# FOOD AND ENVIRONMENT
# – WALKING THE TIGHTROPE

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"Free Enterprise was born with man and shall survive as long as man survives".

-A.D. Shroff
1899-1965
Founder-President
Forum of Free Enterprise

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By

**Dr. M.S. Swaminathan***

## THE CHALLENGE OF SUSTAINABLE AGRICULTURE

On the eve of the UN Conference on Environment and Development held at Rio de Janeiro in June 1992, the Union of Concerned Scientists published an open letter titled, World Scientists' Warning to Humanity, which stated that "human beings and the natural world are on a collision course". The letter stated further, "if not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know". This warning was signed by over 1600 scientists from leading scientific academies in 70 countries. The list included 104 Nobel Laureates.

Colborn, Dumanaski and Myers (1996) in their book "Our Stolen Future" and James Morgan (1999) in his book "The Last Generation" also provide a picture of the grim future that awaits the generations yet to be born, if we lose future time in restoring harmony between humankind and nature.

It is now widely realised that the genes, species, ecosystems and traditional knowledge and wisdom that are being lost at an

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increasingly accelerated pace limit our options for adapting to local and global change, including potential changes in climate and sea level. The Hadley Centre of the UK Meteorological office has recently predicted that even if Governments cut green house emissions, sea levels may rise by at least 2 meters over the next few hundred years. If the global community can limit emissions upto 550 ppm, which is twice the preindustrial levels and 50% above today's, about 2 billion persons can be saved from water shortages, low crop yields and increased coastal flooding, especially in India and Africa (New Scientist, 30 October 1999).

The Global Biodiversity Assessment published in 1995 by the United Nations Environment Programme (Cambridge University Press) estimates that about 13 to 14 million species may exist on our planet. Of this, less than 2 million species have so far been scientifically described. Invertebrates and microorganisms are yet to be studied in detail. In particular, our knowledge of soil microorganisms is still poor. Also, biosystematics as a scientific discipline is tending to attract very few scholars among the younger generation.

Another important paradigm shift witnessed in recent decades in the area of management of natural resources is a change in the concept of "common heritage". In the past, the atmosphere, oceans and biodiversity used to be referred to as the common heritage of humankind. However, recent global conventions have led to an alteration in this concept in legal terms. Biodiversity is now the sovereign property of the nation in whose political frontiers it occurs. Further, the Trade Related Intellectual Property Rights (TRIPS) provisions of the World Trade Agreement have made it mandatory to cover products of genetic improvement with either patents and *sui generis* methods of intellectual property rights protection. Under the UN Convention on the Law of the Sea, nations with coastal areas have access to a 200 mile Exclusive Economic Zone (EEZ). The Climate

Convention and the Kyoto protocol provide for both common and differentiated responsibilities to countries. Thus, the global commons can be managed in a sustainable and equitable manner only through committed individual and collective action among nations. In the Asia-Pacific Region, Australia can play a catalytic role in fostering cooperation in both avoiding and mitigating the adverse impact of climate change. A Chinese proverb warns, "if you do not change direction, you will end up where you are headed". Since we do not want to reach where we are presently headed, what change of course should we bring about in the field of agriculture?

**Ecstacy and agony**

As we say good bye to this century we can look back with pride and satisfaction on the revolution which the farm men and women of the Asia/Pacific region have brought about in contemporary agricultural history. While we can and should rejoice about the past achievements of our farmers, scientists, extension workers and policy makers, there is no room for complacency. We will face several new problems, such as the following:

- First, increasing population leads to increased demand for food and reduced per capita availability of arable land and irrigation water.

- Second, improved purchasing power and increased urbanisation lead to higher per capita food grain requirements due to an increased consumption of animal products.

- Third, marine fish production is tending to become stagnant and coastal aquaculture is facing environmental problems.

- Fourth, there is increasing damage to the ecological foundations of agriculture, such as land, water, forests, biodiversity and the atmosphere and there are distinct possibilities for adverse changes in climate and sea level.

- Finally while dramatic new technological developments are taking place, particularly in the field of biotechnology, their environmental, health and social implications are yet to be fully understood.

Since land and water are shrinking resources for agriculture, there is no option except to produce more food and other agricultural commodities from less per capita arable land and irrigation water. In other words, the need for more food has to be met through higher yields per units of land, water, energy and time. It would therefore be useful to examine how science can be mobilised for raising farther the ceiling to biological productivity without associated ecological harm. It will be appropriate to refer to the emerging scientific progress on the farms as an "*evergreen revolution*", to emphasise that the productivity advance is sustainable overtime since its is rooted in the principles of ecology, economics, social and gender equity and employment generation.

