industry sectors to improve their competitiveness through the use of advanced computer, communications and space systems.

Industrial Technologies

— to increase the international competitiveness, efficiency and scope of Australia's manufacturing industries, with emphasis on technologies that are broadly applicable to the development of new products, processes and services.

Minerals, Energy and Construction

— to increase the international competitiveness, expand earnings, and increase the gross domestic product and the value of the services provided by Australia's minerals, energy and construction industries.

Animal Production and Processing

— to improve the economic and social wealth of Australia by helping the animal and food industries to develop a wider range of quality products and by enhancing the efficiency and international competitiveness of these industries.

Plant Production and Processing

— to improve and sustain the productivity and profitability of industries based on field crops, pastures, horticulture and forests; and

— to improve knowledge of Australia's soils, plants and insects.

Natural Resources and Environment

— to provide the scientific knowledge required for the effective management and conservation of Australia's natural resources and environment, particularly in relation to the conservation and protection of natural heritage and sustainable use by dependent industries.

Policy & Planning

Distribution of Research Effort

In May 1989 the Government issued its Statement "Science and Technology for Australia". In that Statement base funding levels for CSIRO for the three years 1989–90 to 1991–92 were set down. The appropriation is to be maintained in real terms at the 1988–89 level (which was $348·1 million). On this basis CSIRO can expect to receive $371·6 million in 1989–90. This guarantee of funding will permit planning for resource management which has not been available to the Organisation at any time in the past.

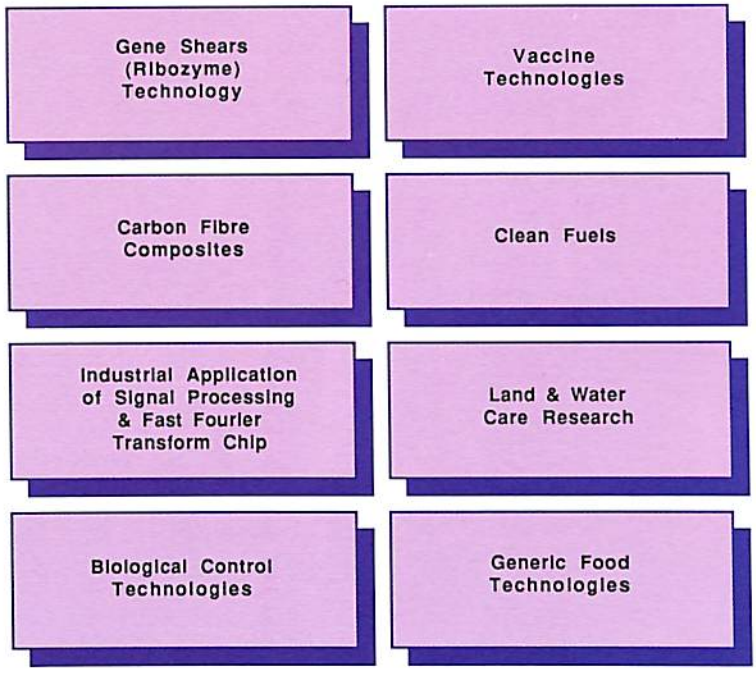
Other May Statement benefits included:

- retention of external incomes without reduction in Budget Appropriation. This, in effect, reversed proposed decreases in base funding for CSIRO by $2·1 million (1988–89), $6·6 million (1989–90) and $11·6 million (1990–91) in the three years of the forward budget;
- a grant of $5·0 million for equipment during 1988–89; and
- a further $14 million in 1989–90 and $19 million in each of the subsequent four years to support equipment and priority research projects.

While substantial, these grants are well below the amount needed to restore funding to the 1983–84 level, when CSIRO received Appropriation funding of $331·6 million ($434·5 million in 1989–90 dollars).

The research programs identified for extra funding from the May allocations address problems of high national significance or take advantage of an international lead to exploit a technology for Australia's benefit.

CSIRO research programs to receive extra funding as a result of the government's statement on 'Science and Technology', May 1989.



The revised CSIRO Research Classification Scheme used here in describing the allocation of resources between major sectors of activity was introduced in February 1989.

The pie chart on the page opposite shows how the research effort was divided amongst the nine sectors in 1988–89. The bar chart below shows the contributions of direct appropriation and external funds to each sector.

External funds obtained from industry and competitive funding schemes amounted to $87·9 million, 20% of the total expenditure on research. Strong industry support for animal production and processing research continued, particularly through the contributions from the Australian Wool Corporation and the Australian Meat and Livestock Corporation.

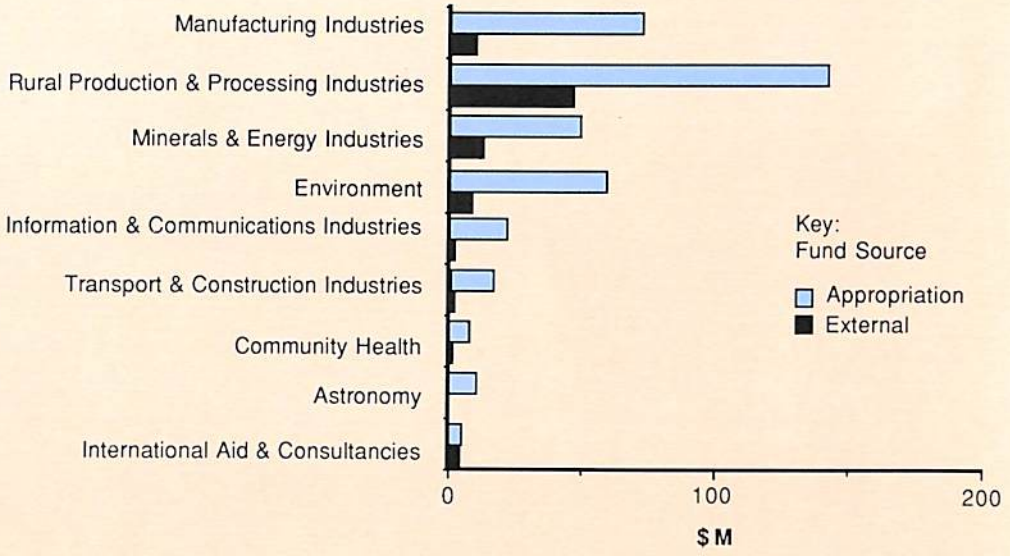
Rural Industry Research Funds now represent about 7% of total expenditure on research. Funds from competitive funding bodies such as the National Energy Research, Development and Demonstration Program and the Australian Centre for International Agricultural Research have increased to about 4% of total funds available to the Organisation.

The CSIRO research sectors are divided into sub-sectors that relate to areas of major economic or community activity. The six diagrams on the following pages illustrate the relative extent of effort devoted to these sub-sectors.

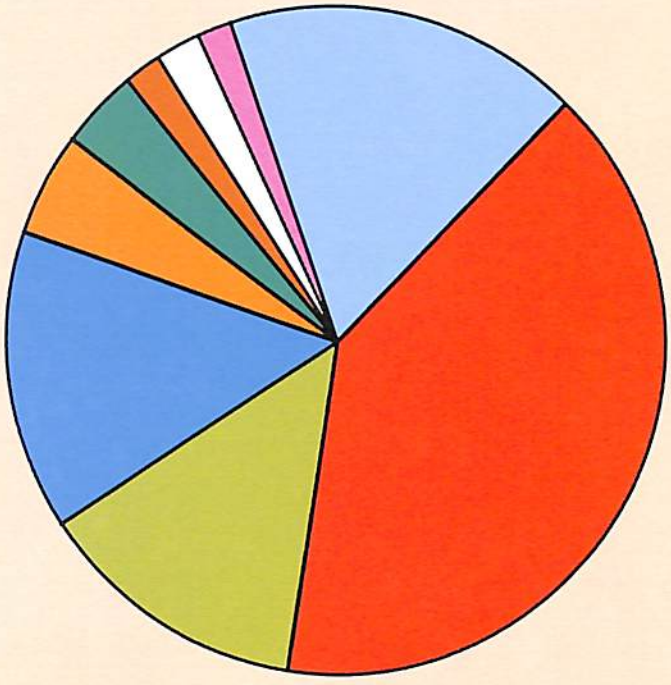
A category common to most sectors is that of Generic Activities. This covers technologies and broad research that is applicable to several sub-sectors within the sector.

CSIRO Distribution of Research Effort 1988-89

Cash Expenditure in Research Sectors 1988-89



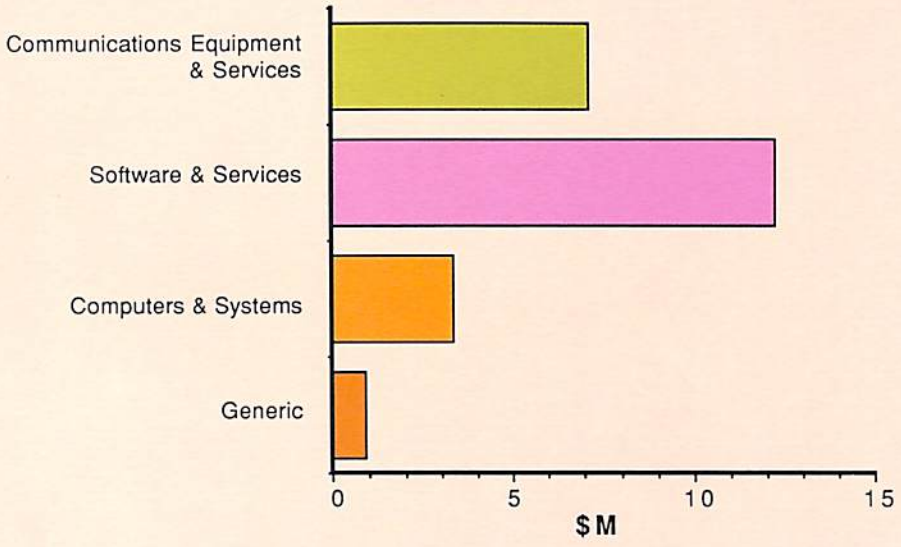
CSIRO Distribution of Research Effort 1988-89
(Proportion of Cash Expenditure from all Fund Sources)



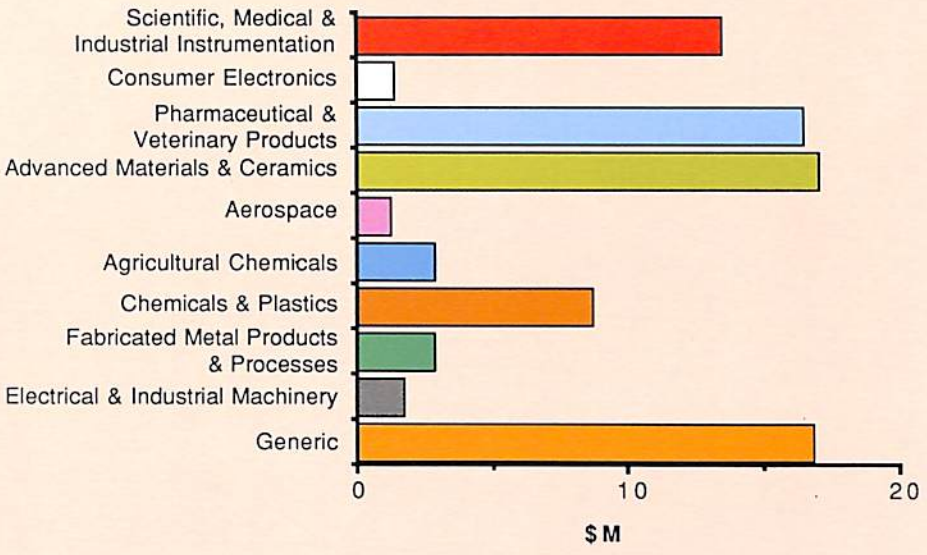
- Manufacturing Industries 17.40%
- Rural Production & Processing Industries 39.95%
- Minerals & Energy Industries 13.26%
- Environment 14.44%
- Information & Communications Industries 4.97%
- Transport & Construction Industries 3.84%
- Community Health 1.90%
- Astronomy 2.25%
- International Aid & Consultancies 1.96%

Total Cash Expenditure: $472.0M

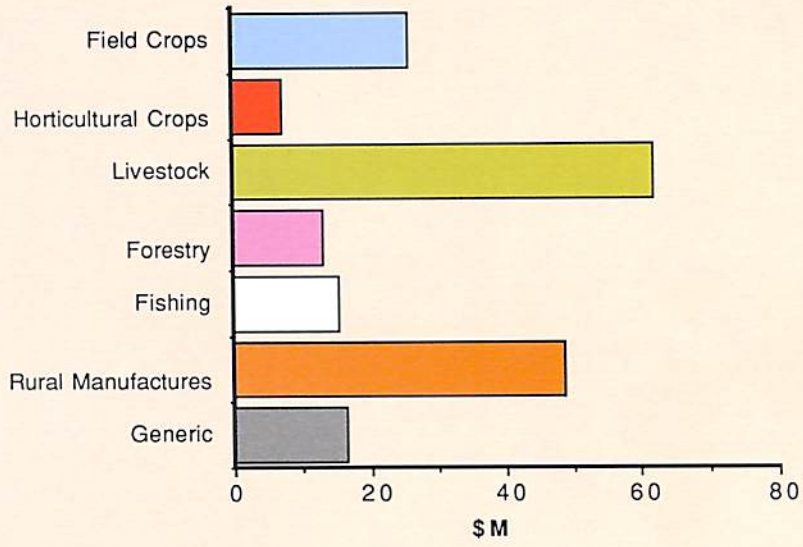
Information and Communications Industries



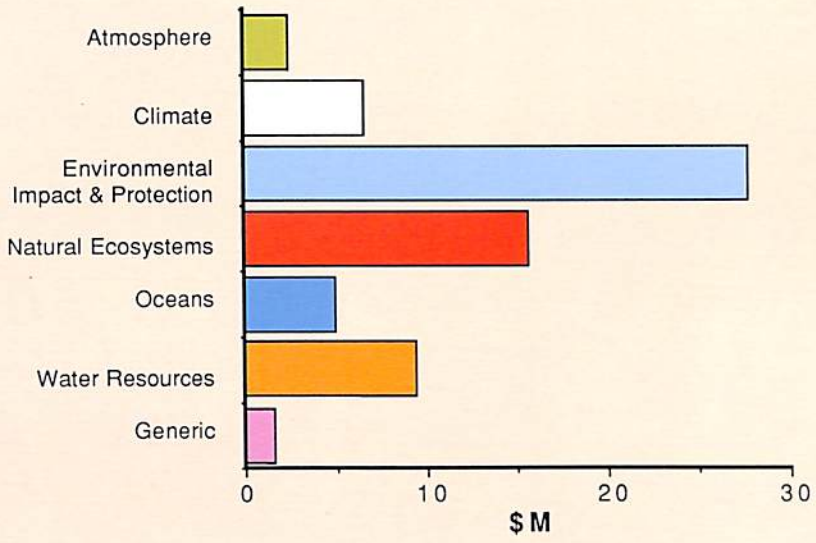
Manufacturing Industries



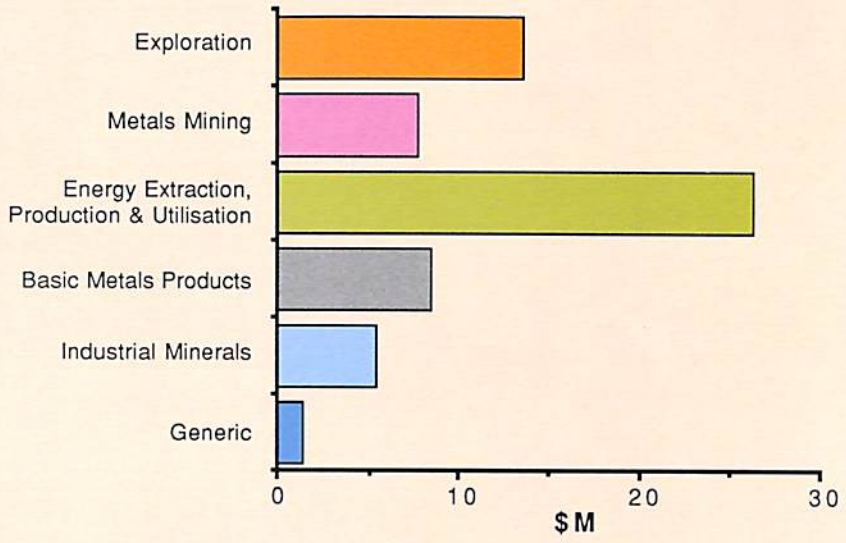
Rural Production and Processing Industries



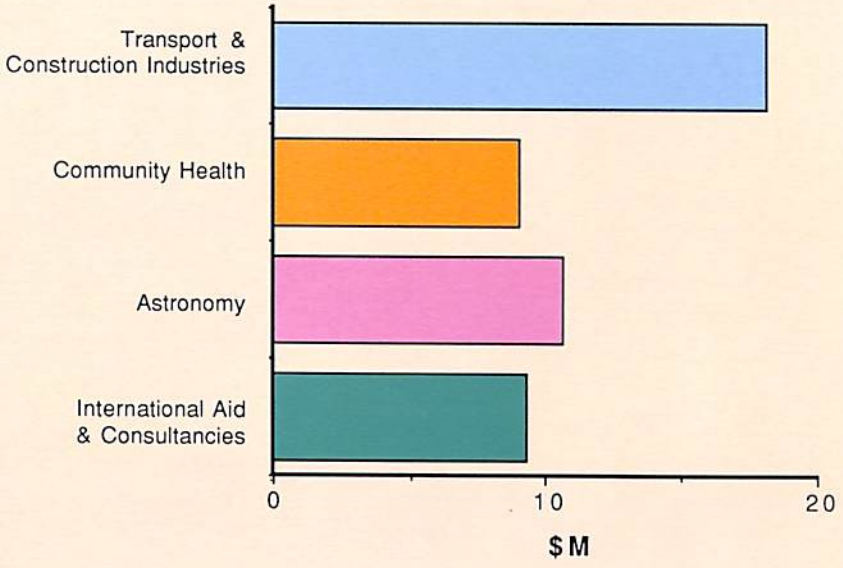
Environment



Minerals and Energy Industries



Minor Sectors



Research

CSIRO's research has produced many major advances in the past year. The examples described in this section illustrate the Organisation's commitment to advancing Australian industry and community well-being.

