

Report of the Director

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Global perspectives of factors influencing agricultural, biological and environmental sciences, and their associated industries

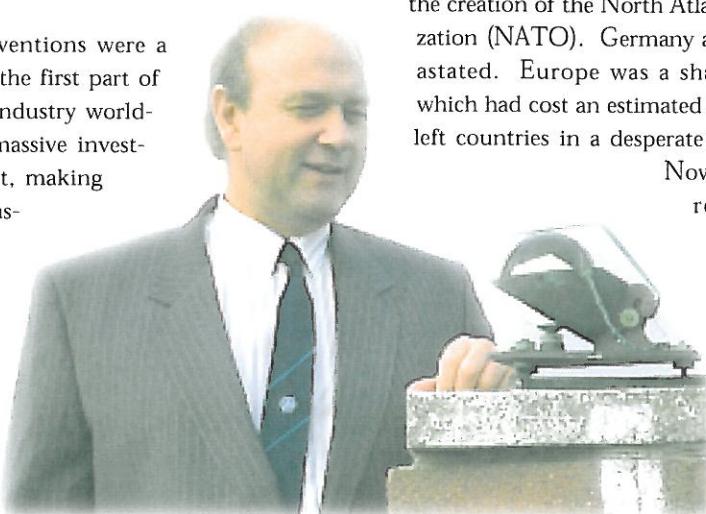
Preamble

Scientific discovery and inventions were a special feature of 1996 and the first part of 1997. The biotechnology industry worldwide continued to receive massive investments, creating employment, making stunning advances and releasing products into the marketplace. In Europe, problems of food contamination by the proteinaceous agent responsible for Bovine Spongiform Encephalopathy (BSE) and by *Escherichia*

coli (*E.coli*) O157 dented public confidence in the enforcement of regulations. Global economic output, agricultural output and the world's population grew. Food aid needs declined, and more attention was given to sustainability issues.

Fifty years ago, the delegates of 51 nations gathered in London for the first United Nations (UN) Organization General Assembly. The UN Educational, Scientific and Cultural Organization (UNESCO) was founded. Winston Churchill delivered his 'Iron Curtain' speech at Fulton, Missouri; communism tightened its grip on Eastern Europe, and the West responded with the creation of the North Atlantic Treaty Organization (NATO). Germany and Japan were devastated. Europe was a shambles after a war which had cost an estimated 40 million lives and left countries in a desperate ordeal for survival.

Now, out of the ashes, relative prosperity and peace have been achieved, but a multiplicity of languages still separate the Europeans, along with cultural and



historical differences. Some of the boundaries remain ambiguous, and there continues to be a tendency for fragmentation, regardless of the existence of the European Union (EU), and internalisation of trade, communications and entertainment. Europe retains more of the characteristics of an annelid than a vertebrate.

Whereas 50 years ago the major scientific advances were in chemistry and especially physics, nowadays the biological and related sciences dominate the headlines. Nevertheless, important discoveries in chemistry and physics were made in 1996. For example, element 112 (atomic mass 277) was synthesised by GSI Darmstadt, with the heaviest nucleus (112 protons and 165 neutrons) ever created in the laboratory. Theoretical analysis predicted that although element 112 decays rapidly, the periodic table contains a region of comparatively long-lived superheavy elements beginning at element 114. At the European Laboratory for Particle Physics, Geneva, the first atoms of antimatter, antihydrogen atoms, were produced, thereby confirming the theory of apparent symmetry between normal matter and antimatter. The existence of antiparticles, such as positrons and antiprotons, had been demonstrated in 1932 and 1955 respectively, raising then the possibility of antiatoms and bulk antimatter, identical to atoms and normal matter, except for the reversal in electrical charge and certain other quantum properties.

In August, the US National Aeronautics and Space Administration (NASA) announced that there was evidence for life on Mars having existed more than 3.6bn years ago. This remarkable claim was based on studies of the 1.9kg meteorite ALH 84001, found in 1984 in the Allan Hills ice field of Antarctica and thought to have landed on Earth about 13,000 years ago. It is one of about 12 meteorites whose chemistry matches the unique Martian chemistry found by the Viking spacecraft that landed on Mars in 1976. It was claimed that polycyclic aromatic hydrocarbons of Martian origin, mineral features characteristic of biological activity, and tubular and egg-shaped structures reminiscent of bacteria-like organisms were in the meteorite. Similar claims were made in the UK for another putative Martian-derived meteorite, EETA 79001.

By the end of 1996, several thousand artificial satellites were circling the earth, and even more items of space 'junk' from defunct satellites and related hardware. About 1,000 of the satellites were in geosynchronous orbit. The primary function of many of

the satellites is to provide a television service, whereas others deploy observational instruments to monitor meteorological changes, land and sea use, natural resources and transportation for civilian and military purposes.

A boom was noted in science-fiction television and cinema. 'Star Trek' and its derivatives helped spawn dedicated TV channels building on successful earlier shows, more recent series such as 'The X-Files', and the film 'Jurassic Park'. Difficulty in separating fact from fiction, scepticism over regulatory mechanisms, ignorance of scientific terminology and concepts, careful avoidance of taking up scientific careers, a total dependency on the products of science in every aspect of life and lifestyles are the collective attributes of modern adults. Antipathy to science has even permeated those areas of arts-dominated, scientifically ignorant academia concerned with 'imperialistic ideology'. Science has been described by Patrick Riley of University College London as an epistemological philosophy embracing the Humean (after David Hume, the 18th Century Edinburgh philosopher) dichotomy of rational and real knowledge. The scientific process or method involves the validation of ideas, concepts and hypotheses about the real world by experimental comparison of the behaviour of objective reality with that predicted by conceptual models or structures. Put simply, it is a method of acquiring and using knowledge and truth, but is rarely presented as such.

Matthew Parris, occasional commentator on the progress of the Plant Varieties Bill in the House of Commons noted in *The Times* the emergence of a moral, ethical or political authoritarian consensus, a development of 'political correctness', that punishes dissent or perfectly legal activities. Hysteria and emotion, stoked by the activities of tabloid media, can be seen to suppress critical analysis and silence legitimate questions. Such developments are an anathema to science.