The green revolution has so far helped to keep the rate of growth in food production above population growth rate. The green revolution, was however, the result of public good research, supported by public funds. The technologies of the emerging gene revolution in contrast, are spearheaded by proprietary science and can come under monopolistic control. How then can we harness the power of frontier science to promote an ever-green revolution in our farms?

The 20th century began with the rediscovery of Mendel's laws of inheritance. It ends with moving specific genes across sexual barriers with the help of molecular mapping and recombinant DNA technology. The impact of science and technology in every field of crop and animal husbandry, inland and marine fisheries and forestry has been profound. Let me illustrate this, taking the improvement of wheat production in India as an example. Wheat cultivation started in the Indian subcontinent over 4000 years ago. Wheat kernels have been found in the Mohenjodaro excavations dated 2000 BC. From that period up to August 1947, when the colonial rule ended, Indian farm men and women developed the capacity to produce 7 million tonnes of wheat per year. Between 1964 and 1968, when semi-dwarf strains containing the Norm 10 genes for dwarfing were introduced in irrigated areas, wheat production rose from 10 to 17 million tonnes per year. In other words 4000 years of progress was repeated in 4 years. (Swaminathan, 1993). During 1998-99, wheat production in India exceeded 70 million tonnes, i.e. a ten-fold increase in about 50 years.

Similar progress has been made in improving the production and productivity of rice, maize, soybean, potato and several other crops as well as in farm animals in many developing countries around the world. **New technologies supported by appropriate services and public policies as well as international scientific cooperation have helped to prove doomsday predictions wrong and have led to the agricultural revolution (the green revolution) becoming one of the most significant of the scientific and socially meaningful revolutions of this century.** A world without hunger is now within our reach. A hunger free world will be possible if every nation pays concurrent attention to improving food **availability** through ecologically sustainable methods of production, to enhancing economic access to food by promoting a job-led economic growth strategy, and to ensuring the biological **absorption** of food in the body through the availability of safe drinking water and environmental hygiene. Steps should also be taken to enlarge the base of the food security basket by revitalising the earlier tradition of cultivating a wide range of food crops (See MSSRF, 1999).

Emerging farming technologies will be based on precision farming methods leading to plant scale rather than field scale husbandry. Farming will be knowledge intensive, using information from remote sensing Geographical Information System (GIS), Global Positioning Systems (GPS), and information and computer technologies. Farmers in industrialised countries and already using satellite imagery and GPS for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need them urgently. Among other recent tools, the GIS methodology is an effective one for solving complex planning, management and priority setting problems. Similarly, remote sensing technology can be mobilised in programmes designed to ensure drinking water security.

Let me cite two examples of their value from our recent work.

First, GIS was applied for determining priorities in a programme designed to launch a total attack on hunger in the Dharampuri district in Tamil Nadu, India. Socio-economic data like the percentage of poor population, percentage of unemployment, literacy rate, and infant and maternal mortality rates were mapped in GIS. The layers were prepared for each factor and registered together. Different levels were given to classify each factor. They were overlaid to get a profile map showing the poorest villages which need to be accorded priority in the hunger-free area programme.

Second, GIS proved to be a invaluable tool in developing strategies for the conservation and sustainable and equitable use of biodiversity. The Gulf of Mannar region in South India is a biological paradise. Unfortunately, anthropogenic pressures and the unsustainable use of coral reefs, sea grass beds and mangroves are causing serious damage to this priceless heritage. With financial support from the Global Environment Facility (GEF) and technical advice from Dr. Graeme Kelleher formerly of the Great Barrier Reef Authority, a **Gulf of Mannar Biosphere Reserve Trust** is being created by the Government of Tamil Nadu. The aim is to make all stakeholders regard themselves as Trustees of this area. This evolution of the Gulf of Mannar Biosphere Reserve into a **Biosphere Trust** held in trust for posterity is an example of UNESCO's vision of Biosphere Reserves for the 21st century articulated as Seville becoming a reality.

Rather than forming islands in a world increasingly affected by severe human impacts, biosphere reserves can become theatres for reconciling people and nature. They can bring the knowledge of the past to the needs of the future.