Research Highlights

Contents

Increases to productivity

Vaccine against infectious bursal disease virus in poultry

A new poultry vaccine developed in a collaborative industry/CSIRO project is shortly to go into commercial production.

CSIRO's partner, Arthur Webster Pty Ltd, expects world-wide sales of about $5 million per annum when the vaccine against infectious bursal disease virus (IBDV) is marketed overseas by the early 1990s.

Arthur Webster, Australia's largest manufacturer of veterinary vaccines and a large-scale exporter, has already contributed $600,000 to the IBDV research.

Diseases that kill are not the only economically significant ones in the intensive livestock industries.

Chicks infected with IBDV rarely die but are less able to resist other infectious organisms or to respond to vaccines.

IBDV destroys the immune system in young chickens and results in accumulated production losses estimated to cost the world poultry industry at least $50 million every year.

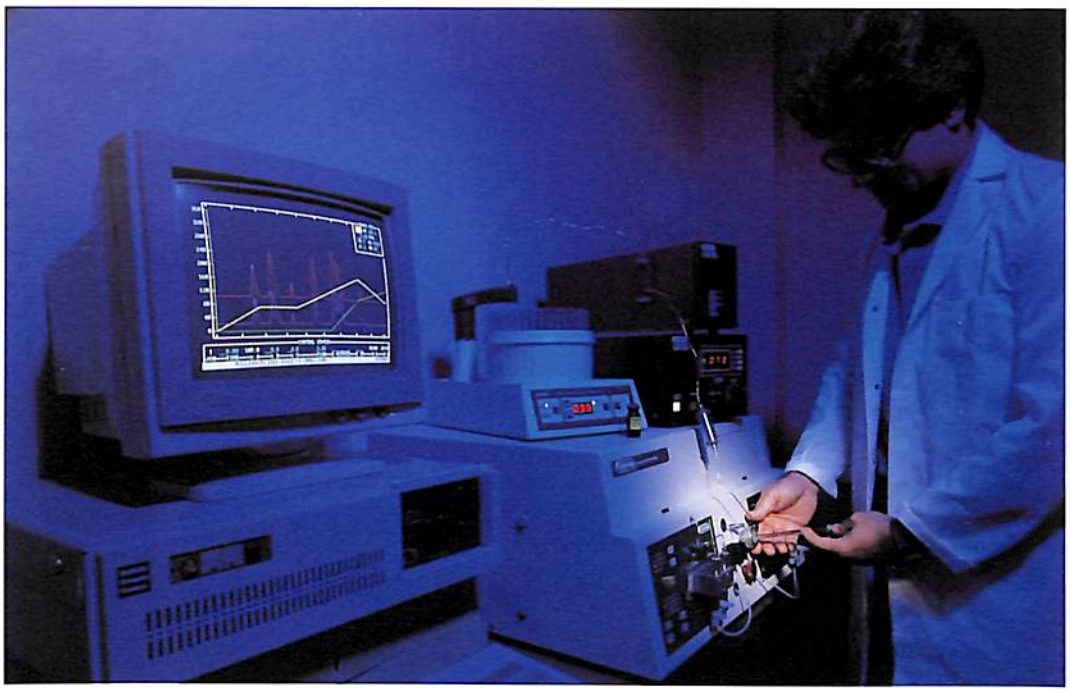
The best IBDV vaccines are currently produced from inactivated virus grown in other chickens that have been raised essentially germ-free.

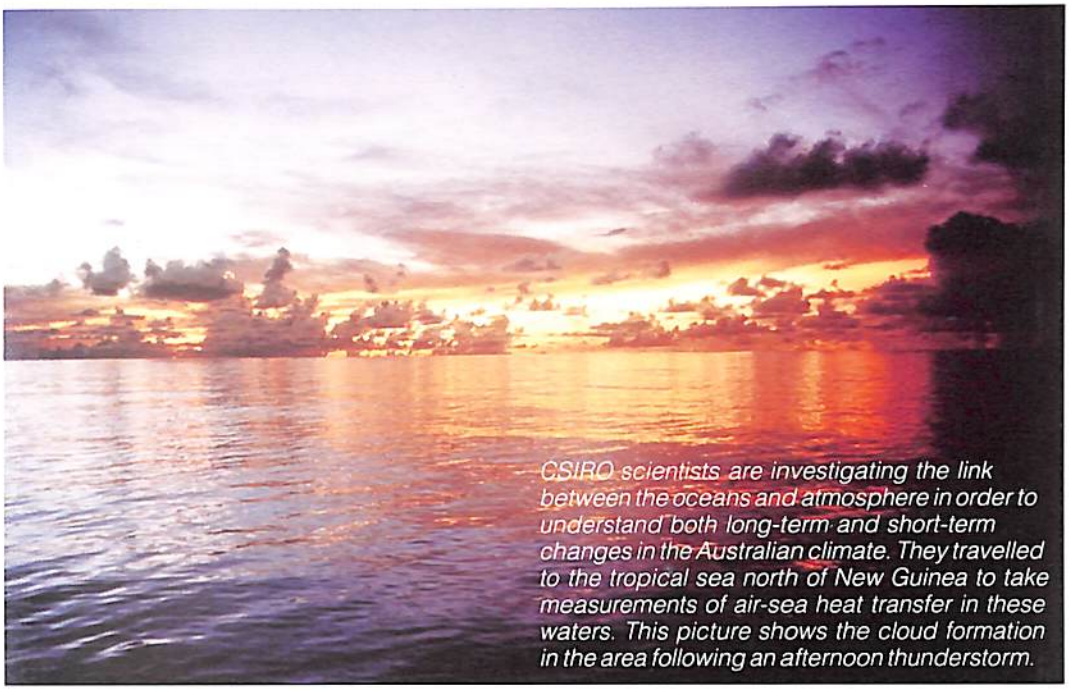
However, this process is both expensive and labour intensive. CSIRO scientists working in two Institutes have identified which IBDV proteins induce the production of protective antibodies in breeding hens, cloned the appropriate viral gene and are using genetic engineering techniques to produce the viral protein in fermentation cultures.

The resulting vaccine is simple to produce and extremely effective.

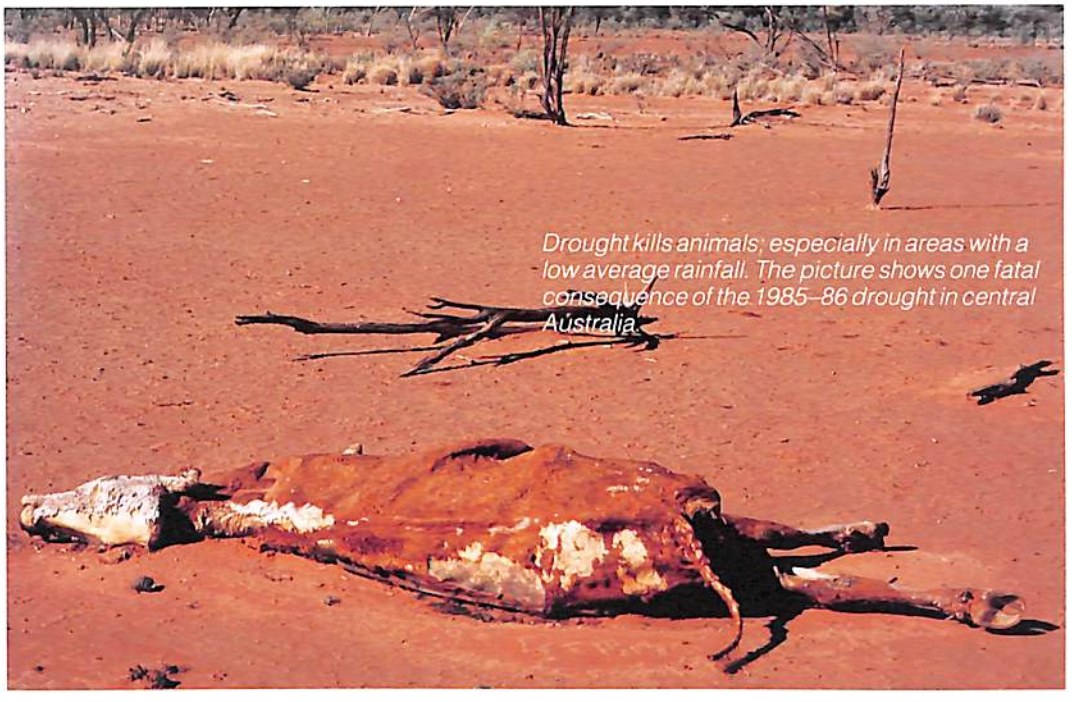
Chicks hatched from vaccinated hens are completely protected from IBDV.

CSIRO scientists have developed a vaccine against infectious bursal disease virus in poultry in collaboration with an industry partner. A high-performance liquid chromatography system was used to purify vaccine proteins.





CSIRO scientists are investigating the link between the oceans and atmosphere in order to understand both long-term and short-term changes in the Australian climate. They travelled to the tropical sea north of New Guinea to take measurements of air-sea heat transfer in these waters. This picture shows the cloud formation in the area following an afternoon thunderstorm.



Drought kills animals, especially in areas with a low average rainfall. The picture shows one fatal consequence of the 1985–86 drought in central Australia.

Drought prediction

Australia is the world's driest populated continent. CSIRO scientists are developing techniques to predict the incidence of drought well in advance.

Australia's rural industries and water supply authorities will be the main beneficiaries of the new techniques, planned for testing by 1990.

CSIRO is using large-scale atmospheric and oceanic models to establish the system. These models are designed to reproduce the climatic distributions of atmospheric pressure, temperature and rainfall observed around the globe.

The main cause of drought seems to be an abnormal variation in sea surface temperatures. For Australia, the El Nino event — a rise of 2–3 degrees Celsius in the temperature of the equatorial Pacific Ocean between Peru and the International Date Line — is an important variation.

When this variation is included in an atmospheric model, the model correctly simulates drought conditions occurring over the eastern half of Australia as well as rainfall variations at other locations around the world.

For long-term drought forecasting, researchers need to predict sea surface temperature changes two or more seasons in advance.

To achieve this, they have developed a simple model of the low-latitude Pacific Ocean basin that is demonstrating a high degree of accuracy in its predictions.

The final drought-prediction system will result from the application of these and other modelling techniques.

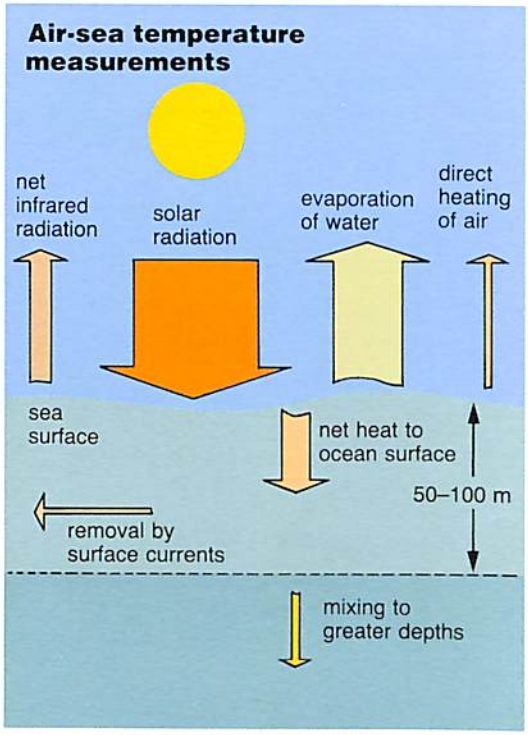
One crucial factor determining climatic variations, including drought, is the transfer of heat between sea and air.

The key area for study of this aspect is the region of very warm surface waters east of Indonesia and north of New Guinea. Much of the energy transfer that drives the atmospheric circulations determining climate in the surrounding countries occurs in this region.

Recently CSIRO scientists on the Organisation's oceanographic research vessel, the Franklin, made the first direct measurements of air-sea heat transfer in this critical area. The CSIRO measurements quantify the tight link between the tropical oceans and atmosphere, and provide an insight into the physical mechanisms forming this vital connection.

Ultimately, this knowledge will help us predict more accurately both long-term and short-term changes in the Australian climate.

The physical processes involved in the exchange of heat between the atmosphere and oceans are depicted in this diagram. The width of the arrow indicates the relative importance of the process, based on annual mean values. The net heat transfer to the ocean surface determines the sea surface temperature, an important indicator of the changes in climate.



Immunological castration and spaying

CSIRO scientists are using a revolutionary approach to the control of sexual behaviour and fertility in both male and female animals in the livestock industries.

Traditionally this control has been achieved with surgical procedures that cause trauma and production losses.

Now in a collaborative project between CSIRO and a consortium formed by Peptide Technology Ltd and Arthur Webster Pty Ltd, a novel vaccine has been developed that stimulates the immune system to produce antibodies that bind and neutralise the brain factor normally triggering reproduction.

This brain factor is common to both sexes.

Since immunised males and females do not show sexual behaviour and are infertile, they are described as "immunocastrated" or "immunospayed", respectively.

The effects of vaccination are not permanent and reproductive function will eventually return to normal unless a booster vaccination is given.

Initially the most important use of this vaccine will be in the cattle industry, and field trials are currently being held in collaboration with beef producers.

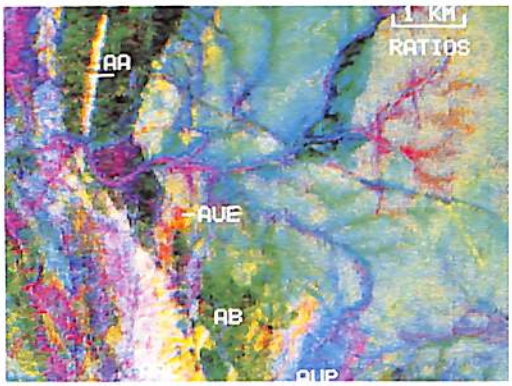
Immunospaying can be used in female animals not required for reproduction to prevent conception and to optimise growth before slaughter.

In young females vaccination may be used to delay puberty until an appropriate time for first mating.

The technology can also be applied to bulls. Immunocastration will suppress sexual and aggressive behaviour while leading to better growth performance than in surgical castrates.

Strong domestic sales of the vaccine are expected when it is launched in about two years — prior to sales overseas — especially as it also addresses animal welfare issues.

Further developments of the vaccine are likely to include applications to sporting and domestic animals.