Education was a global topic in 1996. Common themes were literacy and numeracy deficiencies in school children and school-leavers, multiculturalism, the use of the information superhighway, drug abuse, the need for training and re-skilling programmes for the unemployed and underemployed, the rapid escalation in public-sector costs of higher and further education, and the suitability of graduates and post-graduates for employment. Most countries adopted measures to increase the proportion of school-leavers

entering university, and raising the status of women in higher education.

Economics

During 1996, according to World Bank and International Monetary Fund (IMF) estimates, global economic output increased by 3.8%, slightly faster than in 1995, despite the disappointing economic performance of many EU nations. For the countries of the Organization of Economic Co-operation and Development (OECD), real gross domestic product increased by just 2.2%, reflecting the mid-cycle economic dip.

In the EU, lower interest rates and steady exchange rates should have aided economic activity, but the effects of the various policies to achieve economic and monetary union (EMU), outlined in the Maastricht Treaty on European Union, led to reduced average economic growth of just 1.6%, a decline from the weak level of 2.5% in 1995. The key convergence criteria for qualification are (i) public-sector deficit to be at or below 3% of Gross Domestic Product (GDP), (ii) outstanding public debt to be no more than 60% of GDP, (iii) inflation rate to be no more than 1.5% above average of the three best-performing countries, (iv) long-term interest rates to be similar to the average of the three best-performing countries, (v) currency exchange rates should have been within the normal Exchange Rate Mechanism (ERM) band for at least two years.

More substantial upturns in activity, compared with the EU, were noted in Australia, Japan, New Zealand, the USA, and most of the Least-Developed Countries (LDCs). Growth rates in South and East Asia were close to 8%.

Several African countries remained amongst the poorest in the world, despite a recovery in economic growth rates. In nearly all the More-Developed (or industrialised) Countries (MDCs), policies were in force to help bring about non-inflationary growth, reduce public-sector deficits, deregulation, and liberalisation in the terms of trade. Fiscal policy remained tight in the EU.

Virtually no improvement was noted in the unemployment rate in the OECD countries, where the average rate remained at about 7.3%, excluding those in voluntary and involuntary early retirement or those not formally registered as job-seekers. New Zealand, the UK and the USA, however, benefited from declines in unemployment. A report in the

National Institute Economic Review concluded that the only way to reduce, or even control, taxes and public spending is to put the unemployed back to work. The proportion of GDP spent on social security has grown substantially in recent years, straining other parts of the public sector, not least publicly funded research and development (R&D). In the EU, governments, organised labour and various management organisations tried to address the burgeoning costs of social security, including pensions, unemployment benefits, parental leave, and sickness absence costs. Difficult as the problem may be, the costs must be reduced if only to satisfy the entry criteria for EMU.

For the LDCs, real economic growth averaged 6.5% in 1996, slightly higher than in 1995. Improved foreign investments, expanding domestic growth and export volumes, better control of inflation, and the waning impact of the Mexican financial crisis all aided the more favourable economic environment. Although the Middle East displaced Latin America as the region with the highest overall inflation rate, the IMF expected the median inflation rate to decline from 10% in 1995 to 7% in 1996.

Global trade in goods and services was projected by the IMF and other bodies to have risen between 6.4-6.7%, the strongest growth taking place in the LDCs. Low or falling interest and inflation rates, coupled with higher corporate profitability, sustained a 12% gain in dollar terms of the world's stock exchanges. At the end of the year, comments by Alan Greenspan, the US Federal Reserve Chairman, about 'irrational exuberance' in asset values on Wall Street, destabilised the markets somewhat.

A sceptical attitude towards EMU was adopted by the financial markets, principally in respect of time-scales and convergence of economic cycles. The EU Intergovernmental Conference negotiations were retarded by the UK's strong opposition to further strengthening of the dirigiste EU, or to any move in the direction of a federal super-state. Moves to control BSE, and the ban on exports of UK beef and beef products, led to a campaign by the UK of non-cooperation prior to the Florence Summit, aided by the decision of the European Court to force the UK to introduce, with few exceptions, a 48-hour limit for the working week.

Sobering analysis of the latest (1995) data on productivity and employment in the manufacturing industries, sourced from the UN Monthly Bulletin of

Statistics and the International Labour Organization Yearbook of Labour Statistics, shows that since 1990, US industry raised its output by 17%; Canada by 10%; while France, Italy and the UK only managed 1-2%; but, for Japan and Germany, there were falls of 5% in output.

The image of the banking system was severely affected by accusations that well-respected Swiss banks had concealed extensive assets derived from Nazi Germany and its area of influence, and that Swiss banks had deliberately hidden the deposits of Holocaust and other victims. There were also questions beyond banking profits about the role of the 'neutral' nations in Europe during the World War II. Britain paid a high economic price for its non-neutral stance in both World Wars.

International Politics

The sovereignty of nation-states was increasingly diluted, regardless of the tendency towards fragmentation of larger nations to form smaller regional entities, by their inability to act without taking into account reactions from regional trading blocs, neighbours and the world community. Accordingly, international law reluctantly took on a strong resemblance to constitutional law as inter-state relations became increasingly judicialised and politicised. In the area of international adjudication, the workload of the International Court of Justice increased. Two new international tribunals began operations in 1996 - the World Trade Organization's (WTO) Appellate Body was formed to hear appeals against WTO panel reports, and the inaugural meeting took place of the International Tribunal for the Law of the Sea. The UK has yet to ratify the UN Convention on the Law of the Sea which will have implications for the UK economy in that, for example, uninhabited rocks without an economy (e.g. Rockall) cannot be used as a basis for territorial claims to fishing and mining rights.

Uncertainty about the future rôle of the UN extended into 1996. Given that unpaid contributions by members reached \$2.8bn, \$1.5bn of which were attributable to the USA, the organization was technically bankrupt. This led to a scaling-down of posts and activities reaching into all the programmes and associated agencies. Although the majority of nations supported the re-election of Boutros Boutros-Ghali to a second 5-year term as Secretary-General of the UN, the USA exercised its veto power in the Security Council. By the end of the year the Security

Council and General Assembly had ratified the appointment of Kofi Annan of Ghana, the Under-Secretary-General for Peacekeeping Operations, to succeed Boutros-Ghali in January 1997.