Biotechnology will play an increasingly important role in strengthening food, water and health security systems. Recent widespread public concern relating to genetically modified (GM) food stresses the need for more effective and transparent mechanisms for assessing the benefits and risks associated with transgenic plants and animals. An internationally agreed Biosafety Protocol on the lines recommended in Article 19 of the Convention on Biological Diversity (CBD) is an urgent necessity. Biotechnology companies should agree to the labelling of GM foods in the market. All food safety and environmental concerns should be addressed with the seriousness they deserve. Broad based **National Commissions on Genetic Modification for Sustainable Food and Health Security** could be set up, consisting of independent professionals, environmentalists, representatives of civil society, farmers' and womens' organizations, mass media and the concerned Government regulatory authorities. This will help to assure both farmers and consumers that the precautionary principle has been applied, while approving the release of GM crops.

**Biodiversity-rich but biotechnology-poor** countries are adversely affected by the prevailing non-adherence to the ethical and equity principles in benefit sharing contained in Articles 8 and 15 of CBD. The primary conservers, largely tribal and rural women and men, live in poverty, while those who use their knowledge and material for producing commercial products become prosperous (Swaminathan, 1999). The invaluable contributions of tribal and rural families to genetic resources conservation and enhancement have been recognised in the Convention on Biological Diversity. Yet the political will to implement the equitable benefit sharing provisions of CBD is lacking. We need urgent steps to recognise and reward the contributions of indigenous communities to providing material of great importance to global food and health security. The following three validated findings will be adequate to stress the significance of traditional knowledge and conservation efforts to help mitigate handicaps caused by ageing in human beings.

| Country | Plant | Property |
|---|---|---|
| India | *Trichopus* zelyanicus | Helps to remove fatigue |
| India | *Bacopa monnieri* | Helps to improve memory |
| Tropical Africa | *Prunus africana* | Treatment for benign Prostatic hyperplasis |

Article 27(b) of the TRIPS component (Trade Related Intellectual Property Rights) of the World Trade Agreement is now under review. **All nations should agree to incorporate in this clause the ethics and equity principles enshrined in articles 8(j) and 15 of CBD.** The World Intellectual Property Rights Organization (WIPO) which has launched a study of the need to recognise the Intellectual Property Rights of the holders of traditional knowledge, should complete this study soon and help to make the principles of ethics and equity the foundation of IPR.

## Emerging Scientific Revolutions

Fortunately, as we approach the new century we are experiencing three major revolutions in science and technology, which will influence agriculture and industry in a fundamental manner. It will therefore be appropriate to make a brief reference to them.

i) The *gene revolution* - which provides a molecular understanding of the genetic basis of living organisms, as well as the ability to use this understanding to develop new processes and products for agriculture, industry, the environment, and for human and animal health.

ii) *the ecotechnology revolution* - which promotes the blending of the best in traditional knowledge and technology with frontier technologies such as biotechnology, space and information technologies, renewable energy and new materials, and

iii) *the information and communication revolution* – which allows a very rapid growth in the systematic assimilation and dissemination of relevant and timely information, as well as a dramatically improved ability to access the universe of knowledge and communicate through low cost electronic networks.

In principle, these three types of advances – when coupled with improvements in the management and governance - greatly increase the power of a scientific approach to genetic improvement, the integrated management of natural resources and ecosystems, and the management of local and regional development strategies. Eco-technologies enable the adoption of ISO 9000 and ISO 14000 standards of environmental management. These scientific revolutions seem to be proceeding at an ever increasing pace, with most of the action occurring in industrialised nations. Also, new discoveries of great relevance to sustainable food and health security are coming under the purview of proprietary science, since they are covered by Intellectual Property Rights. It is the duty of organisations devoted to public good mobilise recent advances in science and technology for meeting the basic needs of the economically and socially underprivileged sections of the human family.

## i. THE GENE REVOLUTION

The past ten years have seen dramatic advances in our understanding of how biological organisms function at the molecular level, as well as in our ability to analyze, understand and manipulate DNA molecules, the biological material from which the genes in all organisms are made. The entire process has been accelerated by the Human Genome Project, which has poured substantial resources into the development of new technologies for working with human genes. The same technologies are directly applicable to all other organisms, including plants. Thus, a new scientific discipline of genomics has arisen. This discipline has contributed to powerful new approaches in agriculture and medicine and has helped to promote the biotechnology industry.

Several large corporations in Europe and the United States have made major investments in adapting these technologies to produce new plant varieties of agricultural importance for large-scale commercial agriculture. The same technologies have equally important potential applications for addressing food security in the developing world.