Remote sensing data from the Landsat satellites' Thematic Mapper have proved especially important for mineral and petroleum exploration. The picture shows a Thematic Mapper image of greenstone rocks near Marble Bar in Western Australia.

Remote sensing — thematic mapping for resource assessment

Collaboration between two CSIRO Institutes has given Australia access to valuable data from the United States' Landsat earth resources satellites.

Although remote sensing data from Landsat's Thematic Mapper (TM) have been transmitted since 1982, they could not be received in Australia because there was no government funding to upgrade the Australian Landsat reception facility.

The Thematic Mapper is an advanced scanner with better spatial resolution — 30m instead of 80m — and a wider spectral range than earlier Landsat multispectral scanners.

CSIRO scientists, in association with the Australian Centre for Remote Sensing (ACRES), initiated a low-cost project to modify the ACRES Landsat facility to receive TM data. Fifty per cent of the project cost was met by members of the Australian Mineral Industries Research Association Limited (AMIRA).

TM data have proved especially important for mineral and petroleum exploration, although they can be used to monitor and map both renewable and non-renewable resources.

The first data were received in August 1986 and by May 1989 approximately 55,000 Thematic Mapper images had been acquired.

Images are processed at ACRES in Alice Springs and sold through AMIRA. The net revenue from sale of the images is more than $2 million, and a percentage of this is paid to CSIRO.

CSIRO researchers are continuing to improve the applicability of the data to exploration for minerals and petroleum, and to management of renewable resources.

They have demonstrated that advanced image-processing techniques can enhance the usefulness of TM data in geological applications, including in areas with considerable vegetation.

Car maker using cellular manufacturing

CSIRO-designed software is being used successfully to raise productivity at a major Australian car-manufacturing plant.

In collaboration with CSIRO, General Motors Holdens Automotive Limited is implementing cellular manufacturing in its restructure of the operations of a small-parts fabrication plant at its Elizabeth site in South Australia.

This manufacturing technique uses software to perform analyses of standard manufacturing information and identify the fundamental groupings of processes and parts used.

The results are used in a unique interactive computer-aided design system that enables manufacturing engineers to redesign the plant to consist of a number of self-contained manufacturing cells.

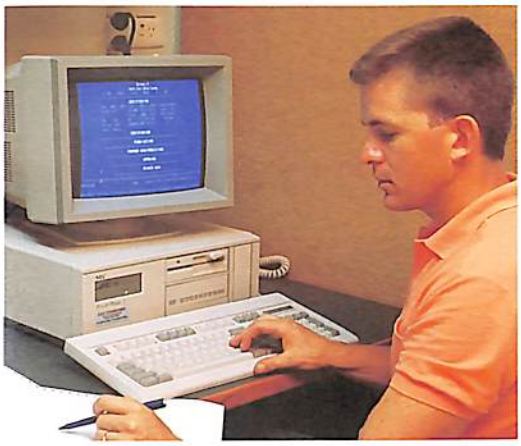
As far as possible, each cell has all of the process capabilities required to fully manufacture its assigned "family" of parts.

The benefits of cellular manufacturing include specialisation and improved control of manufacture, a leaner and more responsive operation with reduced production lead times, and a broadening of the roles and responsibilities of the shop-floor personnel.

This project's success has shown that major benefits can be achieved from a comprehensive change in operating method and with minimal capital investment.

Cellular manufacturing is resulting in increased productivity through the rearrangement of existing equipment into a number of self-contained manufacturing cells.

Exports



The new CSIRO computer-aided valuation system will help the Australian wool industry market raw wool more effectively. The system will act as an expert assistant, enabling wool buyers to analyse the half-million items of information on sale lots available on a typical auction day.

Raw wool marketing

CSIRO research is helping the Australian wool industry to market raw wool more effectively.

The technical feasibility of a CSIRO-designed raw wool marketing system, based on objective measurement and other explicit information, has been successfully demonstrated at two CSIRO seminars attended by representatives from Australian and overseas wool growing, exporting, broking and processing industries.

The new CSIRO computer-aided valuation system is based entirely on catalogued descriptions of greasy wool sale lots.

Wool, still one of Australia's most valuable export commodities, is currently marketed under a "sale-by-sample" system where auction samples are accompanied by selected objective measurements.

Introduced in the 1970s as a result of CSIRO research, the "sale-by-sample" system produced industry savings of more than $100 million annually.

Since 1985 the core test results have been augmented by full-length staple sampling and testing.

The new system could be used to define a user's typing system, predict processing performance, assess dark fibre risk and optimise wool selection strategies.

Every item of information available on a single lot can be manipulated, and that may mean up to 80 items gathered from wool growers, classers and testing houses.

Until the new marketing system is fully introduced it can easily be operated within the current selling system and is compatible with industry moves towards a "sale-by-description" wool marketing system.

The new system would act as an expert assistant, enabling wool buyers to analyse the half-million items of information on sale lots available on a typical auction day.

It recognises the need of modern textile processing for greater reliability and accuracy in the specification of the raw material, and incorporates an understanding of the relationship between raw material properties and subsequent processing performance.

Sensory Research Centre

Australia's exports of processed foods to the $300-billion Japanese domestic food market are likely to be enhanced by CSIRO's new Sensory Research Centre.

The Centre will conduct research into the food preferences of people in Asian countries, with the aim of increasing Australia's share of the lucrative Asian food export market.

This will enable Australian food manufacturers to design and modify foods for the Asian market.

The Centre brings together many areas of expertise in sensory perception and evaluation, ranging from the taste-testing of foods to the physiology and biochemistry of taste and olfaction.

Cross-cultural food preferences are being studied because little is known about the characteristics of flavours preferred by Asian consumers.

Enormous potential exists for increasing Australia's processed food exports to Asia, and particularly Japan.

Although Australia exports food worth $1·4 billion to Japan, only $125 million, or less than 10 per cent of the total value, is highly processed food.

It is estimated that overseas countries add $80 billion to the value of our exported raw agricultural commodities each year.

An increased demand in Asia for food products from Australia, achieved through the Centre's research, could have a significant effect on the Australian economy.

CSIRO is testing various foods in its research into the determinants of Asian food preferences, with the aim of increasing Australia's share of the lucrative Asian food export market.

Improving the cotton industry

The spectacular growth of the Australian cotton-growing industry over the last 25 years has led to cotton's becoming a major export crop, surpassed in value only by wheat and sugar, and earning export income of about $500 million per annum.

Currently, CSIRO researchers are investigating ways for the cotton industry to reduce its dependence on chemical pesticides in its strategy to control the destructive *Heliothis* bollworm.

Two species of this insect cause serious damage to crops, particularly cotton, and cost Australian agriculture about $400 million each year.

In support of this research, ICI (Australia) Ltd has agreed to contribute $560,000 over three years to develop a genetically engineered virus, designed to control the insect biologically.

Scientists have identified a gene that will make the species-specific virus lethal to the insect's larvae. This is the first step towards creating a new, residue-free method of controlling the world's worst insect pest of cotton, maize and grain legumes.

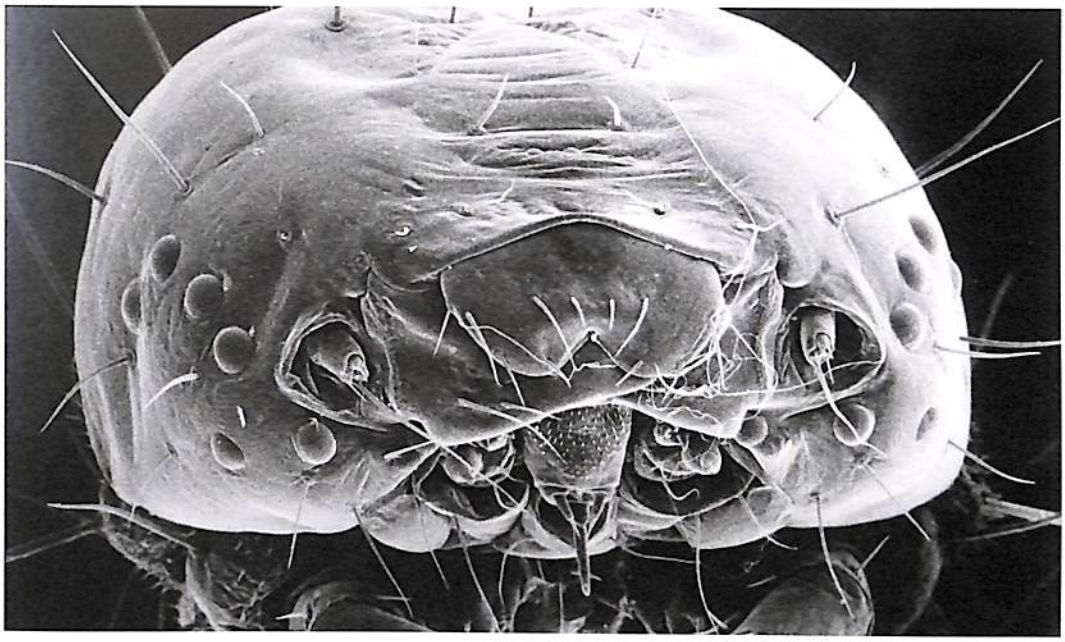
ICI estimates that world-wide sales of the virus could be worth $50 – 100 million annually, with substantial royalties flowing to CSIRO.

Other CSIRO scientists have developed new cotton varieties that have rapidly become dominant in Australia. They account for over 70 per cent of the national crop and have added about $45 million per annum to export earnings.

The most successful of these CSIRO varieties has been the novel okra-leafed Siokra. As well as outperforming USA-bred varieties in yield, it is resistant to pests and disease, reducing the need for chemical sprays.

CSIRO and an Australian partner, Cotton Seed Distributors Ltd, plan to produce and distribute the new varieties world-wide, and expect substantial sales and royalties from the United States, southern Europe and Africa.

CSIRO scientists are developing a genetically engineered virus designed to control the Heliothis *insect biologically. The picture shows the magnified head of the* Heliothis *larva.*



Proton Magnetic Resonance Thermal Analysis — a new tool to characterise coals

In the rapidly expanding coal export market an understanding of the nature and behaviour of different types of coal is vital in matching Australian coal resources to the requirements of overseas users.

More coal users are specifying coals with particular characteristics for specific applications, and currently used coal characterisation tests are not considered adequate.

CSIRO and the Joint Coal Board — the New South Wales coal regulatory authority — have developed a new and sophisticated instrument to test the coking power of coals.

Based on proton magnetic resonance thermal analysis (PMRTA), the first such instrument is currently being used at the Joint Coal Board's evaluation laboratory at Cessnock, New South Wales.

PMRTA is a technique that allows changes in the molecular properties of organic solids, such as coal, to be detected and recorded as the solids are heated to high temperatures and then decompose.

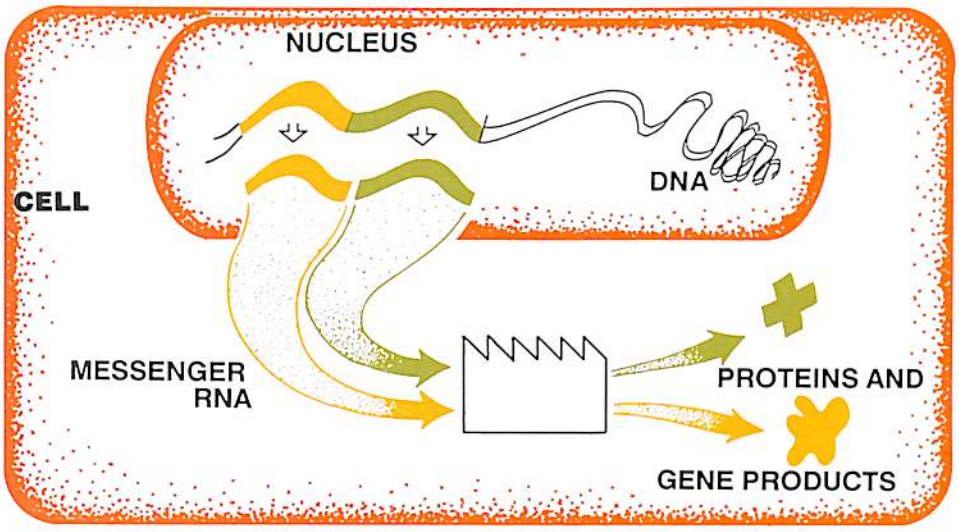
The ability of PMRTA to define and measure the so-called "plastic properties" of a coking coal — which come into being when it is heated and turns into a fused plastic mass — is especially important for the purpose of characterising these materials.

PMRTA opens the way for improved testing and characterisation methods because it is based on the measurement of fundamental molecular properties of coal specimens.

The instrument has been tested on more than 100 coals and the information gathered is being incorporated into a data base to provide a comprehensive core of reference data on Australian coals.

The PMRTA technique also has wider applications in the analysis of all hydrogen-containing materials.

New industries, technologies or products



Genes carry coded instructions for producing proteins — the building blocks of life. The instructions are picked up by molecules known as messenger RNA and carried to the part of the cells that produces proteins.

Gene Shears

A CSIRO research team has achieved an exciting breakthrough in genetic engineering research — the discovery of a way of destroying the genetic instructions carried by specific, targeted genes.

The scientists have designed ribonucleic acid (RNA) molecules — Gene Shears — that cut 'messenger' RNA molecules, causing them to lose their ability to convey genetic information.

In the largest joint venture CSIRO has ever undertaken, the French company Groupe Limagrain is investing $22·5 million over six years in Gene Shears Pty Ltd — the company designed to exploit the new technology commercially. CSIRO has filed patent applications covering the commercial use of Gene Shears around the world.

The researchers have successfully tested the Gene Shears technique *in vitro* and are exploring its use to effectively inactivate any gene in the cells of animals, plants and micro-organisms.

For some time genetic engineers have been able to add genes to living organisms, using recombinant DNA techniques, but until now they could not cut off genetic messages with any great degree of reliability.

The Gene Shears technology promises to affect all areas of biotechnology through insertion of synthetic genes encoding the Gene Shears into the genetic blueprints of bacteria, plants and animals.

In the cheesemaking industry Gene Shears could protect bacterial cultures from destructive viruses that cost huge amounts in lost production each year.

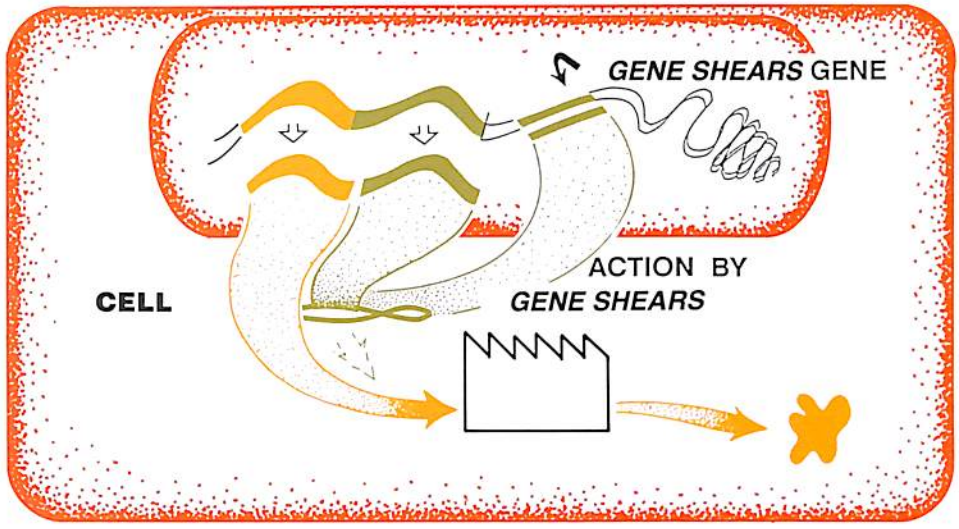
In plants, the discovery could be used to control costly viral diseases, to improve the taste and use of plant seeds and tissues and to produce new hybrid, high-yield plant varieties.

Molecular biologists also see the revolutionary technology as a potential technique for the control of genetic and viral diseases in animals and humans.

Tropical pasture legume technology takes off in the North

Stylo technology pioneered by CSIRO is moving rapidly into widespread commercial practice in northern Australia, with about 500,000 hectares currently sown to the CSIRO varieties Verano and Seca.

Stylos are tropical pastures legumes sown to improve native grasslands and pastures for cattle



Gene Shears are actually special RNA molecules that can be designed in the laboratory to target and destroy specific messenger RNA molecules. In this way a harmful or undesirable gene can be prevented from expressing the physiological characteristics for which it is responsible.

grazing. The technology is based on aerial oversowing and low inputs of fertiliser.