The five recognised nuclear powers (China, France, Russia, UK and the USA) agreed in 1996 to ban nuclear explosions, some 51 years into the atomic era. Although India vetoed the draft Comprehensive Test Ban Treaty at the UN Conference on Disarmament, it was nonetheless approved by the General Assembly. By the beginning of 1997, 41 of the 44 nations recognised as possessing nuclear facilities and whose agreement is essential for the Treaty to come into force, had signed the Treaty together with 90 other nations. Even though neither Russia nor the USA had ratified the Chemical Weapons Convention, the fact that 65 other nations had done so meant that the Treaty entered into force in April 1997.

Conflicts were much in evidence in 1996. The NATO-led, 32-nation Implementation Force in Bosnia and Herzegovina enforced the peace accord negotiated in Dayton, Ohio, bringing about relative peace in the former Yugoslavia. On the other hand, war continued in the Russian republic of Chechnya, and civil wars still occurred in Central and South Asia. Military confrontation occurred in the Korean peninsula, and public order collapsed in Albania. The bloodiest conflicts were between the Hutu and Tutsi in Rwanda and Burundi, and between Rwanda and Zaire. Aggressive Chinese policy towards democratic elections brought about a confrontation with Taiwan, and there was also disagreement with Japan over ownership of the Senkaku islands in the China Sea. International terrorism and organised crime presented challenges to all nations.

A resurgence of tensions and armed conflicts in the Middle East was probably the most dangerous development at a regional level, with the potential to evolve quickly into full-scale international war. Abetted by those nations that wanted to gain re-entry into the Iraqi market, Iraq challenged the terms of the armistice following the Persian Gulf War, and the conflict overspilled into the Kurdistan region. Conflict also resurfaced between Israel and the Palestinian Arabs, leading to a serious deterioration in relationships between Israel and its Arab neighbours.

Poland and Hungary were admitted to membership of the OECD, the second and third former communist states to join the Paris-based research group

which studies economic conditions in industrialised countries.

Membership applications for the Association of Southeast Asian Nations (ASEAN) were accepted by the seven existing members (Brunei, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam) in respect of Cambodia and Laos. Much to the chagrin of the EU and USA, the military dictatorship of Myanmar (Burma) was granted observer status. The ASEAN Regional Forum of ASEAN members, and 14 other nations with security interests in the Asian-Pacific region, discussed creating a Southeast Asia Nuclear-Weapon-Free Zone, opposing China's attempts to extend its jurisdiction in the Sea.

For the first time, a Euro-Asia summit to stimulate commercial relations and beneficial policies was held in Bangkok and involved the heads of state of the EU nations and 10 Asian countries.

The member nations of the Andean Group (Bolivia, Columbia, Ecuador, Peru and Venezuela) decided to rename the organisation the Andean Community, heralding the intention to move towards greater integration akin to that which occurred after the European Community was formed.

Populations

By mid-1996, the world population was estimated by the Population Reference Bureau to be 5.771bn, about 88 million greater than in 1995, with 98% of the increase taking place in the LDCs. The annual rate of increase was about 1.52% as birth rates declined in both LDCs and MDCs. At the present breeding and death rates, the world's population will double in 46 years. A population growth rate of 1.9% for LDCs compared with 2.2% for LDCs excluding China, would indicate a population doubling time of 32 years in the LDCs. Each day, the world population increased by about 240,000 people, the result of 383,000 births and 143,000 deaths. World-wide, 32% of the population was below 15 years of age; this figure was 38% of the population of LDCs excluding China, compared with 20% or less in the MDCs. Only 5% of the population was over the age of 65 in LDCs, compared with 14% or greater in the MDCs.

About 43% of the global population was urban, comprising 35% of the population of LDCs and 75% of MDCs; this accounts for the growing gulf between rural and urban perceptions of lifestyles and rôles.

Life expectancy at birth was 64 for males and 68 in females for the LDCs, and 70 and 78 in the MDCs, respectively. One of the greatest challenges is the care of the increasing number of the elderly infirm.

The total fertility rate (average number of children a woman would bear in her life-time at the current rate) was 3.4 in the LDCs, down from 3.5 in 1995. Africa once again remained the region with the highest fertility, women having an average of 5.7 children, rising to 6.1 in urban sub-Saharan Africa. Africa also had the lowest life expectancy (53 for males and 56 for females), and the fastest population growth (2.8% *per annum*).

In the MDCs, Europe had a negative rate of population growth (birth rate minus death rate of -0.1%), primarily due to trends in the European republics of the former Soviet Union.

No massive new refugee influxes were reported during the year, and the world's refugee population was calculated to have declined from 14.5 million in 1995 to 13.2 million in 1996. Repatriation was regarded as the primary solution. The overall population of concern to the Office of the UN High Commissioner for Refugees (UNHCR) fell to 26.1 million, of whom 3.4 million were returnees, 4.6 million were displaced persons within their national boundaries, and 4.8 million were of humanitarian concern, mostly victims of conflict. Around 9 million people were thought to have moved within or between the countries of the Commonwealth of Independent States following the dismantling of the former Soviet Union.

Little change was reported in the humanitarian crisis afflicting the African Great Lakes region (Burundi, Rwanda, Tanzania and Zaire) where more than 2 million Rwandans and Burundians had fled into neighbouring countries. About 1.7 million refugees were repatriated voluntarily to Mozambique, but outbreaks of violence in Liberia postponed the repatriation of 750,000 refugees. Over 650,000 Malian, Ethiopian, Eritrean and Somalian refugees have returned in recent years. In Europe, approximately 250,000 displaced persons resettled in Bosnia and Herzegovina. The largest refugee caseload of concern to the UNHCR was the 2.2 million Afghan refugees in Iran and Pakistan.