**The key technological developments in this area are:**

a. *genomics* : the molecular characterization of species.

b. *bioinformatics:* data banks and data processing for genomic analysis.

c. *transformation:* introduction of individual genes conferring potentially useful traits into plants, trees, livestock and fish species.

d. *molecular breeding:* identification and evaluation of useful traits by use of molecular assisted selection, which greatly speeds up traditional breeding processes.

e. *diagnostics:* identification of pathogens by molecular characterization.

f. *vaccine technology:* use of modern immunology to develop recombinant DNA vaccines for improved control against lethal diseases of animals and fish.

Let me cite one example from the work of MSSRF scientists to illustrate the value of the new tools. As a part of the anticipatory research programme to meet the consequences of sea level rise arising from global climate change, genes responsible for conferring the ability to withstand sea water intrusion were identified in a few mangrove species through molecular mapping. They have been transferred to annual economic plants through recombinant DNA technology.

The sequencing of the genome of rice *(Oryza sativa L.cv.* Nipponbare) by an international consortium supported by the Rockefeller Foundation and the International Rice Research Institute will permit allele mining for all genes of rice and possibly for other cereals. Thus, altogether unforeseen opportunities for creating novel genetic combinations have been opened up.

As mentioned earlier, there are widespread public concerns about the potential adverse impact of genetically modified organisms (GMOs) on human health, biodiversity and the environment. Several of these concerns are genuine. In order to take advantage of recombinant DNA technologies without associated harm to human or ecological health, it is important that every country has in place suitable institutional structures and regulations for biosafety, bioethics and biosurveillance. At the same time, there is need for greater investment of public funds for public good research, the results of which can reach the unreached. For example, in food and agriculture, there is need to strengthen both National Agricultural Research Systems and the International Agricultural Research Centres supported by the CGIAR.

## ii. THE ECOTECHNOLOGY REVOLUTION

Knowledge is a continuum. There is much to learn from the past in terms of the ecological and social sustainability of technologies. At the same time, new developments have opened up new opportunities for developing technologies which can lead to higher productivity without adverse impact on the natural resources base. Blending traditional and frontier technologies leads to birth of ecotechnologies with combined strengths in economics, ecology, social and gender equity, employment generation and energy conservation.

For example, in the area of water harvesting and sustainable use, there are many lessons to be learnt from the Australian experience. There is need to conserve traditional wisdom and practices, which are often tending to become extinct (Agarwal and Narain, 1997). The decision of the World Intellectual Property Organization (WIPO) to explore the intellectual property needs, rights and expectations of holders of traditional knowledge, innovations, and culture is hence an important step in widening the concept of intellectual property. FAO has been a pioneer in the recognition of the contributions of farm families in genetic resources conservation and enhancement by promoting the concept of "Farmers Rights". Like WIPO, UPOV (Union for the Protection of New Varieties of Crops) should also undertake the task of preparing an integrated concept of breeders' and farmers' rights. UPOV itself should be restructured to become a **Union for the Protection of Farmers' and Breeders' Rights.**

### iii. THE INFORMATION TECHNOLOGY REVOLUTION

New communication and computing technologies are already influencing life on our planet in a profound manner.

a. Access to the internet will soon be universal, and it can provide unrestricted low-cost access to information, as well as highly interactive distance learning. The internet will not only facilitate interactions among researchers, but also greatly improve their ability to communicate effectively with the potential users of their research knowledge.

b. Computing makes it possible to process large-capacity databases (libraries, remote sensing and GIS data, gene banks) and to construct simulation models with possible applications in ecosystem modeling, preparation of contingency plans to suit different weather probabilities and market variables.

c. The software industry is continuously providing new tools that increase research productivity and create new opportunities for understanding complex agroeco systems.

d. Remote sensing and other space satellite outputs are providing detailed geographic information useful for land and natural resources management.

The promotion of ecotechnology development and dissemination, the effective adoption of integrated systems of gene and natural resources management and the effective harnessing of information technologies should become essential elements of the "science and technology for basic human needs" movement.

## LESSONS FROM DEVELOPMENT ASSISTANCE FOR AGRICULTURAL RESEARCH

Agriculture, including crop and animal husbandry, forestry, fisheries and agro-processing, is still the mainstay of the rural economies of most developing countries in the Asia/Pacific Region. Although the share of agriculture in national GDPs is gradually going down in many countries in this region as a result of the diversification of income sources, the onus for providing jobs or sustainable livelihoods still rests predominantly with the farm sector. In India, for example, the contribution of agriculture to national GDP is now only 30 percent; however 60% of the population of India, now numbering a billion, depend on agriculture for their livelihood. Agricultural progress under such situations has to lead to not only more food production, but also to more jobs and income.