Each year an additional 70,000 hectares are being improved by oversowing with the new legumes, resulting in a major increase in cattle production in northern Australia.

The increased beef production is currently worth $38 million per annum.

A new variety, Amiga, will soon be available commercially for sowing with Seca, making it possible to extend stylo pastures into cooler and drier environments.

Amiga and Seca have been found to be more productive and persistent in environments marginal to Verano.

It is estimated that Amiga will boost the area sown each year to stylo pastures to 100,000 hectares, allowing an extra $7·6 million to be derived annually from beef production.

New research is aimed at producing varieties suited to sub-tropical areas and resistant to the fungal disease, anthracnose, which has caused considerable damage in recent years. An intensive program combining biotechnology and epidemiological techniques with applied plant breeding is being carried out to safeguard stylo varieties against the effects of the disease.

Using whey proteins in food

A new separation process devised by CSIRO will help the cheesemaking industry reap the full economic benefit of whey protein recovery.

Proteins found in whey — the watery by-product of cheese manufacture — are nutritionally valuable and account for about 20 per cent of the original milk protein.

However, only limited use can be made of the whey protein concentrate produced by ultrafiltration.

Ultrafiltration is a process using a semi-permeable membrane that allows only certain milk components to pass through. It is used for the selective concentration of milk in the APV-Sirocurd cheesemaking process, developed by CSIRO.

Now CSIRO dairy researchers have perfected a method of separating the two major whey proteins,

making it possible for the food industry to take advantage of the unique properties of each.

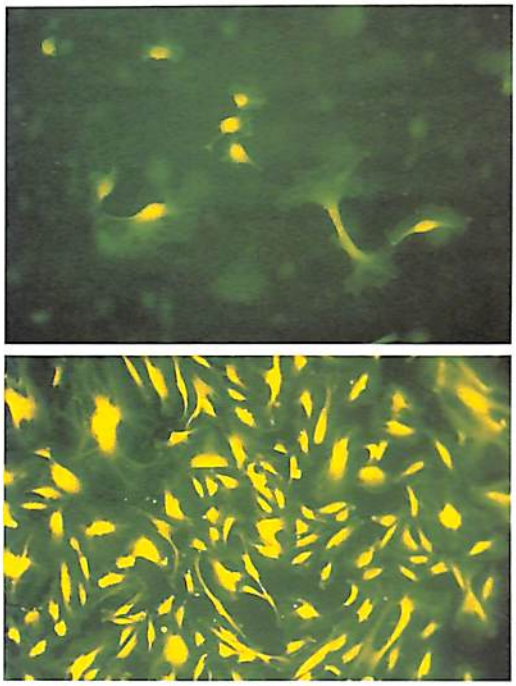
The process is soon to be commercialised through a collaborative research and development agreement with an Australian dairy company, and should result in the production of new high-value "tailor-made" food ingredients for both domestic and export markets.

One protein acts as an emulsifier, and can be used, for example, to replace 20 per cent of the protein present in processed cheeses, thus increasing the quantity of protein available for cheesemaking.

As this protein closely resembles one found in human milk, the further "humanisation" of infant milk formulas will also be possible.

The high solubility, pH stability, and clarity of solutions of the other protein fraction will enable it to be used to enhance the nutritional value of fruit-based drinks.

It will also find use in processed meats, confectionery and other products where superior aeration, gelation and adhesion qualities are required.



The greatly improved response of human vascular endothelial cells after three days growth on a surface-modified form of the polymeric biomaterial, seen in the second picture, can be contrasted with the poor response of three days growth of similar cells on conventional polymeric biomaterial in the first picture.

Biomaterials

Unique biomaterials developed by CSIRO scientists will improve the health of many heart and trauma patients.

In association with industrial partner Telectronics Pacing Systems Pty Ltd, CSIRO researchers have developed and tested several polymeric biomaterials, in cell culture, that can be used to replace narrow arteries.

Over the last 40 years, artificial replacements for arteries and major veins manufactured from chemically and biologically inert synthetic polymers have been used very successfully in cardiovascular surgery.

However, the polymers presently used cannot replace narrow arteries, as materials like teflon gradually become blocked with blood clots.

The new polymer biomaterials solve this problem by encouraging the growth of endothelial cells on the polymer surface, forming a durable cell coverage that inhibits blood clotting and other undesirable interactions with the blood.

These cells normally form the inner layer of arteries or veins, in contact with blood.

Currently, in association with the University of New South Wales, CSIRO is testing the new biomaterials in animals.

Natural substances can also be used as biomaterials, and CSIRO is collaborating with the University of Melbourne and Wallace Biomedical Pty Ltd to develop biomaterial uses of collagenous materials.

Collagen is the principal protein component of all connective tissues, including skin, bone, ligament and tendon.

The researchers have developed a technology for the cost-effective production of purified and reconstituted collagen products that retain the essential biological properties of natural collagen, but do not produce an immune response.

Collagenous materials based on this technology are now being evaluated in a variety of applications in wound care and dentistry.

Gallium arsenide research goes commercial

New and exciting gallium arsenide device technology could be the key to Australia's entry into a multi-billion-dollar world communications market.

Gallium arsenide (GaAs), like silicon, is a semiconductor. It is ideal for making electronic devices with high switching speeds, high operating frequencies, low electrical noise and low power consumption.

Although GaAs is less well known than silicon, it is actually very widely used: gallium arsenide devices are built into every communications satellite and earth station, and have applications in other high-value-added electronic equipment.

Other laboratories also see GaAs as a replacement for silicon in computer chips. However, CSIRO has concentrated on the microwave and millimetre-wave applications of GaAs technology.

Using a technique called molecular beam epitaxy, scientists grow their own active GaAs-based material, and from it make discrete devices, such as field effect and high electron mobility transistors and integrated circuits.

This machine is used to grow gallium arsenide semiconductor layers of precisely controlled composition and thickness on base wafers of gallium arsenide. In a vacuum of 10^{-14} atmospheres, the wafer is bombarded with controlled amounts of gallium, arsenic and other substances. The incoming molecules stick to the wafer surface in such a way that the crystal structure of the growing layer accurately matches that of the base material.

Although GaAs devices currently account for less than ten per cent of world semiconductor production — worth about $40–50 billion a year — the market is growing rapidly.

In 1988, prior to initiating commercialisation, CSIRO carried out an exhaustive market survey and produced a Business Feasibility Report confirming that there was genuine potential for an Australian industry based on CSIRO's GaAs technology.

Triune Pty Ltd, CSIRO's partner in the commercialisation of this project, is a newly incorporated Australian company formed specially to exploit the GaAs technology.

Although local production will be mainly for export, other sectors of the Australian electronics industry will benefit from access to domestic supplies of these semiconductor components.

About a third of this market will be in the area of high-performance processing — the field for which the chip was developed.

The device is expected to open up a wide variety of digital signal processing applications in medicine, industry and consumer electronics. CSIRO and Austek are examining the following uses: the processing of ultrasound data (for medical imaging and acoustic radar), video processing, spectrum analysis, and analog encryption of speech.

Other potential applications of the FFT chip include use in the processing for synthetic aperture radar (a high-resolution, airborne radar system) and in high-performance graphic equalisers for enhanced sound reproduction systems.

The research that led to the development of the new chip was partly supported by a grant under the Federal Government's GIRD (Grants for Industry Research and Development) scheme.

Signal processing chip launched

A digital signal processing chip, initially designed by CSIRO scientists and later developed with researchers at Austek Microsystems Pty Ltd, has been commercially launched in Australia and the United States.

Conceived by CSIRO engineers, the chip performs a mathematical procedure, called the Fast Fourier Transform (FFT), that is widely used in signal processing.

Traditionally this process has been carried out by either main-frame computers or sets of interconnected chips; now it can be done by a single chip.

Not only is the chip much faster — fast enough for real-time processing — but also much cheaper.

The key to the single-chip processor was a new FFT algorithm, for which world-wide CSIRO patents are pending, that allowed the processing hardware to be dramatically simplified.

Austek, which is manufacturing and marketing the final device (the A41102 Frequency Domain Processor) under licence to CSIRO, estimates that the world market for digital signal processing devices will reach $2 billion by 1992.

$100-million HIsmelt plant

The results of collaborative research work between CSIRO and CRA Ltd on a new iron-making technology — HIsmelt — will be incorporated in a $100-million iron-making plant to be built by a joint venture company, HIsmelt Corporation Ltd.

Partners in the joint venture company, CRA Ltd and Midrex Corporation of the United States, plan to start building the HIsmelt iron-making plant, located south of Perth in Western Australia, in early 1990.

They are aiming to complete the research and development necessary to establish the commercial viability of the HIsmelt process.

HIsmelt — high intensity-smelting — makes use of the direct bath smelting of iron ores.

The successful operation of the HIsmelt technology will offer the steel industry a more profitable and cleaner method of producing liquid pig iron, the essential first step in the production of steel.

In addition, the new technology permits the use of lower value iron ore "fines" and consequently will boost Australia's iron ore reserves.

Following the successful commercialisation of the non-ferrous Sirosmelt bath smelting process, CSIRO scientists, working as part of the HIsmelt development team, have been able to extend their skills and experience into the parallel area of ferrous smelting.

CSIRO has been involved jointly with CRA in the development of a new, high-intensity, ferrous bath smelting process since 1981.

In 1983 CRA offered to support future CSIRO work on direct ferrous smelting on a commercial-in-confidence basis, and currently CSIRO is maintaining a major research effort on various aspects of the commercial development of HIsmelt.

The CSIRO work involves laboratory and pilot-scale experimentation, the development of thermodynamic fluid flow and kinetic models, process flowsheeting and pilot plant trials.

The development phase of HIsmelt is expected to span three years, with continuing CSIRO collaboration.

Pilot plant for new permanent magnets

A pilot plant developed for the fabrication of neodymium-iron-boron (NdFeB) permanent magnets is expected to form the basis of a CSIRO joint venture company.

NdFeB is representative of a new generation of "hard" magnetic materials that promise to revolutionise the design of many types of electric motors and other electro-magnetic devices.

Applications range from tiny stepper motors in wrist watches to propulsion motors in ships, submarines and locomotives.

Being the strongest magnetic material known it has many novel uses, for example in high-quality moving-magnet loudspeakers and in jaw implants designed to retain false teeth.

There are large-scale applications in computer peripherals and magnetic resonance imaging (MRI) used in medical diagnostic equipment, where it eliminates the need for supplies of liquid helium used to refrigerate superconducting magnets.

The pilot plant employs a powder metallurgy process that requires special grinding and handling techniques because the powdered material combusts spontaneously in air.

With an annual throughput capacity of about one tonne, the plant's production should be sufficient to meet initial demand from local industry.

Community & Environment

As part of a major CSIRO program of marine environmental studies at Jervis Bay, New South Wales, scientists are measuring the productivity of the leaves of sea-grasses growing in the Bay.

Jervis Bay marine environment studies

In 1988, CSIRO won a $4·5 million contract with the Department of Defence to undertake a major program of marine environmental baseline studies at Jervis Bay, New South Wales.

The detailed and extensive three-year studies were designed by CSIRO to provide essential biological and oceanographic information needed to implement a long-term marine Environmental Management Plan. Some of the information will also be used by the Department for the proposed relocation of naval facilities to Jervis Bay.

The program will investigate:

- sea-grass meadows in Jervis Bay, and the effectiveness of transplanting sea-grasses to disturbed areas;
- the mangrove and saltmarsh floral communities;
- the population of fish and large invertebrates along sandy coastline, and the biology of important recreational and commercial species of fish;
- underwater video techniques for studying organisms in the deeper waters of the Bay;
- invertebrate animals living in all the various Jervis Bay environments;
- water quality, including testing for metals, herbicides and pesticides in flora, fauna and marine sediments, and studying the effects of tributyl tin — from antifouling paint used on boats — on sea-grasses and common marine invertebrates; and
- water circulation in the bay, and the exchange of bay and oceanic waters.

CSIRO is being helped by staff from the Institute of Marine Ecology at the University of Sydney, the Australian Museum, the New South Wales Fisheries Research Institute and the Australian Defence Forces Academy.

Managing kangaroo numbers

In Victoria, South Australia and Western Australia there is increasing interest in developing alternatives to shooting for the control of kangaroo numbers.

CSIRO scientists have developed a method that painlessly controls the populations of the common western and eastern grey kangaroos in southern Australia.

Mimicking the natural effect of periodic droughts or food shortages on immature pouch young, the

method defers a natural increase in the kangaroo population for one year.

The approach is based on early CSIRO work on kangaroo reproduction and more recent work on kangaroo lactation.

Most grey kangaroos are born between November and March and very few are born in winter. By early winter most female greys are carrying tiny young which have not yet grown fur or opened their eyes.

By exposing these females to a drug that specifically blocks lactation at this time, the young are lost.

Owing to the inability of the female grey kangaroo to conceive immediately after giving birth, and to the seasonal nature of reproduction in this species, the mother usually does not mate and conceive again until the next summer.

Contrasted with other techniques of population control this method has the following advantages:

- it does not disturb the population and so lead to dispersal, as happens after shooting;
- it does not harm the adults or affect their future reproduction potential in subsequent years; and
- it requires minimum effort by the landholder.

The next phase of the project is to develop the best means of delivering the drug, whether by food pellets, salt licks or in water outlets.

Treating waste-water

CSIRO scientists are investigating several low-cost processes for treating sewage.

Cheaper and quicker sewage treatment

A promising new way of treating sewage is being tested in a 100-kL-per-day pilot plant at Lower Plenty, Victoria.

Developed by CSIRO scientists, the sewage treatment process is a modification of Sirofloc — the successful, CSIRO-designed surface and underground water treatment process based on regenerable magnetic particles.

The Sirofloc process for water clarification uses fine particles of magnetite to cause rapid adsorbtion

CSIRO scientists have developed a promising new way of treating sewage, based on the CSIRO-designed water treatment process called Sirofloc. The picture shows a pilot-scale clarifier containing the water obtained from the magnetite-sewage treatment process.

of turbidity and colour from water, and is in full-scale operation at three locations in Australia and the United Kingdom.

The new technique should reduce the cost of treating sewage, with the capital cost of a treatment plant being halved and the total treatment cost reduced to two thirds that of a conventional activated-sludge plant.

Primary settled sewage is rapidly clarified by means of magnetite particles, in conjunction with a secondary coagulant such as ferric salts from waste effluents produced by metals processing. Regeneration of the magnetite after clarification produces an effluent 30 times more concentrated than the raw sewage.

The equipment required is much smaller, because of the rapidity of the purification and separation steps.

Research is now concentrated on the treatment of the high-strength sewage waste obtained.

This treatment is expected to be economic whether achieved by anaerobic degradation or

physico-chemical separation, because of the very concentrated nature of the material.

A larger pilot plant for Sydney's Water Board capable of treating 200 kL of raw sewage per day, will be operational in Sydney early in 1990.

New waste-water treatment technique

CSIRO is developing a cheap, effective system for waste-water treatment using artificial wetlands.

The process uses native aquatic plants to treat primary settled sewage and can be adapted for single households or populations of up to 10,000 people. It also has potential to deal with a range of other waste-waters such as effluents from abattoirs and feedlots and mining run-off.

The plants are grown in a permeable material such as gravel to allow rapid flow of waste-water through the wetland and good contact with the root systems of the swamp plants. The roots process the waste-water by taking up nutrients, adding oxygen, and improving clarity.

The system is virtually flood-proof, provides no free-standing water for pests such as mosquitoes, is odourless and will tolerate "shock loads" of nutrients.

Construction and maintenance costs will be low compared with more conventional processes, and once established the swamp plants will also offer an interesting addition to the landscape — a thriving community of Australian natives.

Pilot systems have been established at sewage treatment works in Griffith, NSW, and at army barracks in Wagga Wagga, NSW. Four household units have also been constructed.

Field testing will be needed over the next two years as a basis for design of full commercial systems.