Food Aid

Short-term food prospects for many low-income, food-deficient countries (LIFDCs) improved in

1996-1997. Food aid needs declined except for certain countries which experienced crop failures, natural disasters and continuing civil strife. FAO estimated that 40% of the population of Africa had been undernourished in recent years, and civil strife created special difficulties in the Great Lakes region. LDCs would need about 9-11 million metric tonnes (mmt) of food aid in the form of cereals during the 1996-1997 crop year, according to the results of an annual analysis by the US Department of Agriculture (USDA). Sub-Saharan Africa, Afghanistan, Bangladesh, Iraq, Laos, Tajikistan, Turkmenistan and North Korea were the main areas of aid needs. In contrast, food aid needs were reduced in most of the LDCs in Latin America and Asia in 1996, as a result of stronger economic growth and above-average agricultural production. On the basis of minimum commitments under the 1995 Food Aid Convention, the donor nations (Australia, Canada, EU members and organisations, Japan, Norway, Switzerland, USA, and various other contributors) were expected by the UN Food and Agriculture Organization (FAO) to supply 7.5mmt grain equivalents in the 1996-1997 crop year, up from 7.16mmt in 1995-1996, but down from 9.35mmt in 1994-1995, and an average of 13.88mmt during 1991-1992 to 1993-1994. The aid needs for each LDC were defined by the USDA as the difference between a target level of food consumption and what could be grown and commercially imported. The target was the average level *per capita* over the previous five years. The 9m-11mmt needed to meet that target in 1996-1997 would still fall short of supplying minimum nutritional standards.

Food aid is usually needed either in the short term to meet emergencies caused by natural or human disasters, or in the longer term to assist LDCs in their agricultural sectors to provide more food generally, as well as allow access to food and improved incomes for the large rural populations. Donors have provided food aid to LDCs as direct aid and as concessional sales at reduced prices or with low-interest loans. Because of the world cereal shortage in 1995-1996, cereal prices were at record levels and concessional sales were all but eliminated. Consequently, the LIFDCs increased their expenditures in cereal imports by 35% from 1994-1995, even though import volumes were down.

Cereal-aid shipments, mostly as wheat, were estimated by FAO to have been 7.2mmt, with 5.7mmt directed to the LIFDCs. The aid to LIFDCs was

down by nearly 30% from the previous year, and down by nearly 40% from the average of the previous four years. Much of the decline in shipments was to sub-Saharan Africa, but there were declines in shipments to Latin-American and Caribbean countries. North Korea received more aid than hitherto. Food aid shipments to countries in Eastern Europe and the former Soviet Union (non-LIFDCs) were down by 30% from 1994-1995. Most of the decline in shipments was attributable to reductions by the EU and USA, both of whom combined still account for 75% of the global cereal food aid. In 1994-1995, over 30% of food aid went through multilateral channels such as the World Food Programme.

In November 1996, the FAO estimated that the 1996-1997 food aid shipments will have reached 7.5mmt, an increase of 4% over the previous year. Most of the modest increase was expected to have come from the EU and to have gone to the LIFDCs in Africa and Asia.

OECD figures show that, for 1996, MDCs reduced their state aid to LDCs, as a proportion of GNP, to the lowest level for 45 years, presumably because of 'compassion fatigue', public cynicism and downward pressure on public spending. Nevertheless, the decline was more than offset by increased private investment such that the total level of resources flowing into the LDCs reached record levels. Further analysis of the data shows that the private finance was predominantly restricted to a narrow band of fast-growing, high-income countries in Asia and Latin America. Direct aid by OECD countries to LDCs was \$59bn in 1995, down 9% from 1994, and accounted for 0.27% of GNP of OECD members. Private investment increased to \$159bn in 1995, taking total resource flows into the LDCs to \$239bn. About 40% of aid went to Africa, 30% to Asia and 10% to Latin America.

The case for investment in agricultural R&D to assist LDCs is clear. Besides generating agricultural advances in the recipient LDCs, the MDCs reap further benefit from the international stability, economic growth and lucrative new export markets so derived. Refugee crises, costly emergency relief, and dangerous military interventions are avoided. The R&D investments can be based in part in the donor country and linked with the recipient region.

The World Food Summit was held in Rome in November 1996, under the auspices of FAO to dis-

cuss global food security, at a time when 14% of the world's population suffered from chronic undernutrition, and more than 80 nations were classified as LIFDCs. The world is facing a sharp decline in the supply of tillable land and fresh water *per capita*.

The Summit released a 'Declaration on World Food Security' that identified the causes and actions to correct food insecurity. The goal of the anachronistically lavishly entertained summit was 'reducing the number of undernourished people to half their present level no later than 2015'. Poverty was recognised as the primary cause of food insecurity, not simply a global shortage of food. It was ironic that the majority of the world's most hungry people lived in rural areas, and more investment in agriculture was a priority, as was improved mechanisms to deal with food aid crises.

A so-called 'plan of action' was adopted by the World Food Summit: no new international bureaucratic structures were erected; nations were not asked to make specific pledges of support; and nations, and non-governmental and international organisations were expected to decide their own courses of action. The FAO Committee on World Food Security will have responsibility for monitoring progress.

The World Food Summit took place more than two decades after the 1974 World Food Conference, and the Overseas Development Institute noted that there are numerous achievements worthy of declaration. The proportion of undernourished people has fallen from 38% in 1969/71 to 20% in 1990/1992. A combination of new technologies and market development has stimulated world food production, such that it has outpaced population growth, although *per capita* food production has not increased in most highly indebted, low-income countries, particularly in sub-Saharan Africa. In the early 1990s, there were about 850 million people with inadequate access to food, down from 900 million in the early 1970s, even though the population of the LDCs had increased by 1.5bn over those 20 years. Famine has been largely confined since 1974 to conflict situations; drought-related crises affecting pastoralists in marginal regions have been alleviated for the most part. FAO's Global Information and Early Warning System has met the needs of those donors lacking access to the highly competent USDA intelligence network. Presently, there is no widespread sense of urgency or deepening crisis. Yet, despite all those remarkable achievements, there are far too many bodies with overlapping man-

dates, responsibilities, remits and missions; an institutional incoherence world-wide has led to valuable resources being spread far too thinly. Recent funding trends lean towards nations supporting high-profile, short-term special initiatives, rather than steady, longer-term investment in, say, the work of the Consultative Group on International Agricultural Research (CGIAR) network of Research Centers, or appropriate National Agricultural Research stations (NARs).