A majority of the 1.3 billion individuals, who according to the World Bank now live on a daily income of less than 1 US dollar belong to the categories of landless and resource-poor small farm families (Swaminathan, 1999). Such landless labour families often migrate to towns and cities looking for jobs leading to the growth of urban slums. The State of Agriculture Report of FAO (1998) points out that rural non-farm equipment can help to reduce poverty substantially. In other words, an integrated on-farm and off-farm employment strategy is essential if agricultural progress is to lead to rural prosperity. Thus, it is in the context of agriculture's pivotal role in strengthening not only national food and nutrition security, but equally importantly the livelihood security of the poor that the impact of development assistance has to be measured.

A further dimension which needs to be considered is the impact of development assistance on the ecological foundations of sustainable advances in biological productivity. Agricultural progress depends upon the conservation and enhancement of land, water, biodiversity and forests, as well as on the prevention of atmospheric and ocean pollution and the protection of the ozone layer. It is in this background, that the development assistance provided by Australia has been particularly meaningful.

Taking the example of India, it is clear that development assistance has played a significant role in strengthening the research and educational infrastructure in agriculture. Between 1900 and 1947, the annual growth rate in food production in India was hardly 0.1 percent. Between 1970 and 1999, this rate grew to nearly 2.8%. This helped to keep the growth rate in food production above that of the rate in growth of population. How did India transform itself from a position of hopelessness on the food production front to one of the leading agricultural producers of the world?

India's independence was born in the backdrop of the great Bengal Famine of 1942-43, which resulted in nearly 3 million deaths. Independent India therefore accorded high priority to agricultural research and education. Today, the Indian Council of Agricultural Research, the national coordinating and funding agency for agricultural research and education supports one of the largest national agricultural research systems (NARS) in the world. The Indian NARS consists of 35 agricultural and veterinary universities, 4 national universities in agriculture, veterinary sciences, dairying and fisheries, and a large number of national institutes and Advanced Research Centres all over the country. Inter-disciplinary - and inter-institutional collaboration is achieved through All India Coordinated Research Projects, which represent national grids of inter-disciplinary experiments.

Among development agencies, the US Agency for International Development (USAID) was the earliest to extend support to developing Agricultural Universities on the model of the US Land Grant Universities. The first such University was established at Pant Nagar in the State of Uttar Pradesh in 1958. The manner in which the US government extended its assistance was a novel one. USAID entrusted the task of helping in the development of one Indian Agricultural University to one US University. In this manner, symbiotic partnerships were developed between leading and established US Universities and their now born Indian counterparts. This partnership played a major role in human resource development and capacity building. It also helped to introduce a flexible system of farm education based on a trimester and course-credit system of curriculum organisation.

The Rockefeller and Ford Foundations played an equally significant role in helping India to develop its infrastructure for agricultural research education and development. The Rockefeller Foundation helped to establish a Post-graduate school at the Indian Agricultural Research Institute (IARI), New Delhi. The IARI PG School, established in 1958, made it unnecessary for Indian scholars to go abroad for Ph.D. level training. But for the IARI PG School, it would not have been possible to find the teachers needed to establish State Agricultural Universities. The other very significant contribution of the Rockefeller Foundation was the very valuable scientific and financial support extended to the All India Coordinated Research Projects of ICAR, initially in the case of maize and pearl millet and later in wheat and rice. The Rockefeller Foundation also responded to requests for arranging the visits of leading US agricultural scientists like Dr. E.C. Stakman and Norman Borlaug. The Rockefeller Foundation's support during the period 1957 to 1970 was very helpful to stimulate the transition from yield stagnation in major crops to the green revolution.

The Ford Foundation played a key role in the development of rural infra-structure and extension services through the Community Development Programme. The Ford Foundation also assisted in the establishment of Management schools in the country, including a Water Technology Centre at IARI. The generous assistance of both the Rockefeller and Ford Foundations during the nineteen fifties and sixties was particularly important since assistance was demand driven and helped to fill critical gaps in ongoing work. The assistance was flexible and dynamic. Unfortunately, government based development assistance often lacks similar flexibility and becomes supply driven.