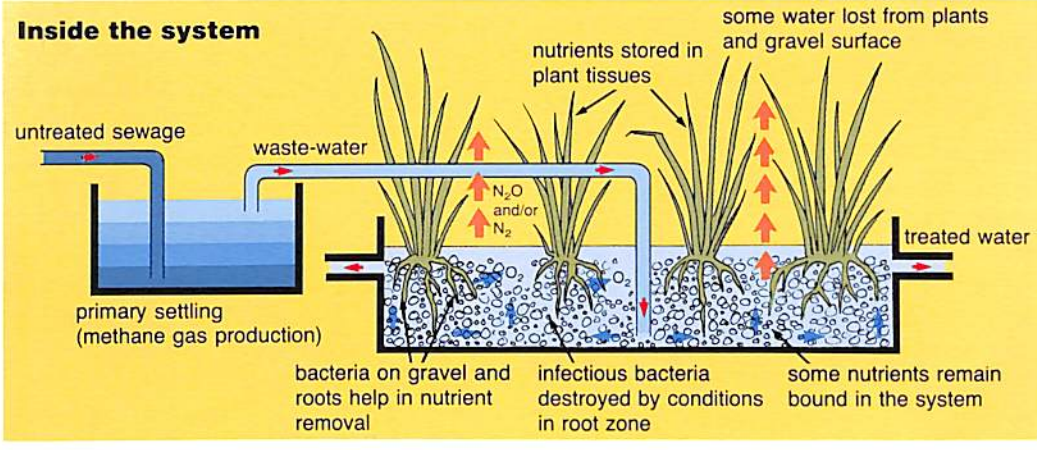
Monitoring the eating habits of Australians

CSIRO scientists are providing essential advice and information on nutrition to public health professionals, government policymakers and food manufacturers.

As well as advising governments and contributing to general nutritional courses for dieticians and other community health workers, CSIRO researchers are conducting large-scale baseline surveys on the eating patterns of Australians.

A recent CSIRO study of the eating habits of 5,000 Victorians — commissioned by the Victorian

The artificial "swamp" cleans up waste-water by removing nutrients, heavy metals and suspended solids. It also reduces the biochemical oxygen demand and destroys micro-organisms.



government — has shown that the overall nutrient intake by this population is gradually conforming to dietary recommendations made by Australian health authorities.

The biggest change in dietary patterns over the last few years has been the move towards polyunsaturated fats and away from other fats.

About 25 to 30 per cent of the population are now complying with individual recommendations on total fat, refined sugar, salt and fibre.

Despite this fairly high compliance with individual recommendations, however, only six per cent are observing all four dietary recommendations. In addition, less than one per cent have managed to increase their complex carbohydrate intake to the recommended level.

This low level of overall compliance is due mainly to the fact that those who change to low-fat diets are compensating by increasing their intakes of refined or natural sugars and not by increasing their intakes of foods such as cereals and vegetables.

Moreover, when people do increase their cereal food intake, this is usually accompanied by a general increase in the intake of salt, which is a common ingredient in breads and breakfast foods.

These findings highlight the sorts of problems that can occur with education programs using single-theme dietary messages such as "reduce fat" without providing information on the optimal way to achieve this given our current food supply.

Fire control

CSIRO is playing a leading role in saving Australia's people and buildings from fire.

Safer buildings

Smoke is the major hazard in building fires. More people die from the effects of smoke than from fire itself.

In particular, some shopping centres and other modern buildings with atria that link together many levels call for a strategic approach to fire and smoke control.

CSIRO, in collaboration with building developers and government authorities, has developed methods to predict and control smoke movement in large modern buildings.

Tests carried out in a mock-up of a proposed major shopping development have demonstrated that the circulation areas and exits can be kept clear of smoke by an effective smoke control system.

CSIRO researchers have also developed tests to assess the fire properties of building materials and contents. This is essential for the screening out of hazardous products. CSIRO provides expert advice to designers, builders and regulatory authorities to help predict the structural performance of high-rise buildings under fire conditions.

The Organisation also operates an independent research and testing facility for the development and certification of building products and systems for the building industry in Australia.

Bushfire video

In another approach to saving life and property from fire, CSIRO has produced a video to educate architects, builders and owners on the ways of improving buildings in bushfire-prone areas.

Made in partnership with Melbourne University, the twenty-minute video is called "Buildings and Bushfires — Improving the Chances of Survival".

Diagrams, staged fires and footage from actual bushfire disasters are used in the video to illustrate the anatomy of bushfires, how they attack buildings, sensible behaviour for occupants when bushfire threatens and the principles of good building design.

The video followed an extensive survey of 1,200 homes involved in the 1983 Ash Wednesday bushfires in South Australia and Victoria, when 76 people died, 2,500 homes were destroyed and financial losses exceeded $440 million.

The survey revealed that the destruction of buildings by bushfires is not inevitable; many buildings can be saved by changes in their design and the use of appropriate materials.

Awarded a silver "Mobie" by the International Television Association, the video is being distributed within Australia and overseas.

Following the 1983 Ash Wednesday bushfires in South Australia and Victoria when 76 people died and 2,500 homes were destroyed, CSIRO carried out the most extensive research and evaluation survey of homes involved in bushfires ever undertaken in Australia.

Australia Telescope Opening

The Australia Telescope

The $50-million Australia Telescope was officially opened by the Prime Minister of Australia, Mr Bob Hawke, on September 2, 1988.

This major Bicentennial event was held at the site of the Telescope's compact array, the Paul Wild Observatory, near Narrabri, in northern New South Wales.

The Telescope's compact array comprises six parabolic antennas, each 22 metres in diameter. Five of them can be moved along a straight east-west track, three kilometres long, to any of 35 observing stations. The sixth antenna is another three kilometres to the west on a shorter track with only two stations.

As the earth rotates, the line of antennas changes its orientation with respect to objects in the sky, and a two-dimensional image can be built up by observing continuously for many hours. The process is repeated many times, with the antennas in different combinations of positions each time, in order to receive a good sampling of radio signals. This group of antennas will be able to "see" detail a hundred times finer than is possible with CSIRO's radiotelescope at Parkes.

The antennas of the compact array are linked by optical fibre cables to a central correlator that is part of a powerful computer network. The correlator multiples the signals from each antenna with those from every other antenna. When all six

The Prime Minister of Australia, Mr Bob Hawke, opened the Australia Telescope on September 2, 1988. Touring the site of the Telescope's compact array at Culgoora in New South Wales are, from the left, Director of CSIRO's Institute of Information and Communications Technologies, Dr Bob Frater; Mr Bob Hawke; the Chairman of CSIRO, Mr Neville Wran; Mrs Hazel Hawke; and CSIRO's Chief Executive, Dr Keith Boardman.

of the antennas are being used it does two million million multiplications every second.

The full version of the Australia Telescope is obtained when the antennas of the compact array are used with two others — a 22-metre antenna near Coonabarabran, and the Parkes radiotelescope, both in central New South Wales. Linking in these other antennas helps to add extra detail to the Telescope's radio pictures.

The Telescope can also be linked with other antennas in Australia and overseas, and with the orbiting radiotelescopes scheduled for launch in the 1990s. When the orbiting telescopes are operating, such giant networks of antennas will mimic, in many respects, a radiotelescope larger than the earth.

The Australia Telescope is a national research facility operated by CSIRO. CSIRO's Division of Radiophysics was responsible for the planning research and development of the Australia Telescope and worked closely with many Australian companies during the project.

The major telescope contract, for the construction of the seven 22-metre antennas at a cost of $15 million, was awarded to Evans Deakin Industries. Other companies participating in the project included Macdonald Wagner, Austek Microsystems Pty Ltd, Barclay Brothers and Convex Limited.

The Australia Telescope's compact array of mobile antennas near Narrabri, New South Wales. This array can be linked to another antenna near Coonabarabran, and to the Parkes radiotelescope.

Awards

CSIRO Medals

The CSIRO Medals represent peer recognition of the contribution made by researchers to the nation's industrial development, or to the Australian community, through outstanding achievements in either basic or applied science. Each year three medals are awarded to CSIRO staff and one to scientific workers elsewhere in Australia. From this year the selection criteria for CSIRO staff have been expanded to recognize outstanding research leadership. This year's winners were:

- Dr Graeme Pearman, from the Division of Atmospheric Research, for his work in global atmospheric chemistry and the Greenhouse Effect;
- Dr Kenneth McCracken, from CSIRO's Office of Space Science and Applications (COSSA), for leadership in space activities in Australia and for achievement in geophysics research;
- Mr John Brooks, from the Division of Radiophysics, for leadership of the Australia Telescope team; and
- Mr Bill Charters, of the University of Melbourne, and Mr Len Taylor, of the Ballarat College of Advanced Education, for their development of the "Solar Plus" pump for heating water.

The Medals were presented by the Minister for Science, Customs and Small Business, the Hon. Barry Jones, at the first ever public CSIRO Medals ceremony, held at the State Library of New South Wales in December.

The 1988 winners of the CSIRO Medals are, from the left: Mr Len Taylor, Mr Bill Charters, Dr Kenneth McCracken, Dr Graeme Pearman, and Mr John Brooks.

Sir Ian McLennan Achievement for Industry Award

Dr Dieter Plate, from the Division of Wool Technology, received the 1988 Award for his work in developing the Sirospun technology. The Award was presented by the Governor of Victoria, Dr Davis McCaughey, at a well-publicised ceremony in November at the Victorian Arts Centre.

The Sirospun spinning technique produces worsted weaving yarn in a single step and offers major cost savings compared with the conventional two-fold yarn approach. Considered a break-through in fabric technology, the Sirosopun yarn resulted in an International Wool Secretariat (IWS) "Cool Wool" program promoting lightweight wools.

The Sirospun process was developed from Dr Plate's work by a consortium involving CSIRO, Repco and the IWS. Its world-wide commercialisation has led to a significant increase in demand for the finer Australian wools.

This Award was established by the former CSIRO Advisory Council in 1985 to recognise outstanding contributions by CSIRO scientists to Australian industry.

Winner of the 1988 Sir Ian McLennan Achievement for Industry Award, Dr Dieter Plate, from the Division of Wool Technology, receives his Award medal from the Governor of Victoria, Dr Davis McCaughey, AC.

Management, Corporate Services

Human Resources

Employee Relations

CSIRO is developing a comprehensive human resources strategy that emphasises flexible and innovative policies and optimises the contribution made by staff. The strategy is being jointly developed by CSIRO management and unions and a discussion paper will be considered by the CSIRO Board in November 1989.

The Organisation is also reviewing its policy of employing a percentage of its staff on limited tenure. The review is aimed at improving arrangements to attract, develop and retain key staff in the research and research support categories. In particular, the broadening of career opportunities for young scientists in CSIRO is being addressed.

The issue of staff tenure was listed in the Industrial Relations Commission in February, and CSIRO and the unions are developing arrangements under the guidelines of the Commission.

In May the Chairman, Mr Neville Wran, announced the introduction of a bonus scheme to provide research teams with a share of fees received from licence and royalty income generated from new technology.

The Organisation is implementing an employee participation plan — agreed to by both the Board and the Consultative Council — to involve staff in decisions that affect them.

In accordance with the award restructuring principles established by the Industrial Relations Commission, CSIRO is examining its awards and classification structures to develop options for streamlining.

Equal Employment Opportunity

A revised Equal Employment Opportunity (EEO) management plan was introduced with increased emphasis on developing local support networks for members of the four EEO target groups: women; Aborigines and Torres Strait Islanders; people with disabilities; and people from non-English-speaking backgrounds.

The EEO contact officer network has been strengthened, and currently CSIRO has about one contact person per hundred staff.

To further enhance the Organisation's capacity to attract and retain staff, work-based child-care centres will be established on three of CSIRO's major sites over the next three years.

Occupational Health and Safety

CSIRO now has a network of nine occupational health and safety (OHS) advisers at its major research sites following the appointment of seven full-time advisers in 1988–89. The central OHS group is concentrating on strategic issues, such as radiation and biological safety, as well as providing technical support and training for site OHS staff.

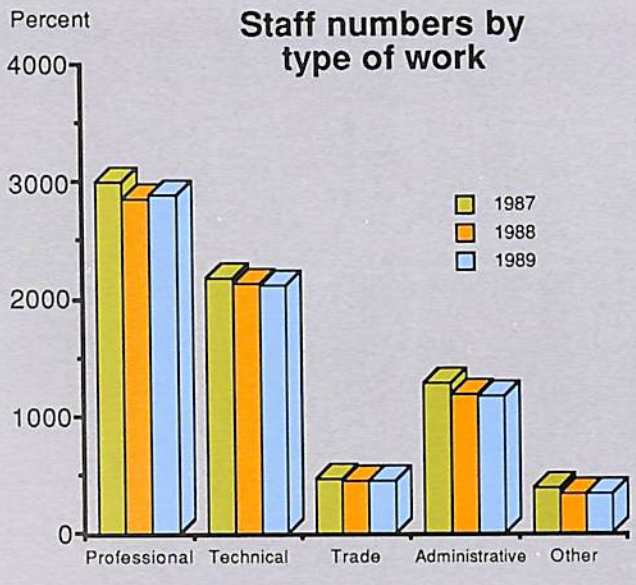
During the year, low-level radioactive contamination was discovered at a former CSIRO research site at Fishermens Bend in Melbourne. Projects involving extraction of radioactive compounds from uranium ores and monazite sands during the period 1940–1965 have resulted in areas of contaminated soils. Radiation safety authorities have advised CSIRO that the materials pose minimal environmental and health risks. CSIRO is now investigating the safe disposal of the materials and making arrangements for staff who worked on the site to receive health counselling and screening.

Employee Development

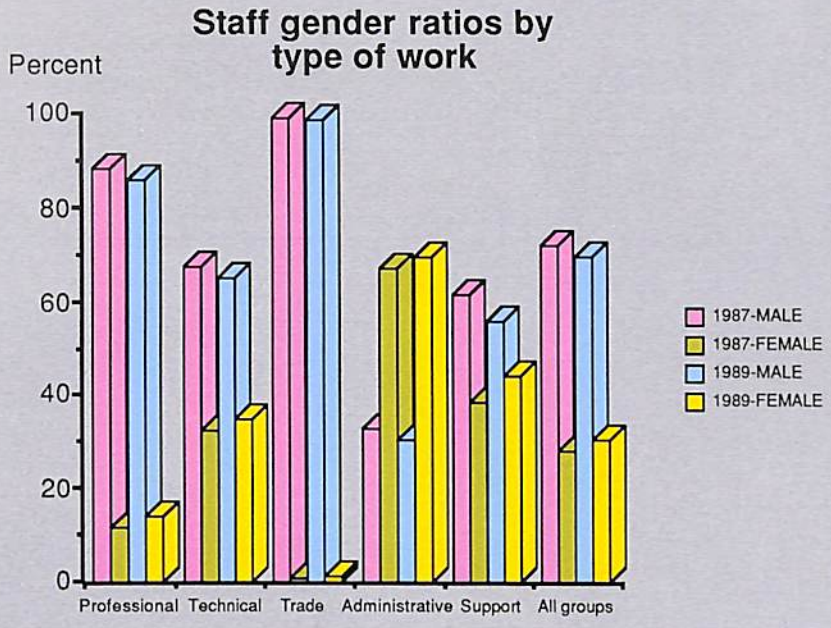
A comprehensive employee development strategy was introduced in October 1988. It is aimed at enhancing the research leadership and management skills of senior staff and also provides training in project management, marketing and commercialisation. In addition, the plan offers a broad range of skills training for all levels of staff.

Two research leadership courses and more than a dozen project management courses were held for individual Divisions and an Institute.

Currently a career-planning program is being developed to increase the pool of top management expertise available within the Organisation to meet medium and longer term requirements.



Overall staff numbers have declined by 352 (4·8%) since 1987. The 1988 reduction in professional staff was largely an outcome of the restructuring of Divisions, whilst that in administrative staff followed the review and streamlining of the corporate centre. The redirection of resources saved from the corporate centre review has made possible the employment of more professional staff in 1989.



The trend in figures shows that CSIRO's EEO policy is beginning to take effect in professional, technical and support groups.

Corporate Resources

Financial Systems and Services

Centralisation of the CSIRO payroll function to the corporate payroll office in Canberra has resulted in a more efficient processing of pays.

In 1988–89, the Organisation's banking and related treasury functions were reviewed and new procedures resulted in increased returns on invested funds.

A series of seminars aimed at increasing the skills and knowledge of staff managing funds for sponsored research was held during the past year. Subjects covered included funds administration, aspects of project management and relationships with funding bodies. Further sessions on broader financial topics are planned.

Property

A property management plan for the effective and economic use of CSIRO's real estate assets was endorsed by the CSIRO Board.