Agriculture and Food Supplies

According to FAO (<http://apps.fao.org>), total agricultural production in both MDCs and LDCs rose in 1996, as did total food production and *per capita* food production. Three longer-term themes were becoming evident in the global agricultural scene. Firstly, world markets for food and feed became more sophisticated and integrated as domestic agricultural policies began to be aligned with the imperatives of the Uruguay round of the General Agreement on Tariffs and Trade (GATT), leading on to the WTO. Secondly, total demand for food increased, especially for fresh fruit, vegetables and meat. Lastly, there has been an overall decline in food production and consumption throughout the 1990s in the countries of Eastern Europe and the former Soviet Union.

Best estimates of global food prices indicate an overall decline by as much as 6% in 1996, with wheat and barley leading the steep fall in cereal prices. Sugar prices fell less sharply. Coffee and tea prices slumped. The 'Economist' non-food agricultural products index was largely unchanged, but individual commodities differed widely in their price performance, *e.g.* rubber fell by 20%, cotton by 8%, but timber rose by up to 50%.

Cereals

As a result of a static supply of grain since 1990, during a period of rapidly expanding demand, the world faced a grain shortage in early 1996. According to USDA forecasts for the production year 1996-1997, total cereal production (wheat, coarse grains and milled rice) would be 1842 mmt, with a total utilisation of 1808 mmt, exports of 220mmt, and total ending stocks (which includes reserves) of 278mmt, some 8% above the previous crop year and approximately 15% of utilisation, the second lowest figure on record.

In early 1996, depleted grain stocks from previous years, alongside poor weather in the USA and high

prices, led to a world-wide surge in cereal production, reversing a downward trend in area planted since 1981. In tandem with projected higher yields, the expected increase in grain production led inexorably to a decline in prices. The only major grain-growing areas of the world to show a decline in area planted and production were the countries of Eastern Europe and the former Soviet Union, where production by 1996 was down by over 30% since 1990.

The volume of world grain trade has changed little since the mid-1980s. Trade volume in 1996-1997, however, was expected to suffer a 6% decline, accounted for by above-average harvests in the major importing countries.

Wheat stocks were expected to remain at a low level again in 1997, according to the International Grain Council - which cut its production forecast for the 1997 crop year to reflect planting reductions in Canada, Russia and the USA. It predicted world production of wheat at 583mmt, up slightly from 579mmt in 1996; consumption was expected to rise 7mmt to 582mmt.

Overpayments to EU cereal farmers during the four-year period to June 1997 were estimated to be in the order of Ecu 17bn, because market prices rose instead of falling as expected. Producers of durum wheat, grown mainly for pasta, accounted for less than 5% of EU cereal production but received at least Ecu 5bn. Such payments amount to nearly half the annual CAP budget of Ecu 40bn.

Oilseeds

The USDA predicted that the world production of oilseeds in 1996-1997 (256.3mmt) would exceed the production level of 1995-1996 (255.4mmt), but fall short of the record set in 1994-1995 (260.7mmt). A further decline in the area devoted to oilseeds was anticipated as growers switched to more profitable cereal production. In order of production levels, the main oilseeds are soy(a)beans, cottonseed, peanuts/groundnuts, sunflower, rapeseed/canola, copra/coconut and palm kernal. Edible vegetable oil production amounted to 86.5mmt, which includes palm oil and olive oil, the industry not regarding these as seed oils. Oilseed ending stocks fell to the very low level of 21.3mmt, giving rise to competitive world markets for oilseed, meal and oil, especially in view of importation demands from China. The USDA projection differs somewhat from that in the Oil World Annual 1997, which indicated a produc-

tion deficit in 1996-1997 that will lead to the reduction in oilseed stocks to historical lows by Autumn 1997.

Plans by the EU to bring about a radical change to the Ecu 2bn annual aid to the olive oil sector were impeded by the five producer countries (France, Greece, Italy, Portugal, and the largest producer - Spain, which accounts for 40% of output). EU production is around 75-80% of world production.

Sugar

About 70% of the world's sugar supply was derived from monocotyledonous sugar cane and the remainder from the dicotyledonous sugar beet. A production level of 125mmt centrifugal sugar in the crop year 1996-1997 represented a 2% increase over the 1995-1996 record harvest. The world's largest producer was India (17mmt), followed by Brazil (14.5mmt).

World sugar consumption was expected to increase to 122.9mmt, a record level, with most of the growth in the LDCs. Brazil continued with its policy of processing sugar cane for fuel. In the MDCs, consumer preference for sugar substitutes on dietary grounds depressed the demand for, and prices of sugar. World sugar carryover stocks, at 24.7mmt, increased to about 20% of consumption, and were expected to increase to 22% by the end of 1997.

Coffee

There were large increases in the production of green coffee in Brazil, Indonesia, Colombia and Côte d'Ivoire, leading to a recovery in world coffee production for the production year 1996-1997, to 99.1 million 60kg bags. Coffee prices fell. In the previous year, severe frost damage severely depleted coffee production in Brazil, a nation which, in recent years, accounted for 25% of world production. Washed arabica accounted for about half of world consumption; its increased price volatility was because it was in short supply, particularly from the main source, Colombia. Robustas and unwashed arabicas, produced in Brazil and elsewhere, substitute for washed arabica in coffee blending. The International Coffee Organisation's market review suggests a shortfall in coffee production in respect to consumption during 1997.

Cocoa

Sharply increasing its earlier estimate of the 1995-1996 world cocoa bean production to 2.88mmt, the USDA predicted that the 1996-1997 production level would fall to 2.66mmt. Côte d'Ivoire at

1.05mmt remains the single largest producing nation, despite a 12% decline in production. World consumption was expected to exceed production, leading to a substantial drop in carryover stocks.

Cotton

In 1995-1996, the USDA estimated that cotton production reached record levels of 91.5m 480lb bales. The few main producers were the USA, China, India and Pakistan, but only the USA showed an increase in production over 1994-1995 levels. Production in China, India and Pakistan was lower because of insect infestation and white-fly-transmitted cotton leafcurl geminivirus leaf virus, and a decrease in planted area. The 1996-1997 production level is predicted to be lower than the 1995-1996 level. World consumption of raw cotton was expected to rise by 1.1% from the previous year to 85.7m 480lb bales in 1996-1997, reversing the downward trend of recent years, but the cotton trade was still expected to decline as cotton stocks increase by 3-4%. More than 40% of the stocks are held by China. The major cotton exporters in recent years were the USA, Uzbekistan, French Africa and Australia.