An useful model for beneficial development assistance is provided by the international agricultural research centres sponsored and supported by the Consultative Group on International Agricultural Research (CGIAR). IARCs like the International Maize and Wheat Improvement Center in Mexico (CIMMYT) and the International Rice Research Institute (IRRI) in the Philippines extended significant help in bringing about wheat and rice revolutions in several countries including India. Their success is due to their fostering genuine research partnerships between NARS and IARCs and the attention they pay to human resource development. IARCs provide meaningful models in the field of capacity building and sustainable collaboration.

## MUTUALLY BENEFICIAL PARTNERSHIPS: LESSONS FOR THE FUTURE

The first lesson is that unless there is a strong national commitment and a sense of ownership in relation to externally funded projects, success will be uncertain. For example, concessional food aid has been both praised and criticised, particularly, if it is extended in normal times to make good for low agricultural productivity in the recipient countries. Two examples from India show that if there is strong political will at the national level, food aid can be converted into an opportunity for progress rather than become a cause for inertia and inaction. In 1965-66, India experienced a severe drought and had to import over 10 million tonnes of wheat and other food grains largely under the PL 480 programme of the United States. Australia also extended assistance. But it was in the same year that the Government of India initiated the High yielding varieties programme (HYVP) in wheat, rice, maize, sorghum and pearl millet in 32 million ha. HYVP led to the green revolution and transformed national and international mood from despair to hope with reference to India's agricultural capability.

Another example relates to milk production. India received in the sixties and seventies substantial assistance from European Union countries, New Zealand and Australia in the form of milk powder and butter oil. The money generated by selling these were used by the National Dairy Development Board to build milk cooperatives. Today India is the world leader in milk production. Thus, where there is the necessary political will and action, short term development assistance can be used as a catalyst for achieving long term self-reliance.

A second lesson is the need for humility on the part of development assistance agencies. It is important to understand clearly the agro-ecological and socio-economic conditions and the cultural-spiritual values prevailing in a country, if there is to be a proper match between felt needs and development agency response. The attitude of the Development Agency should be one of sustained partnership and not of patronage. A withdrawal strategy should be built into the design of assistance, so that the programme does not collapse when the external agency withdraws. A third lesson relates to the building of the competence and self-confidence of the scientists belonging to the NARS. In particular, attention should be paid to leadership training. Unless there are national scientists whose voice is listened to with respect by their political leaders, sustained progress will be difficult. Expatriate experts can never fill the void created by lack of strong national scientific leadership. This goal can be realised if development assistance is based on the principles of symbolic partnership, sustainability and social relevance. Above all, development agencies should realise that to be effective, scientific leadership must be home grown and not externally imposed.

We are entering an era of expanded partnerships not only between development agencies and NARS, but also with the private sector. In all cases, the ultimate goal should be to create a technological and policy environment which can enable every individual to have an opportunity for a productive and healthy life.

## CONCLUSIONS

To sum up, there is no time to relax on the food production front. It is obvious that we have to produce more, but produce it in a manner that there is no adverse environmental or social impact. Water is likely to be a serious constraint in many countries. Hence, priority should be given to developing and spreading efficient water management techniques, including aquifer management, waste water recycling and cojuctive use of surface and rain water. Future agricultural production technologies should be based on the foundation of integrated natural resources management. This is where Australian experience and expertise will be of particular value.

The world can produce enough food for a population of 10 billion by harnessing the untapped yield reservoir existing even with currently available technologies, if greater attention is given to soil health care and water management. We must **defend** the productivity gains so far made, **extend** the gains to semi-arid and marginal environments, and **work** for new gains using blends of frontier technologies and traditional ecological prudence. The problem of generating adequate purchasing power to enable families living in poverty to have economic access to food will still confront us. This is where a job-led economic growth strategy based on micro-level planning, micro-enterprises and micro-credit will be of great help. Integrated production and post-harvest technologies and on-farm off-farm employment strategies will be needed to provide livelihoods for all in rural areas.

With increasing globalisation of economies, it will be necessary to agree at the international level that safeguarding and strengthening the livelihood security of the poor should be a major goal of liberalised trade. The current trend of increasing rich-poor divide will have to be stopped, if social conflicts are not to increase. Thus, we are really walking a tightrope in terms of achieving sustainable solutions to the problems of population, poverty and environmental degradation. The various international conferences held during this decade starting with the Childrens' Summit held in New York in 1990 and ending with the World Conference on Science held at Budapest in 1999, have indicated possible solutions to these problems. It is now for nations to act individually and collectively so that the uncommon opportunities now opened up by science and technology and democratic systems of governance for creating a food secure world are not missed.

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-Eugene Black

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