Rationalisation of CSIRO properties has resulted in the sale of 14 properties for a total of $6·3 million.

Acquisitions of property included the former National Building Technology Centre at North Ryde in Sydney, a developed site adjacent to the Tropical Ecosystems Research Centre property in Darwin, and a house in Narrabri, New South Wales.

Work continued on major building projects at the Division of Chemicals and Polymers in Clayton, Victoria ($14·0 million) and at the Floreat Park site in Western Australia ($11·0 million).

Smaller building projects, including the visitors' accommodation centre in Darwin and the Division of Entomology's Glasshouse Services Facility in Canberra, were completed during the year.

The proposed North Ryde Stage 1 Redevelopment ($21·0 million) in New South Wales was approved by the Parliamentary Public Works Committee subject to funding.

Information and Library Services

The Print Advisory Unit handled $0·6 million of print contracting for CSIRO during the year, as well as conducting seminars and Divisional visits to advise staff on contracting work to external printers.

The Film and Video Centre's 8-part TV series "The Good Food Show" was screened by the ABC, and the Centre has released the first 5 of 30 "Researchers" clips to be shown on TV channels throughout Australia.

External earnings for the Information Services Unit were $2·2 million, with sales of books and journals grossing $1·4 million. Eighty-nine journal issues and 23 books were published.

An automatic, national, CSIRO telephone information service, called Sirodial, was installed to handle the questions most often asked by the general public. Topics covered include the environment, insects and home maintenance.

CSIRO is automating much of its library service and has introduced an internal on-line acquisition system.

Corporate Legal Service

The injunction restraining CSIRO from proceeding with its program to control the declared noxious weed Paterson's curse was dissolved by the Supreme Court of South Australia in November 1988. CSIRO has resumed the program in collaboration with state authorities.

The growing commercial orientation of CSIRO is increasing the demand for legal services throughout the Organisation. The corporate legal service, in collaboration with Sirotech, is providing education in basic legal principles for CSIRO staff and is helping Divisions to handle straightforward matters.

Siromath Pty Ltd, the mathematical consultancy originally formed by CSIRO, was restructured in May 1989 to include Steedman Ltd as a substantial shareholder and manager of the business.

Management Information Systems

Information sysems have continued to be used as an agent for change in operational practices. Local administrative systems installed Australia-wide, and systems changes centralising the payroll functions,

have produced recurrent savings of about $7·5 million per annum through the closure of the regional administrative offices.

The introduction of an organisational research data base now provides the focal point for integration of text and resource information from all systems.

This year saw the commencement of a significant step forward in providing a flexible machine — independent software environment; the full implementation of the Systems Network Architecture backbone; and considerable changes to the mainframe computing environment.

To provide support and education for users of new systems, user-support offices have been established in each state.

Centre for International Research Cooperation

During the year CIRC managed training placements for over 60 overseas scientists and technicians in CSIRO and other Australian scientific laboratories, and also implemented two training programs for managers from the China National Non-Ferrous Metals Industry Corporation.

A contract has been negotiated with the Food and Agriculture Organisation (FAO) of the United Nations for CIRC to manage the placement of all FAO Fellows in Australia.

CIRC is also managing Australian input into a Kenyan forestry project sponsored by the Japanese International Cooperation Agency.

Through the government's treaty-level Australia—Saudi Arabia Agreement on Trade and Technical Cooperation, collaborative projects, particularly in the fields of food processing and animal health, are being developed between CSIRO and Saudi Arabian institutions.

CIRC has helped CSIRO Divisions assume responsibility for the management of international consultancies and projects. Marketing of CSIRO's international consulting capabilities has been transferred from CIRC to CSIRO International Consulting, an arm of Sirotech.

Consultative Council

The Consultative Council is the central forum for consultation between management and staff in CSIRO. Composed of eight senior management representatives and an equal number of representatives from staff associations, it formally meets in April and October each year with ongoing work carried out by its various subcommittees.

Under Section 56(2) of the *Science and Industry Research Act* 1949, the Council has a duty to consider and report to the Board on any matter affecting, or of general interest to, staff of CSIRO, including any matter referred to it by the Board.

Currently the Council has subcommittees dealing with personnel policy and conditions, industrial democracy, equal employment, employee development and a human resource strategy for CSIRO. It is chaired by CSIRO's Chief Executive and its deputy chairperson is the general secretary of the CSIRO Technical Association.

The main issues considered in the past year included: the development of an industrial participation plan for CSIRO; guidelines for managing unsatisfactory performance; the establishment of child-care centres for major CSIRO sites; and training initiatives for staff.

The need for improved communication within the Organisation was also discussed and the Council made several recommendations aimed at improving communication throughout CSIRO.

Following concern over budget cuts, the Council passed a number of motions at its October 1988 meeting that called for greater recognition to be given to the contribution made by CSIRO to Australia's economic and social prosperity.

The Council urged the Government to establish a science and technology committee and to establish avenues for input and feedback on government science and technology policy by the scientific community. In March 1989 the Minister for Industry, Technology and Commerce, Senator Button, accepted the Council's invitation to address a staff meeting in Melbourne on the prospects for CSIRO and its staff.

Fellows of the Food and Agricultural Organisation of the United Nations from Indonesia, the Philippines and Tanzania studied forest fire control in Australia during a two month visit organised by the Centre for International Research Cooperation.

Face painting at CSIRO's ACT Open Days

Community and Education

Open Days

CSIRO held two "Open Day" events and the official opening of a major laboratory as part of its policy of promoting its research work to the general public and taking science into the community.

About 9,000 people visited CSIRO's major site at North Ryde, in Sydney, when for the first time in its history all the CSIRO Divisions located at the site opened their doors to the public on 26 and 27 November, 1988.

A broad range of research work was exhibited by the Divisions of Biotechnology; Building, Construction and Engineering; Coal Technology; Exploration Geoscience; and Food Processing. The Wheat Research Unit in the Division of Plant Industry and the Institute of Information and Communications Technologies also participated in the Open Days.

On 17 and 18 September, 1988, CSIRO Divisions located in the Australian Capital Territory combined to host CSIRO Open Days for about 4,000 visitors.

On show was the world's largest collection of Australian insects, held by the Division of Entomology, a display of Australia's unique wildlife, preserved in the Division of Wildlife and Ecology's Australian National Wildlife Collection, and a display on how to save life and property from bushfires, put on by the Division of Forestry and Forest Products.

Other participants in the ACT Open Days were the Divisions of Plant Industry, Mathematics and Statistics, Soils, and Water Resources, the CSIRO Office of Space Science and Applications and the Centre for Environmental Mechanics.

The Premier of Western Australia, Mr Peter Dowding, officially opened the new Floreat Park rural research laboratories in Perth on 8 December 1988. To mark the occasion, displays were mounted by laboratories in the following Divisions: Plant Industry; Forestry and Forest Products; Entomology; Animal Production; Mineral Products; and Exploration Geoscience.

CSIRO Education Programs

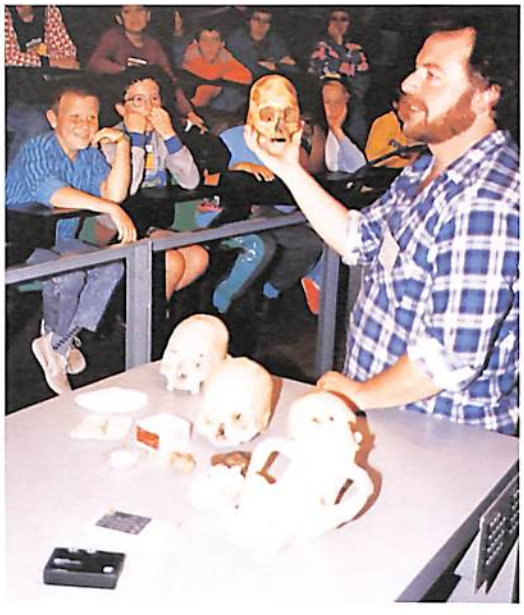
CSIRO's Double Helix Science Club doubled its national membership in the past year to 5,000.

The club's rapid expansion was made possible by two sponsorships: $100,000 per annum for two years from the BHP Company Limited, and $125,000 per annum for two years from the Commonwealth Department of Employment, Education and Training.

The club has a weekly segment on Channel 9's national children's television show "C'mon Kids" and organises events such as excursions, talks and science activity sessions.

The Helix, the club's quarterly magazine, now includes contributions from a number of professional science bodies, such as the Royal Australian Chemical Institute, and is distributed to all members of the Australian Science Teachers' Association and every secondary school in Australia.

The national network of seven CSIRO Science Education Centres will soon be realised, with the Brisbane, Darwin and Perth Centres due to open in late 1989.



Double Helix Club members in Canberra attended a lively presentation on the importance of fossils, where they are found and how they are formed.

The existing centres in Adelaide, Hobart, Melbourne and Sydney, which are always fully booked, are showing science in action to over 25,000 students and teachers each year. Visitors undertake experiments that show how CSIRO research is being used in the community as well as the science behind many commercial products and processes.

CSIRO's Women in Science project encourages girls to continue with science and mathematics at senior secondary level. The project received funding from the Commonwealth Government's Curriculum Development Centre in 1988 to upgrade the written material supporting the CSIRO video program "Women in Science". The video is shown in schools prior to talks by women scientists and technicians.

This year CSIRO has jointly organised the new BHP Science Awards, which will provide rewards for students undertaking scientific investigations as well as offering substantial prizes for outstanding science teachers.

CSIRO's Student Research Scheme in Canberra allowed each of 49 senior secondary students to undertake a research project under the supervision of a practising scientist. This year's scheme was sponsored by the ACT Administration's Office of Industry and Development, which donated $10,000.

The CSIRO Visitors' Centre at the Parkes radiotelescope site attracted over 85,000 visitors this year. The centre provides information about the Australia Telescope, astronomy and the work of CSIRO as well as offering an audiovisual show on these topics.

Sirotech

Sirotech

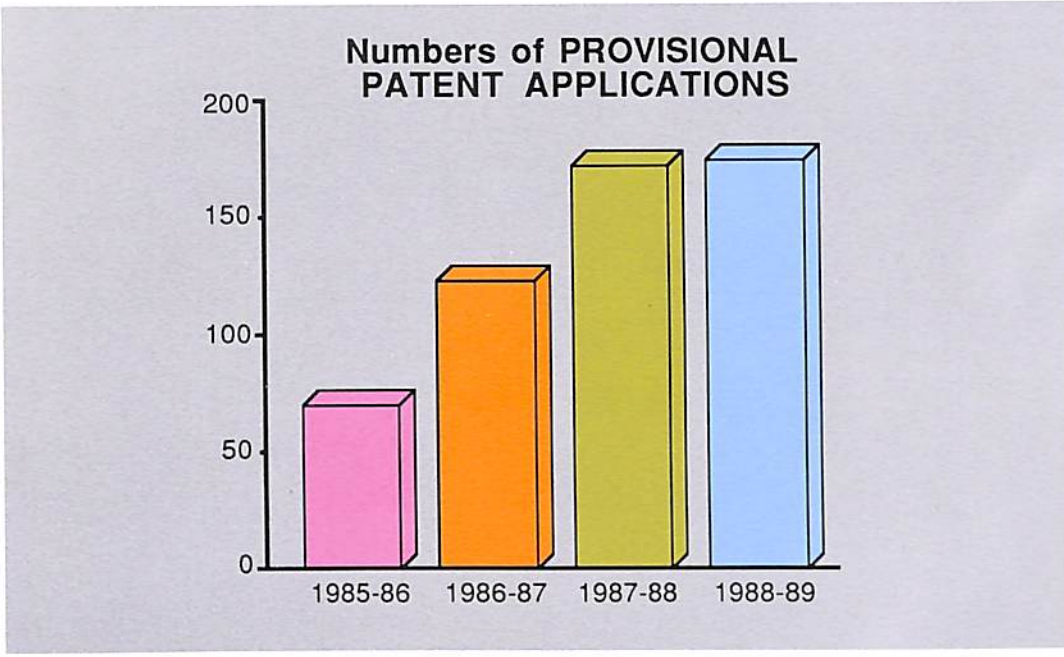
Sirotech Limited was established in 1984 as a wholly owned subsidiary of CSIRO to assist in transferring CSIRO technology to Australian industry. Since that time the company has established a strong expertise in the field of technology transfer as well as in managing CSIRO's patent portfolio.

During 1988-89 Sirotech implemented the recommendations of an earlier external review. It underwent a restructuring that enhanced links with CSIRO through the addition of two Institute Directors to the Sirotech Board. Contact between Sirotech marketing and the six CSIRO Institutes was improved by assigning Sirotech project leaders to support specific Institutes.

Sirotech has assisted CSIRO in the following major commercialisation projects:

- consolidation of the Preston group, the spin-off company formed in a joint venture between CSIRO and Advent Western Pacific. The company has just completed an extensive simulation system for the Sugar Research Institute and is on track with the development and installation of a major rule-based crew scheduling system for Qantas Airways Limited;
- collaborative research agreements to develop diagnostic testing for human and animal disease management; a program for the breeding and introduction of a new tropical cattle breed with enhanced beef production and a strong resistance to disease; and new products and processes for the mining industry;
- licensing agreements to install the Sirocurd cheese-making process in the United States for the first time; to market in the United States and Europe the Auspig software modelling package for the nutritional management of intensive pig production; to manufacture in Australia a device to provide real-time, coloured, scanning electron microscope images.

A new international consulting venture managed within Sirotech, called CSIRO International Consulting, has been established to promote the



involvement of CSIRO in international consulting projects. Already CSIRO has been engaged by the World Bank to help in the preparation of a forestry project in Zimbabwe, and has secured a contract as a key contributor to an AIDAB-funded remote sensing project in the Philippines. The value of these projects will be about $400,000.

Provisional patent filings, to provide patent protection for CSIRO developments with commercial potential, totalled 174 in 1988–89, compared with 172 in the previous financial year, and 123 the year before.

Charter, Structure and Management

Charter

CSIRO, an independent statutory authority, operates under the provisions of the *Science and Industry Research Act* 1949. Mr Barry Jones, Minister for Science, Customs and Small Business, and Minister Assisting the Prime Minister for Science and Technology, was the Minister responsible for CSIRO throughout the reporting year.

Structure

CSIRO's current structure was established by the *Science and Industry Research Amendment Act* 1986. This established a 10-member Board responsible for determining policy and ensuring the efficient functioning of CSIRO. The Chief Executive, who is a member of the Board, is responsible for the Organisation's activities.

Research is performed in 34 Divisions and research units, grouped into six Institutes. A Corporate Centre provides central services to support managers and staff in the development and implementation of policies and to provide services such as payrolling that are best performed at the corporate level.

Divisions and Institutes are located all over Australia, with many Divisions having more than one site. CSIRO also maintains a small number of field stations overseas, mainly concerned with biological studies that could benefit Australia.

Management and Staff

The Chief Executive, the six Institute Directors and the Director of Corporate Services form the Executive Committee, which assists the Chief Executive in managing the activities of the Organisation.

Each Institute has its own management committee, which consists of the Director and Divisional Chiefs. The Institute Committee provides a forum for setting the strategic direction for the Institute and assisting in the formulation and implementation of Corporate and Institute policies for research and management.

CSIRO staff are employed under Section 32 of the *Science and Industry Research Act* 1949. At 30 June 1989 CSIRO had a total staff of 6,995. Names of senior staff are shown opposite.