For the first time, commercial cotton growers in Australia and the US planted genetically engineered (or genetically modified; GM) cotton, developed by Monsanto. The GM cotton contained the 'Bollgard' (Bt) gene derived from *Bacillus thuringiensis*, a soil-borne bacterium toxic to heliothis caterpillars. A new genetically engineered cotton, resistant to Buctril herbicide, was available in 1996. Mid-season reports from the Australian Cotton Research and Development Corporation confirmed that more than 30,000 hectares of GM (INGUARD™) cotton used 68% less pesticide spray.

Rubber

The International Natural Rubber Agreement was finally ratified by China and the USA, the last two signatories. The Agreement is designed to try to stabilise prices and supplies. Many manufacturers complained of shortages of this natural product that requires intensive labour inputs for harvesting. Synthetic products derived from polybutadiene and styrene butadiene offered tough competition, and rubber prices fell.

Tobacco

Against the efforts of anti-smoking organisations and bodies such as the World Health Organisation, the production and consumption of tobacco increased.

Half the world's cigarettes were smoked in East Asia. The world production of raw tobacco, at 6.33mmt, was the largest total since 1993, with China, the USA, India and Brazil the major producers. Carryover stocks from previous harvests declined.

In the USA, regulations were approved to give the Food and Drug Administration (FDA) the authority to regulate the marketing and sale of tobacco products to young people. In 1997, following numerous attempts over many years to seek legal redress from tobacco manufacturers, US governmental coercion brought about agreement on multi-billion dollar payments by the manufacturers to recompense public-sector health costs and individual claims, as well as agreement to restrict tobacco advertising. The tobacco companies also agreed to pay fines should teenage smoking fail to decline. Retroactive confiscation of assets, whilst allowing production and sale of the offending product to continue and pay taxes, is unusual in a modern democracy. Health risks faced by the individual smoker are well known, as are risks for an extensive range of other hedonistic and essential items, some even more socially offensive and equally health-damaging than tobacco smoke. Does democratic power exculpate the individual from responsibility for his or her well-being, and the well-being of those around them?

Wood, Paper and Pulp

Heavy pressure remained on traditional wood supplies during 1996, but there was a drop in prices for many forest products, especially pulp, panels and non-structural lumber. Scarce raw materials have led to technology-driven improvements in the use of traditional and alternative sources of plant fibres, and as expansion of new manufacturing capacity accounted for the drop in prices.

Not surprisingly, given the reduced rates of extraction, tropical timber producers suffered shortages of raw materials, and low prices caused by increased international competition. Malaysia, in line with an international agreement among tropical producers to reduce harvests to 'sustainable' levels, announced it would cut its annual harvests by 19% to 30m³ by 2000. Japan's economic recovery strengthened demand in the region for wood products.

Oversupply occurred in Europe as high-producing Scandinavian countries joined the EU. The UK increased production from the coniferous forests planted after World War II. A quota system was

introduced by the USA to regulate imports of Canadian timber, and this accounted for rising prices by the end of 1996. Russia, with about 57% of the world's softwood reserves estimated by satellite surveys, has suffered a dramatic decline in lumber output from 80m m³ to 22.3m m³ by 1996. A combination of poor infrastructure and political instability impeded proper and balanced exploitation of its forest resources.

For paper, pulp and board, the trends in 1996 indicate that output might not exceed 1995 levels. If true, there would have been a plateau to the 13 years of increased output in world pulp, paper and board output. World production in 1995, the last year for which secure figures were available, rose to 277.8mmt, an increase of 3.4% over 1994. The USA remained the largest producer and consumer *per capita*, accounting for nearly 30% of the world's output. Pulp and recycled paper prices have been volatile for the past 3 years, particularly in the face of aggressive pricing by many producers to try and sustain market share in East Asia in the face of low-cost competition from Indonesia and the USA. Future trends for the forestry industry point inexorably to greater consolidation and integration of organisations that are currently competing, and improvements in environmental standards if the industry is to thrive. Interestingly, the Finnish Government privatised several state-owned companies in the pulp and paper, chemical and heavy metal industries to increase its R&D budget by 25% over the next 3 years. The windfall is estimated to be worth a total of \$650 million.

Depletion of global forestry resources and the loss of essential biodiversity were the factors which initiated the innovative research programmes at SCRI on tree genetics and breeding, using coniferous as well as tropical and temperate broad-leaved species. Forestry demands long-term planning, where breeding cycles can be as long as 50 years. Our related programme on alternative plant fibres is crucial to relieve pressure on tree harvesting.

Food Processing, Retailing and Consumer Issues

Surveys of trends in retailing point to growth in processed ready-to-eat meals and convenience foods, breakfast cereals, non-bread bakery products, soft drinks, meat substitutes, and chilled, frozen and fresh fruit and vegetables. Consumer interest was noted in dietary fibre, 'functional foods', fish oils, ethnic food, food labelling, environmental issues, food contamina-

tion (especially provoked by the scares over BSE and *E.coli*), and the use of genetically modified (or manipulated, enhanced or engineered) organisms (GMOs).

Food poisoning incidents did not decline in 1996. Over 9000 cases of food poisoning caused by *E.coli* O157:H7 were reported in Japan, and a large number of cases were reported in Scotland. Tamper-proof packaging became commonplace in retail outlets.

Substantial growth occurred in fruit juice sales. By way of illustration, about 85% of orange juice traded on world markets comes from Brazil, which produces about 46% of the world's total orange juice. Florida produces about 39% and most of the rest comes from Spain, Mexico, Morocco, Israel and California. Brazil and Florida specialise in oranges for processing into concentrate for shipping to bottlers for reconstitution. World consumption of processed orange juice expanded to 2.2mmt in 1996, recently averaging 5.5% growth per year in Europe, and 12.5% in Asia. SCRI has considerable interest in the potential for blackcurrant, raspberry, blackberry, hybrid-berry, strawberry and other juices, as well as their essences, flavourings and distillates.

The US Congress announced its intention to repeal the Delaney Clause which prohibits any trace in food of materials causing cancer in laboratory animals. In future, the regulatory authorities would have to prove food to be unsafe before it could be banned, rather than the reverse - the present law requires the processors to prove their products are safe. This proposed change in law runs contrary to the trends in the EU, but is in the spirit of the WTO initiative.

In the EU, restrictions were placed on many food flavourings and colourants, but anti-dumping duties were lifted on importations of the sweetener, aspartame, from Japan and the USA. Olestra, a fat substitute developed in the USA, was launched.

The beverages market was mixed. Many of the major beer brewers attempted to carve out a share in the rapidly expanding, low-volume craft beer market. A lag in the sales of spirits in the USA led to more aggressive advertising. In Europe and the USA, the wine vintage was claimed to be fairly good for the most part. Sales of northern and southern hemisphere wines grew strongly, and consumption patterns in the non-wine-producing countries of the western world became more international and experimental.

On the bases of value and volume, cola drinks remained the major soft-drink products, but several new products based on plant products such as guarana, coffee, caffeine, and fruit juices were launched successfully. Sales of carbonated and still mineral waters increased. In the UK, there was a massive expansion in sales of alcoholic soft drinks ('alcopops') coinciding with a decline in the sale of cider and provoking an outcry about encouraging under-age drinking.

Developments in food processing included improved automation, new packaging materials based on polyethylene terephthalate and polyolefin, modified atmospheric packaging to improve shelf-life of animal and plant products, improved low-temperature cabinet design, diagnostics for potential spoilage, and recyclable packaging.

Consumers International, a federation of 215 consumer organisations in more than 90 countries, issued a booklet entitled 'Safe Food For All' that discussed food concerns such as agricultural trade policies, advertising and scarcity. The booklet was promoted by the UN Environmental Programme to enlighten consumers on various aspects of food production and consumption and their impacts on the environment.

Food safety scares, exacerbated by the announcement in March 1996 that a possible link may exist between BSE and Creutzfeldt-Jacob disease, had dramatic effects in consumer behaviour, bringing about short-term changes in diet for much of the population (see article on p.127). Public and political attitudes to agriculture and science were severely affected. What were actually regulatory fiascos founded on ignorance, became justifications for giving media exposure to trenchant anti-technology voices.

As GM 'vegetarian' cheese, where recombinant rennin/chymosin replaces rennin extracted from calf stomachs, and tomato paste reached UK supermarket shelves and as a wide range of products using GM soybean and maize is starting to come on stream, consumer and environmental lobby groups campaigned for monitoring and labelling of GMOs and all products derived from them, and for major constraints on biotechnology. In October, the World Health Organisation and the FAO held an expert consultation on food safety and biotechnology in an attempt to determine basic policies on both those issues. In Europe, contrasting with North America

and Australia, as much emphasis was put on the ethics of genetic modification as on verifying the safety of the product. Certain groups kept up pressure to call a moratorium on biotechnology, blissfully unaware of the many beneficial and indeed crucial aspects of biotechnology which currently underpin wealth creation, healthcare and other aspects of the quality of life world-wide. The fact that the gastrointestinal tract is designed to deal with foreign nucleic acids and proteins, and safeguards mankind from taking on the genetic attributes of fresh fruit and vegetables, or any accidentally swallowed animal or microbial life, has not crossed the minds of many of those who protest. Environmental escapee genes would have to compete with natural selection systems. The current monitoring and regulatory systems in force are already more rigorous and protected than those applied to almost any other area of human activity including new drug discovery.

In Central and Eastern Europe, as well as in countries of the former Soviet Union, there was evidence of import dumping of poor-quality and mislabelled food, but local producers were still undermined by widespread attitudes that foreign food was better than the domestic equivalents.

Environment

Few appreciate that the services of ecosystems and the natural capital stocks that produce them, are of fundamental value to humanity and to the total economic value of Earth. An international team estimated that the current economic value of 17 ecosystem renewable services (habitats, biological or system properties and processes, food, waste assimilation, erosion control *etc.*) for 16 biomes was estimated to be in the range of \$16-54 trillion (10^{12}) per year, with an average of not less than \$33 trillion per year. Global gross national product is around \$18 trillion per year.

In its first Global Environment Outlook report, the UN Environment Programme called for cost-benefit analyses to promote changes in energy use, disseminate environmentally sound technologies, tackle water shortages, and improve environmental data gathering and analyses for decision-making. Poverty, population growth, inefficient resource use and wasteful consumption in the MDCs were seen to be the main factors in unsustainable global development, where natural resources are being consumed faster than they can be renewed. The real challenge is to reverse past and current trends in environmental degradation.

In September 1996, eight nations (Canada, Denmark - on behalf of Greenland, Finland, Iceland, Norway, Russia, Sweden and the USA) agreed to create a Joint Arctic Council, with the intention of protecting the fragile Arctic environment, while encouraging, somewhat oxymoronically, long-term development in the region. For several years, there have been opinions expressed about creating a group to safeguard Nordic interests in the EU, interests which include Scotland and other low-density-populated parts of Northern Britain, where land-use activities are environmentally constrained.

Climate change remained at the forefront of environmental discussions in 1996. The second meeting of signatories to the UK Framework Convention on Climate Change met in Geneva. There was agreement to the EU and USA proposal that the OECD member states should adopt legally binding limits to emissions of 'greenhouse gases', with targets and timetables for their reduction from the turn of the millennium. Australia, Russia and members of the Organization of the Petroleum Exporting Countries opposed the proposal, and most LDCs were concerned about the effects of these mandatory reductions on the growth of their economies.

The UK Meteorological Office and University of East Anglia released preliminary figures indicating that 1995 had the highest annual average temperature ever recorded since relevant meteorological statistics began in 1856. They calculated that the average global temperature in 1995 was 14.84°C; the NASA-operated Goddard Institute came up with a slightly higher figure. While 1996 appeared to be cooler than 1995, initial calculations indicated it was the eighth warmest to date, continuing the warm trend evident throughout the 1980's and 1990's. Nonetheless, no definitive conclusions about global warming could be reached without studying data over a longer period.