Senior Staff

Senior Staff as at July 1 1989

CORPORATE CENTRE

Limestone Avenue Campbell ACT 2601
Tel: (062) 48 4211

Chief Executive
Dr N.K. Boardman

Director, Corporate Services
Mr P.H. Langhorne

Principal Secretary
Dr T.E. Heyde

Corporate Planner
Dr D. MacRae

Manager, Public Affairs
Mr L.R. Bevege (Acting)

INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGIES

Director: Dr R. H. Frater
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8220

Divisions and Chiefs

Information Technology
Chief: Dr J.F. O'Callaghan
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NORTH RYDE NSW 2113
Tel: (02) 887 9326

Mathematics and Statistics
Chief: Dr R.L. Sandland
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8103

Radiophysics
Chief: Dr D.N. Cooper
Cnr Vimiera and Pembroke Roads
MARSFIELD NSW 2112
Tel: (02) 868 0210

The Australia Telescope—National Facility
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Cnr Vimiera and Pembroke Roads
MARSFIELD NSW 2112
Tel: (02) 868 0222

CSIRO Office of Space Science and Applications (COSSA)

Director: Dr G.P. Harris
First Floor Industry House National Circuit
BARTON ACT 2600
Tel: (062) 70 1800

INSTITUTE OF INDUSTRIAL TECHNOLOGIES

Director: Dr C.M. Adam
Normanby Road
CLAYTON VIC 3168
Tel: (03) 542 2897

Divisions and Chiefs

Applied Physics
Chief: Dr W.R. Blevin
Bradfield Road
LINDFIELD NSW 2070
Tel: (02) 413 7211

Biotechnology
Chief: Dr M.J. Sleigh (Acting)
103 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 886 4888

Chemicals and Polymers
Chief: Dr T.H. Spurling
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 542 2244

Manufacturing Technology
Chief: Dr R.H. Brown
Cnr Raglan and Albert Streets
PRESTON VIC 3072
Tel: (03) 487 9211

Materials Science and Technology
Chief: Dr M.J. Murray (Acting)
Normanby Road
CLAYTON VIC 3168
Tel: (03) 542 2777

INSTITUTE OF MINERALS, ENERGY AND CONSTRUCTION

Director: Dr A. F. Reid
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8222

Divisions and Chiefs

Building, Construction and Engineering
Chief: Dr D.C. Gibson
Graham Road
HIGHETT VIC 3190
Tel: (03) 556 2211

Coal Technology
Chief: Prof. L.S. Leung
51 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8666

Exploration Geoscience
Chief: Dr B. J.J. Embleton
Underwood Avenue
FLOREAT PARK WA 6014
Tel: (09) 387 0200

Fuel Technology
Chief: Dr P.G. Alfredson
New Illawarra Road
LUCAS HEIGHTS NSW 2234
Tel: (02) 543 3111

Geomechanics
Chief: Dr B.E. Hobbs
Kinnoul Grove
SYNDAL VIC 3149
Tel: (03) 235 1355

Mineral and Process Engineering
Chief: Dr R. La Nauze
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 541 1222

Mineral Products
Chief: Dr T. Biegler
339 Williamstown Road
PORT MELBOURNE VIC 3207
Tel: (03) 647 0211

INSTITUTE OF ANIMAL PRODUCTION AND PROCESSING

Director: Dr A.D. Donald
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8222

Divisions and Chiefs

Animal Health
Chief: Dr M. Rickard
Cnr Flemington Road and Park Drive
PARKVILLE VIC 3052
Tel: (03) 342 9700

Animal Production
Chief: Dr O. Mayo
Great Western Highway
PROSPECT NSW 2149
Tel: (02) 631 8022

Food Processing
Chief: Dr D.J. Walker
39–51 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8333

Human Nutrition
Chief: Dr P.J. Nestel
Kintore Avenue
ADELAIDE SA 5000
Tel: (08) 224 1800

Tropical Animal Production
Chief: Dr D.F. Mahoney
Meiers Road
INDOOROOPILLY QLD 4068
Tel: (07) 377 0711

Wool Technology
Chief: Dr K.J. Whiteley
Princes Highway
BELMONT VIC 3216
Tel: (052) 47 2611

INSTITUTE OF PLANT PRODUCTION AND PROCESSING

Director: Dr E.F. Henzell
Limestone Avenue
CAMPBELL ACT 2601
Tel: (062) 48 4613

Divisions and Chiefs

Entomology

Chief: Dr M.J. Whitten
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (062) 46 4911

Forestry and Forest Products

Chief: Dr W. Hewertson
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 542 2244

Horticulture

Chief: Dr J.V. Possingham
Hartley Grove
URRBRAE SA 5064
Tel: (08) 274 9244

Plant Industry

Chief: Dr W.J. Peacock
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (062) 46 4911

Soils

Chief: Dr D.E. Smiles
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (062) 46 4911

Tropical Crops and Pastures

Chief: Dr R.J. Clements
306 Carmody Road
ST LUCIA QLD 4067
Tel: (07) 377 0209

INSTITUTE OF NATURAL RESOURCES AND ENVIRONMENT

Director: Dr R.M. Green
Limestone Avenue
CAMPBELL ACT 2601
Tel: (062) 48 4614

Divisions and Chiefs

Atmospheric Research

Chief: Dr G.B. Tucker
Station Street
ASPENDALE VIC 3195
Tel: (03) 586 7666

Fisheries

Chief: Dr F.R. Harden Jones
Castray Esplanade
HOBART TAS 7000
Tel: (002) 20 6222

Oceanography

Chief: Dr A.D. McEwan
Castray Esplanade
HOBART TAS 7000
Tel: (002) 20 6222

Water Resources

Chief: Dr G.B. Allison
Underwood Avenue
FLOREAT PARK WA 6014
Tel: (09) 387 0200

Wildlife and Ecology

Chief: Dr B.H. Walker
'Gungahlin' Barton Highway
CANBERRA ACT 2600
Tel: (062) 42 1600

Centre for Environmental Mechanics

Chief: Dr J.R. Philip
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (062) 46 4911

Reporting, SIEF

The *Science and Industry Research Act* 1949 (referred to below as 'the *Act*') and the *Audit Act* 1901 require the CSIRO Annual Report to include a general account of the operations of the Organisation and:

- a statement of the policies of the Organisation in relation to the carrying out of the scientific research of the Organisation that were current at the beginning of the year, together with a description of any developments in those policies that occurred during the year (see pages 1–8 and 12–18);
- any determinations made by the Minister under sub-paragraph 9(1)(a)(iv) of the *Act* during the year;
- any directions or guidelines given by the Minister under section 13 of the *Act* during the year;
- any policies notified by the Minister under section 14 of the *Act* during the year;
- financial statements for the reporting year in a form approved by the Minister for Finance (see pages 61–76);
- the Auditor-General's report on these statements (see page 60).

The Minister made no determinations, gave no directions or guidelines, and notified no policies under the *Act* during the year.

Science and Industry Endowment Fund

In 1988–89, 10 grants totalling $18,400 were provided from this Fund, which was established under the *Science and Industry Endowment Act* of 1926. Recipients of the 1988 grants ranged from retired professional scientists through amateur naturalists to school science associations. This was in keeping with the intention of the *Act* to promote interest in scientific and industrial research and to provide support to worthy individuals who have no institutional support.

The Science Grants come from the annual return on the 100,000 pounds Australian originally allocated to the Fund by the *Act*.

The Chief Executive of CSIRO is Trustee of the Science and Industry Endowment Fund.

Freedom of Information

Freedom of Information

The following information is presented in accordance with the requirements of section 8 of the *Freedom of Information Act*.

The *Freedom of Information Act* gives a right of access to the general public to documents held in CSIRO.

In the year to 30 June 1989, CSIRO received 16 requests under the *Act*. Of these, 5 requests were granted in full, 3 were granted in part and 8 were withdrawn or, by agreement with the requester, treated outside the provisions of the *Act*.

Categories of Documents

CSIRO holds documents under the following headings:

Financial Management and Administration
Buildings and Property
Personnel and Industrial Relations
Scientific and Industrial Research

The following CSIRO documents are customarily made available to the public free of charge: policy circulars; information circulars; staff circulars; CoResearch (staff newspaper); film catalogue; list of saleable publications; information service leaflets issued by Divisions on a wide range of technical subjects attracting frequent enquiries from the general public; conditions of CSIRO postdoctoral awards; press releases, information on careers in CSIRO and school project material; and Industrial Research News.

Archives and Disposal Arrangements for Documents

CSIRO maintains an extensive archives collection dating from the establishment in 1916 of the Advisory Council for Science and Industry, the original predecessor of CSIRO.

Apart from official files, documents held include personal and scientific material, large quantities of scientific data (including much on magnetic tape) and many maps and photographs.

CSIRO archives are managed by professional archivists and the main collection is housed in Canberra. Limited use has been made of the Australian Archives for the storage of records of a routine administrative nature.

CSIRO encourages the use of its archives and provides access in accordance with the provisions of the *Archives Act* 1983.

Facilities for Access

Arrangements can be made for documents that are the subject of FOI requests to be made available for inspection at the CSIRO office nearest to the address of the applicant. Help will be given to people with disabilities in entering and leaving CSIRO premises if prior arrangements are made.

FOI Procedures and Initial Contact Points

A central Freedom of Information coordinator is responsible for the receipt of requests, referring these to senior officers for decision and granting access to the documents. Initial enquiries should be made to:

FOI Coordinator
CSIRO
Limestone Avenue
CAMPBELL ACT 2601
or PO Box 225
DICKSON ACT 2602

Tel: (062) 48 4123

In accordance with the *Freedom of Information Act*, formal requests to CSIRO should be posted to:

The Chief Executive
CSIRO
PO Box 225
DICKSON ACT 2602

Finance

CSIRO's audited financial statements for the year, which have been prepared on an accrual basis, are presented on the following pages.

Expenditure by CSIRO of funds under its control totalled about $466m in 1989.

Of this amount, $348m (75%) came from funds appropriated directly to CSIRO by Parliament. Another $99m (21%) came from funds provided by industry and other contributors. The remaining $19m (4%) came from revenue earned by the Organisation, unspent funds from 1988 and receipts from the Department of Primary Industries and Energy for its half-share of the operation of the Australian Animal Health Laboratory.

The year's expenditure from appropriation and revenue funds for salaries and general running expenses was $435m.

Executive Office of the
Auditor-General

Australian Audit Office
G.P.O. Box 707
Canberra, A.C.T. 2601

20 October 1989
The Honourable the Minister for
Science, Customs and Small Business
Parliament House
CANBERRA ACT 2600

Dear Minister

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
AUDIT REPORT ON FINANCIAL STATEMENTS

Section 51 of the *Science and Industry Research Act* 1949 declares the Commonwealth Scientific and Industrial Research Organisation to be a public authority to which Division 3 of Part XI of the *Audit Act* 1901 applies. Pursuant to sub-section 63M(2) of the *Audit Act*, the Commonwealth Scientific and Industrial Research Organisation has submitted for my report its financial statements for the year ended 30 June 1989. These comprise:

- statement of activity
- statement of capital accumulation
- statement of assets and liabilities
- statement of sources and applications of funds, and
- notes to and forming part of the financial statements.

The statements have been prepared in accordance with the policies outlined in Note 1 to the Accounts and are in accordance with the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings approved by the Minister for Finance. The statements are in the form approved by the Minister for Finance pursuant to sub-section 63M(1) of the *Audit Act*. A copy of the financial statements is enclosed for your information.

These statements have been audited in conformance with the Australian Audit Office Auditing Standards.

In accordance with sub-section 63M(2) of the *Audit Act*, I now report that the statements are in agreement with the accounts and records of the Organisation and, in my opinion:

- the statements are based on proper accounts and records, and
- the receipt, expenditure and investment of moneys and the acquisition and disposal of assets by the Organisation during the year have been in accordance with the *Science and Industry Research Act* 1949.

Yours sincerely

Australian Audit Office

P. A. Farrelly

P.A. Farrelly
Acting First Assistant Auditor-General

Commonwealth Scientific and Industrial Research Organisation
Statement of Activity for the Year ended 30 June 1989

	Notes	1989 $'000	1988 $'000
Revenue			
Parliamentary appropriations		347 855	347 641
Transfers to capital accumulation		38 542	40 929
		309 313	306 712
Other revenue	2	18 465	31 569
Grants and contributions		99 426	71 507
Transfers to capital accumulation		8 309	5 024
		91 117	66 483
Total Revenue		**418 895**	**404 764**
Expenses	3		
Research Programs			
Animal Production & Processing		90 355	80 092
Industrial Technologies		56 764	53 322
Information & Communications Technologies		20 991	20 788
Minerals, Energy & Construction		69 580	59 155
Natural Resources & Environment		52 960	49 394
Plant Production & Processing		86 392	82 447
Research Support		49 300	53 275
National Facilities		8 948	4 934
Total expenses		**435 290**	**403 407**
Surplus (Deficiency) of revenue over expenses before provisions, unfunded charges, and abnormal items		**(16 395)**	**1 357**
Provisions and unfunded charges	4	**31 456**	**30 684**
		(47 851)	**(29 327)**
Abnormal items	5	**(9 370)**	**3 698**
Deficiency— transferred to Statement of Capital Accumulation		**(57 221)**	**(25 629)**

The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Statement of Capital Accumulation for the Year ended 30 June 1989

	Notes	1989 $'000	1988 $'000
Balance as at 1 July 1988		**630 110**	**609 786**
Transfer from Statement of Activity for capital appropriation		38 542	40 929
Capital receipts from grants and contributions		8 309	5 024
		676 961	**655 739**
Deficiency transferred from Statement of Activity		**(57 221)**	**(25 629)**
Balance as at 30 June 1989 transferred to Statement of Assets and Liabilities		**619 740**	**630 110**

The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Statement of Assets and Liabilities as at 30 June 1989

	Notes	1989 $'000	1988 $'000
Capital accumulation from Statement of Capital Accumulation		**619 740**	**630 110**
represented by			
Current assets			
Cash at bank and on hand		38 195	38 122
Short-term deposits		1 199	—
Debtors	6	1 209	16 629
Prepayments		4 036	3 546
		44 639	58 297
Non-current assets			
Land, buildings and leasehold improvements	7	543 897	554 034
Other non-current assets	8	173 832	166 970
Investments	9	1 916	3 596
		719 645	724 600
Total assets		**764 284**	**782 897**
Current liabilities			
Accrued expenses		7 161	5 496
Creditors		11 990	19 325
Grants and revenue received in advance	1.14	31 784	35 535
Provision for recreation leave	1.5	28 457	28 801
Provision for long-service leave	1.5	7 049	7 344
Provision for workers compensation	1.6	—	1 000
		86 441	97 501
Non-current liabilities			
Provision for long-service leave	1.5	51 694	53 857
Provision for superannuation benefit	1.7	6 409	1 429
		58 103	55 286
Total liabilities		**144 544**	**152 787**
Net assets		**619 740**	**630 110**

The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Statement of Sources and Applications of Funds for the Year ended 30 June 1989

	1989 $'000	1988 $'000
Sources of Funds		
Funds from Operations (see note)		
Inflow of funds from operations		
Sales revenue	3 697	15 329
Other revenue		
Proceeds from sale of fixed assets and CSIRONET operations	11 106	16 381
Grants and contributions	99 426	71 507
Miscellaneous revenues	11 495	12 681
Funds from Government		
Parliamentary appropriations — Recurrent	324 943	317 856
	450 667	433 754
Outflow of funds from operations — expended in the provision of goods and services	443 123	417 140
	7 544	16 614
Funds from Government		
Parliamentary appropriations — Capital works	22 912	29 785
Reduction in assets		
Current assets		
Short term deposits	—	21 350
Consumable stores	—	57
Debtors	15 420	—
	15 420	21 407
Non-current assets		
Land, buildings and leasehold improvements	3 457	3 136
Other non-current assets	2 062	6 387
Investments	2 520	—
	8 039	9 523
Increase in liabilities		
Current liabilities		
Accrued expenses	1 665	1 056
Creditors	—	4 509
Grants and revenue received in advance	—	14 282
	1 665	19 847
TOTAL SOURCES OF FUNDS	**55 580**	**97 176**

	1989 $'000	1988 $'000
Applications of funds		
Increase in assets		
Current assets		
Cash at bank and on hand	73	29 047
Short term deposits	1 199	—
Debtors	—	9 966
Prepayments	490	116
	1 762	39 129
Non-current assets		
Land, buildings and leasehold improvements	6 346	23 198
Other non-current assets	35 546	32 184
Investments	840	2 665
	42 732	58 047
Decrease in liabilities		
Current liabilities		
Creditors	7 335	—
Grants and revenue received in advance	3 751	—
	11 086	—
TOTAL APPLICATIONS OF FUNDS	**55 580**	**97 176**
Note:		
Reconciliation of operating result with funds from operations:		
Surplus (Deficiency) of revenue over expenses before provisions, unfunded charges and abnormal items	(16 395)	1 357
plus:		
Transfers to capital accumulation	46 851	45 953
Proceeds from sale of fixed assets and CSIRONET operations	11 106	16 381
Loss on disposal of fixed assets	206	729
	58 163	63 063
less:		
Parliamentary appropriation for capital works	22 912	29 785
Profit from sale of fixed assets and CSIRONET operations	3 273	3 559
Disposal of fixed assets and CSIRONET operations	8 039	14 462
	34 224	47 806
Funds from operations	**7 544**	**16 614**

The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Notes to and Forming Part of the Financial Statements

Note 1 Summary of Significant Accounting Policies

1.1 General

Except where stated, the financial statements have been prepared in accordance with the historical cost convention, the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings, issued by the Minister for Finance, and the Australian Accounting Standards. The form of the financial statements has been approved by the Minister.