An umbrella group of 60 industrialised concerns, the Global Climate Coalition (GCC), claimed that the wording of chapter 8 (dealing with human influences on climate) in 'Climate Change 1995', the latest report of the Intergovernmental Panel on Climate Change (IPCC), had been changed after peer review. The GCC charge was rebutted by the IPCC. The report claimed that global warming had been detected. After allowing for the cooling effects of aerosols, IPCC Working Group I predicted a temperature rise of between 1-3.5 centigrade degrees by

2100, and a rise in sea-level of 15-95cms, sufficient to threaten large tracts of low-lying land of agricultural and urban importance over the globe. Working Group II noted that warming at the higher end of the temperature range would shift climatic zones towards the poles by about 550km, with consequent effects on natural vegetation and the spread of pests and diseases.

In July, the World Energy Council, a non-governmental interaction group promoting sustainable energy sourcing, reported that global carbon dioxide emissions from burning fossil fuels rose by 12% between 1990 and 1995, mainly from the LDCs. Emissions increased by 4% in most OECD members. Large increases of 35% and 30% were noted in the Middle East and in the Asia-Pacific region (except for Australia, Japan and New Zealand), respectively. Levels in Africa rose by 12.5%. With the honorable exceptions of France, Germany and the UK, all the industrialised countries (the MDCs) were unlikely to meet their target of reducing the CO₂ emissions to 1990 levels by 2000. In Central and Eastern Europe, and the former Soviet Union, 1995 emissions were over 70% above 1990 levels.

Alternative energy sourcing, like organic farming, remains a Cinderella topic. A study in 1996 by the Paris-based International Energy Agency concluded that by 2010, fossil-based fuels would still account for about 90% of total energy demand. Non-hydroelectric renewable sources (biomass, wind, wave, solar, geothermal) would account for only about 1%. The World Energy Council estimated that renewable sources could provide, subject to R&D investment, 5-8% of the world's power requirement by 2020. At the end of 1995, the signatories to the Montreal Protocol set new limits on the release of ozone-depleting substances. Industrial countries agreed to phase out methyl bromide (a fumigant and soil sterilant to control nematode pests among other uses) by 2010, and LDCs planned to stabilise its use at an average of the 1995-1998 levels by 2002. Breeding for pest and disease resistance remains a high priority internationally, commercially and environmentally, reinforcing the research strategy of SCRI.

With regard to halogens, tropospheric concentrations of chlorine attributable to anthropogenic halocarbons peaked near the beginning of 1994, and by mid-1995 were decreasing at a rate of 20-30 parts *per trillion per annum*. Bromine concentrations, however, were still increasing. Stratospheric concentrations of chlorine and bromine were predicted to reach a maximum

between 1997 and 1999, and decrease thereafter, provided that the adjusted and amended limits set by the Montreal Protocol on Substances That Deplete the Ozone Layer were not exceeded.

Contrasting with perceptions shaped by the impacts of acid deposition on vegetation, a report by the European Forest Institute on 22 studies in 12 countries showed that tree growth in Europe had increased over the past few decades. The reasons for this remain unclear, because many of the forests in the study were relatively young. More in line with perceptions was a survey published by the European Commission (EC) on forest conditions in the EU; 20% of all trees at specific sites showed clear signs of foliar damage.

Following on from various reports in 1995 from the WHO, the UK Expert Panel on Air Quality Standards, and the UK Committee on the Medical Effects of Air Pollutants, realigned their views on the potentially hazardous rôle of PM10, a category of airborne particles less than 10 μm in size. The nature of the hazard is receiving more attention in urban areas worldwide. Planners, however, have yet to appreciate fully the atmospheric 'scrubbing' capacity of various types of vegetation adjacent to roadways and factories.

China, by incorporating into its Law the 1989 Basel Convention on the Control of Hazardous Wastes and Their Disposal (a convention which requires all exported waste to have an export permit as well as import approval from the destination country), was able to reject a wide range of toxic imports for recycling. The international waste disposal and recycling industry will now have to take on-board new technologies, rather than rely on cheap labour and low-standards of disposal.

Continued interest in various chemicals, notably the phthalates and nonyl phenols, that can mimic the physiological feminising effects of estrogens when released into the environment, drew attention to those xenobiotics which are able to modify growth and differentiation at parts *per* billion level. Extraordinary efforts and costs are required to eliminate them from the environment.

The EC published a report in 1996 on bathing-water quality on beaches. Three thousand European beaches failed to meet the standards laid down in the 1986 EU directive; 11% of inspected British beaches failed. Globally, the huge capital and recurrent costs in water

purification, and the political implications of water distribution and usage, are becoming major forces in land usage, investment patterns, urban development and international disputes. More than 1100 dams were under construction during 1996, and development continues on one of the largest water-transmission projects in the world, the Great Man-Made River in Libya, which uses Saharan fossil aquifer water conducted to the coastal regions for drinking water and irrigation.

In the UK, the Environment Agency took over responsibilities formally exercised by the National Rivers Authority, the Inspectorate of Pollution, and local authority waste inspectors. The new Agency promised to pressurise industry to invest in environmental protection, conduct a public-education campaign, and publish regular 'state-of-the-environment' reports on the Internet. Separate arrangements were made for Scotland (Scottish Environment Protection Agency). In October, the Landfill Tax came into force, intended to encourage recycling of waste, but landowners feared that tax-avoiding fly-tipping would become commonplace. A 1996 report from the Royal Commission on Environmental Pollution, entitled 'Sustainable Use of Soils', made 91 recommendations to ensure adequate soil protection, a topic neglected legislatively compared with the protection of air and water quality. The topic of soil-plant dynamics is an area of strength in the SCRI research portfolio.

Earlier in the year, the UK suffered its worst oil spill since the 'Torrey Canyon' incident, when the Liberian-registered single-hulled tanker 'Sea Empress' ran aground near the entrance to Milford, Haven, Dyfed. Around 70,000 tonnes of the 130,000 tonnes cargo of light crude oil were spilled, contaminating beaches over a wide area.

Ingenious and daring tactics by self-proclaimed 'eco-warriors' delayed construction of the Newbury Bypass. Extensive road construction in the UK has evoked strong protests because large swathes have been cut through areas of outstanding natural beauty, areas of specific scientific interest and wildlife habitats. In 1997, similar protests were in evidence during construction of the extension to Manchester Airport. A feature of the various protests in recent times is the high level of public sympathy for protecting the rural environment.

With regard to the world's natural flora and fauna, discussions took place during 1996 on coordinating