1.2 Fixed Assets

Except where stated, all fixed assets are valued at historical cost. This year CSIRO has increased the capitalisation threshold limit of other fixed assets from $1000 to $3000. Assets costing less than the threshold limit of $3000 are expensed or written off. This change in accounting policy has had the effect of increasing this year's deficiency by approximately $14 894 938 (Note 5).

The valuation of buildings and leasehold improvements was performed by the Department of Housing and Construction and CSIRO officers as at 30 June 1986. Building valuation includes plant, fixtures and fittings which form an integral part of the building.

Land has been valued by CSIRO's registered valuer as at 30 June 1986.

Computer software, scientific glassware, experimental prototype equipment, and library monographs and serials are not capitalised as fixed assets owing to either their uncertain useful lives or the uncertainty of benefits to be derived from their development.

Assets totalling $8 739 179 (1988, $4 811 474) which are purchased from Specific Research Funds and where the sale proceeds are refunded to the grantor under the terms of the grant agreement, have been expensed during the year of purchase. Separate records for these assets have been maintained and are disclosed in Note 12.

1.3 Depreciation and amortisation

Depreciation on fixed assets, except land and leasehold improvements, is calculated on a straight line basis, so as to write off their cost or valuation less estimated residual value progressively over their estimated useful lives.

The valuation or cost of leasehold improvements is amortised over the unexpired period of the leases or their estimated useful lives, whichever is the shorter.

1.4 Consumable Stores

Stocks of consumable stores mainly consist of fuel and lubricants, chemical supplies, maintenance materials and stationery. They are not material in terms of total expenditure or total assets and are expensed during the year of purchase.

1.5 Employee benefits

Provisions for recreation and long service leave are calculated by multiplying the leave entitlements of employees by their current pay rates. In prior years probability factors were applied to employees with less than ten years service to calculate provision for long service leave. However, as from this year, CSIRO has adopted a policy of providing for long service leave to those employees with more than five years service. This change in policy has had the effect of reducing the total provision for long service leave by $4 975 000.

1.6 Workers Compensation

COMCARE assumed responsibility for CSIRO's workers compensation liability from 1 December 1988.

1.7 Superannuation

CSIRO is an approved authority for the purposes of the *Superannuation Act* 1976 and is required to meet the employer's share of the cost of benefits payable pursuant to that *Act* to eligible employees. CSIRO discharges this liability by periodic payments to the Commonwealth of amounts, expressed as a percentage of the salaries of eligible employees, estimated by the Commonwealth to be sufficient to meet CSIRO's share of the full accruing cost, both of pensions granted on the retirement or death of such employees and any subsequent pension increases.

An actuarial review was performed as at 30 June 1986 and the rate of 15·4% was recommended by the actuary as sufficient to meet the cost of of benefits accruing in respect of future service, allowing for new entrants. This rate became effective as from 1 July 1987.

The amount of employer contributions paid in respect of 1989 was $28 555 396 (1988, $27 879 514) and this represents 15·4% of superannuable salaries.

The Australian Government agreed to a 3% additional superannuation benefit for eligible employees with 1·5% commencing on 1 January 1988 and the balance no later than 1 January 1989. This arrangement is separate from the Commonwealth Superannuation Scheme. CSIRO is required to finance benefit payments as they fall due. An amount of $6 409 561 (1988, $1 428 958) has been provided for the period 1 January 1988 to 30 June 1989 as a provision for eligible employees.

1.8 Investments

Interest in companies (including associated companies) other than SIROTECH Ltd (Note 10) are shown as investments at cost or Board Members' valuation (Note 9). Associated companies are companies in which CSIRO exercises significant influence by holding shares and participating in financial and operating policies.

1.9 Research and Development

Research and development costs are expensed as incurred, except where benefits are expected, beyond any reasonable doubt, to equal or exceed those costs.

1.10 Reporting by Segments

CSIRO principally operates in the field of scientific and industrial research and development in Australia. It is therefore considered that for segment reporting, it operates in one industry and one geographical location.

1.11 Finance and Operating Leases

CSIRO has elected not to account and disclose finance and operating leases because the amount involved is not material. This is in accordance with the Australian Accounting Standard AAS 17 "Accounting for Leases" (Paragraph 23).

1.12 Sponsored Research

CSIRO has entered into various collaborative agreements with external parties for the research and development of technologies, products and scientific know-how. Details of the ownership of intellectual properties vary from agreement to agreement. These agreements do not involve sharing in common of liabilities and interests in assets, other than assets represented by intellectual properties to which CSIRO does not attribute any value in the accounts.

All costs incurred on research and development under the terms of the agreement have been expensed in accordance with Note 1.9 above.

Where CSIRO receives licensing fees and/or royalties from sale of products or technologies developed under the collaborative agreements, these have been bought to account when earned.

1.13 Insurance

CSIRO carries its own risk, with the exception of the insurance on the Oceanographic Research Vessel *Franklin*, Fisheries Research Vessel *Southern Surveyor* and certain passenger vehicles.

1.14 Grants and Contributions

Grants received in advance represent unearned revenue. The balance includes amounts which may subsequently be refunded to contributors. Specific research debtors represent revenue earned not yet received by CSIRO.

This year offsets have been made for grants received in advance and specific research debtors. The net balance is disclosed as grants received in advance.

1.15 Comparative Figures

Where applicable, prior year comparative figures have been restated to reflect the current year's format of financial statements.

Note 2 Other Revenue

	1989 $'000	1988 $'000
CSIRONET computing services	—	2 500
Department of Primary Industries and Energy contribution to the cost of the Australian Animal Health Laboratory	4 677	4 622
Interest	3 703	4 578
Royalties	1 375	9 778
Sale of publications	1 677	1 507
Sale of produce and livestock	416	805
International consultancies	229	739
Profit on disposal of fixed assets	2 293	3 417
Profit on disposal of CSIRONET operations	—	142
Profit on sale of investments	980	—
Miscellaneous	3 115	3 481
	18 465	**31 569**

Proceeds from the sale of fixed assets and CSIRONET operations amounted to $11 106 537 (1988, $16 381 000).

Note 3 Expenses

	General Research Funds	Specific Research Funds	Total 1989	Total 1988
	$'000	$'000	$'000	$'000
Research programs				
Animal Production & Processing	56 868	33 487	90 355	80 092
Industrial Technologies	50 682	6 082	56 764	53 322
Information & Communications Technologies	19 052	1 939	20 991	20 788
Minerals, Energy & Construction	54 603	14 977	69 580	59 155
Natural Resources & Environment	42 651	10 309	52 960	49 394
Plant Production & Processing	67 427	18 965	86 392	82 447
	291 283	**85 759**	**377 042**	**345 198**
Research Support[(a)]	46 773	2 527	49 300	53 275
National Facilities	8 936	12	8 948	4 934
	346 992	**88 298**	**435 290**	**403 407**

(a) Includes loss on sale of fixed assets $206 000 (1988, $729 000).

Note 4 Provisions and Unfunded Charges

	1989 $'000	1988 $'000
Provision for long service leave	(2 458)	(2 107)
Provision for recreation leave	(344)	560
Provision for superannuation benefit	4 981	1 429
Provision for workers compensation	(1 000)	—
Provision for doubtful debts	—	(238)
Depreciation	30 277	31 040
	31 456	**30 684**

Note 5 Abnormal Items

	1989 $'000	1988 $'000
Prior period adjustments relating to buildings and other non-current assets brought to account this year	5 525	8 325
Change in accounting policies:		
Consumable stores	—	(4 612)
Finance leases	—	(15)
Other non-current assets (Note 1.2)	(14 895)	—
	(9 370)	**3 698**

Note 6 Debtors

	1988 $'000	1987 $'000
Specific research debtors (Note 1.14)	—	5 611
Interest receivable	19	66
Advances — SIROTECH Ltd	(44)	276
— Other	80	21
General research debtors	1 241	1 215
Other accrued income	7	9 534
	1 303	**16 723**
Provision for doubtful debts	94	94
	1 209	**16 629**

Note 7 Land, Buildings and Leasehold Improvements (Notes 1.2 and 1.3)

	Leasehold improvements $'000	Buildings $'000	Land[a] $'000	Total 1989 $'000	Total 1988 $'000
At valuation	17 838	455 683	77 252	550 773	551 366
Accumulated depreciation	4 643	47 721	–	52 364	35 082
	13 195	407 962	77 252	498 409	516 284
At cost	785	11 465	4 370	16 620	10 944
Accumulated depreciation	54	229	–	283	24
	731	11 236	4 370	16 337	10 920
Work in progress — at cost	–	29 151	–	29 151	26 830
	13 926	**448 349**	**81 622**	**543 897**	**554 034**

[a] Crown land and land held in Commonwealth title totalling $12 575 000 (1988, $12 950 000) has been included in the above land values. Negotiations have taken place between CSIRO and the Commonwealth Government to have leases or title deeds issued in CSIRO's name.

Note 8 Other Non-current Assets (Notes 1.2 and 1.3)

	At cost $'000	Accumulated depreciation $'000	Written-down value 1989 $'000	Written-down value 1988 $'000
Equipment				
Transport equipment	21 069	1 227	19 842	10 789
Agricultural equipment	2 186	816	1 370	1 595
Computing equipment	51 466	22 701	28 765	29 050
Workshop equipment	6 382	2 873	3 509	4 140
Office furniture and equipment	9 680	3 138	6 542	6 977
General scientific equipment	106 512	48 014	58 498	62 117
Total equipment	**197 295**	**78 769**	**118 526**	**114 668**
National Facilities				
Oceanographic Research Vessel *Franklin*	14 461	4 612	9 849	10 897
Australia Telescope — construction in progress	45 457	–	45 457	41 405
Total National Facilities	**59 918**	**4 612**	**55 306**	**52 302**
Total equipment and National Facilities	**257 213**	**83 381**	**173 832**	**166 970**

Note 9 Investments (Note 1.8)

	1989 $'000	1988 $'000
Shares — at cost		
SIROMATH Pty Ltd[a]	150	150
Other	6	6
	156	156
Shares — at Board Members' Valuation		
Vantage Solutions Australia Ltd[b]	—	2 220
Dunlena Pty Ltd[c]	315	315
Preston Group Ltd[d]	495	495
Austek Microsystems Pty Ltd [e]	100	100
Incor Ltd [f]	10	10
Aquaterre Pty Ltd[g]	—	300
Queensland Metal Corporation NL[h]	840	—
	1 760	3 440
	1 916	**3 596**

Associated Companies

[a] CSIRO holds a 49·5% equity shareholding in SIROMATH Pty Ltd, a private company established to provide high-level mathematical consultancy services, primarily to Australian industry.

[b] CSIRO's shareholding in the company was sold during the year.

[c] CSIRO was originally allotted 350 001 shares (42% equity) in exchange for the assignment of intellectual property which was valued in the shareholders' agreement at $10 000 000 and an expenditure commitment of $5 000 000 towards research and development. During the 1987 financial year, 35 000 shares were transferred to SIROTECH Ltd in recognition of their contribution, on CSIRO's behalf, to the company. CSIRO currently holds 315 001 shares (37·1% equity).

[d] In accordance with the shareholders' agreement, CSIRO was allotted 550 000 fully paid "B" class shares of $1 each for the sale of intellectual property to the company. Subsequently, 55 000 shares were transferred to SIROTECH Ltd. As at 30 June 1989, CSIRO holds 495 000 shares (47·1% equity).

Other Companies

[e] CSIRO holds 130 000 shares in Austek Microsystems Pty Ltd at a cost of $156 585. In addition, CSIRO was allotted 250 000 shares for the assignment of licence rights. The total 380 000 shares have been valued at Board Members' valuation.

[f] As part of the licence rights agreement between CSIRO and Incor Ltd, 50 000 fully paid shares of $0·20 were accepted.

[g] In accordance with the five party agreement signed during the year, the operation of Aquaterre Pty Ltd in the field of electro-dewatering was terminated. Accordingly, CSIRO's shareholding in the company was written off.

[h] CSIRO was allotted 600 000 shares of $0·50 each fully paid in accordance with an "Agreement Field" with Queensland Metal Corporation NL. The objective of the agreement is to have CSIRO carry out research programs and Queensland Metal Corporation NL to contribute to the cost of such programs in accordance with the terms of the agreement. The market value of the shares at 30 June 1989 was $780 000.

Note 10 SIROTECH Ltd

SIROTECH Ltd was established by CSIRO, limited by CSIRO guarantee and governed by a Board of Directors. It was incorporated on 15 November 1984. SIROTECH's main source of revenue comes from an annual service fee paid by CSIRO to cover day-to-day commercial and intellectual property advice. During the year, payments made by CSIRO to or on behalf of SIROTECH totalled $3 849 198 (1988, $3 930 280). SIROTECH's net assets as at 30 June 1989 amounted to $664 963 (1988, $868 097). Due to SIROTECH's commercial activities it is considered inappropriate for its accounts to be consolidated in CSIRO's financial statements.

Note 11 Contractual Capital Commitments

Anticipated payments against capital contracts entered into but not completed as at 30 June 1989 are estimated at:

	Total 1988	Total 1987
	$'000	$'000
Buildings	1 954	15 992
Major laboratory equipment	4 857	780
National Facilities	1 060	7 145
Other non-current assets	3 709	9 450
	11 580	**33 367**
Current	11 580	24 143
Non-current	–	9 224
	11 580	**33 367**

Note 12 Resources Provided Free of Charge (Note 1.2)

	Buildings	Land[a]	Other Non-current Assets	Total 1989	Total 1989
	$'000	$'000	$'000	$'000	$'000
At valuation or cost	19 686	41 380	30 808	91 874	65 995
Accumulated depreciation	2 442	—	12 786	15 228	14 194
	17 244	41 380	18 022	76 646	51 801

[a] Includes lands $10 816 000 (1988, $10 816 000) which have been purchased out of specific research funds and are in CSIRO titles. In accordance with the grant agreements, any sales proceeds from disposal of these assets shall be refunded to the grantors.

Note 13 Contingent Liabilities

Contingent liabilities for which no provision has been provided in the accounts as at 30 June 1989 were:

		1989 $'000	1988 $'000
a)	Guarantee of bank accommodation and debts for associated companies, including performance guarantees	1 020	2 035
b)	Estimated common law claims which are pending but not admitted and will be defended	627	347
		1 647	2 382

Note 14 Monies Held in Trust

14.1 Trust funds are represented by the following investments at cost and cash at bank:

	1989 $'000	1988 $'000
Investments		
Reserve Bank of Australia	—	50
State Electricity Commission of Victoria	12	12
Canberra Building Society	293	346
Commonwealth Bank of Australia	1 861	1 551
Australian Industry Development Corporation	—	20
	2 166	**1 979**
Cash at bank	**114**	**44**
Total funds held as at 30 June 1989	**2 280**	**2 023**

14.2 The components of trust funds are as follows:

William McIlrath Trust Fund	139	123
David Rivett Memorial Lecture Fund	71	64
F.D. McMaster Bequest	1 964	1 725
Sir Ian McLennan Achievement for Industry Award	106	111
Total funds held as at 30 June 1989	**2 280**	**2 023**

Note 15 Auditor's Remuneration

The total amount paid and payable to the Auditor-General for the audit of CSIRO amounted to $234 341 (1988, $303 390). No other benefits were received by the Auditor-General.

Note 16 Board Members' Emoluments

Emoluments or other benefits received or due and receivable directly or indirectly by full-time and part-time Board members were as follows:

	1989 $'000	1988 $'000
Full-time members	97	93
Part-time members	107	101
	204	**194**

These rates are in accordance with determinations of the Remuneration Tribunal.

Certification of Statements

In our opinion, the Statement of Activity, Statement of Capital Accumulation, Statement of Assets and Liabilities, Statement of Sources and Applications of Funds, and the accompanying notes to and forming part of the statements, have been prepared in accordance with the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings and show fairly the operations of the Commonwealth Scientific and Industrial Research Organisation for the year ended 30 June 1989 and the state of affairs as at that date.

N. K. Boardman
Chief Executive

18.10.89

I.L. Farrar
General Manager
Corporate Resources
18.10.89


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