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Volume 4

FOOD SCIENCE AND HUMAN WELFARE

EDITORS

J.V. McLoughlin

B.M. McKenna

Proceedings of the Sixth International Congress of Food Science and Technology, Dublin, September 18-23, 1983

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September 1983, Dublin

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The Sixth International Congress of Food Science and Technology was held in Dublin, Ireland, in September 1983. The Organising and Academic Programme Committees were drawn from the Institute of Food Science and Technology of Ireland and other institutions.

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PREFACE

The Sixth World Congress of Food Science and Technology was held in Dublin in 1983. It was organised by the Institute of Food Science and Technology of Ireland under the auspices of the International Union of Food Science and Technology. The theme of the Congress was *Development, Welfare and Peace;* the ultimate objective, the application of science and technology to human needs. The programme included new developments in the production and preservation of animal and plant foods; recent advances in fundamental aspects of science; the use of biotechnology in industry; plant design and construction; conservation of energy; the consumer's perception of quality; and safety of foods; diseases of affluence and deprivation; special dietary requirements of the aged; infant nutrition; and nutrition education and policy. The problems of the developing countries were given particular attention at this Congress. Presentation related to these areas of the world dealt with the influence of social, economic and political circumstances, systems of land tenure and traditional food practices on human nutritional status. The special relevance of indigenous, labour-saving technologies and the appropriate training of technologists to development was recognised.

The published proceedings consist of five volumes. The first three volumes contain free communications; the fourth and fifth include the invited contributions by authors of established international reputation. This volume comprises twenty-five papers concerned with the interrelations between science, society and the human conditions.

J.V. McLoughlin
B.M. McKenna

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SCIENCE AND TECHNOLOGY FOR NATIONAL FOOD SECURITY

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Globally we are at the crossroads in the application of science and technology for increasing food production and consumption. There are countries like the United States of America where, thanks to the widespread application of science-based technology, agricultural production and productivity have shown such remarkable improvement that steps such as 'payment in kind' to persuade farmers to keep land fallow have to be adopted. On the other hand, there are many poor nations where the per capita availability of food has declined during the 1970s. There are still others where the limited application of science and technology to food production aroused hopes of widespread 'green revolution'; but these hopes were not materialized because of an inadequate match between the technological package and the package of services and public policies essential for the diffusion of new technologies.

The fact that only a dynamic research system can sustain a dynamic production programme is yet to be fully recognized in developing countries. This Congress therefore is being held at an appropriate time. We can objectively examine at this forum the reasons for slow progress in achieving the goal of the World Food Congress of 1974, namely that by 1984, no child or woman or man should go to bed hungry and that no human being's physical or mental potential should be stunted by malnutrition.

Problems of hunger are complex and can be solved only with the necessary combination of political will, professional skill and peoples' action. Science can only show the way. The magic wand which can remove hunger and absolute poverty is in the hands of political leaders and administrators. In a scientific congress of this kind, we can only underline the importance of taking measures which can help to bridge the gap between potential and actual farm yields, even at currently available levels of technology, and draw attention to the new frontiers now emerging in food science and technology.

BUILDING NATIONAL AND GLOBAL FOOD SECURITY

Since the World Food Conference held in Rome in 1974, several steps have been taken to develop a global food security system to insulate humankind from mass starvation due to crop failure or wide gaps between demand and supply. These fall into three broad areas of action, namely: (1) identification of famine indicators and establishment of a global famine early-warning system; (2) creation of an adequate food security reserve; and (3) long-term policy changes leading to both more production and more equitable distribution of food and of resources necessary for this purpose. The following are some of the more significant steps:

A Global Information and Early Warning System: This was initiated in 1975 by the Food and Agriculture Organization (FAO). The system provides data to help initiate suitable preventive and remedial measures to overcome the difficulties that may arise if famine potential develops. About 100 countries participate in it. The system has proved itself on many occasions (as during the African food emergency of 1980-81) to be an essential link in the world's food security network. Although FAO provides the early warning system, national governments must develop a mechanism for timely action.

The International Emergency Food Reserve (IEFR): Started in 1975, it has distributed 1.8 million tons of food grains and about 150,000 tons of other foods to stricken people. IEFR's annual target is 500,000 tons of cereals.

The International Fund for Agricultural Development (IFAD): IFAD was established in 1977 to promote an increased flow of external resources for food production and rural development. IFAD has committed $1,400 million for projects and programmes in 100 developing countries.

The World Food Council (WFC): The WFC was established by the United Nations General Assembly in December 1974 to provide 'co-ordination and follow-up of policies concerning food production, nutrition, food security, food trade and food aid, as well as other related matters, by all the agencies of the United Nations system.' It is enjoined to 'review periodically major problems and policy issues affecting the world food situation and the steps being proposed or taken to resolve them by Governments, by the United Nations system and its regional organization' and to recommend remedial action. WFC is an organ of the United Nations and reports to the General Assembly through the Economic and Social Council.

The WFC organizes an annual, ministerial-level conference to review the global food situation and develop regional and national food security systems. Its major goal is to raise the political priority for food.

The International Wheat Council (IWC): The International Wheat Agreement 1971 consists of two separate legal instruments: the Wheat Trade Convention 1971 (as extended) and the Food Aid Convention (as revised in 1980 and subsequently extended). The Wheat Trade Convention is administered by the International Wheat Council and the Food Aid Convention is administered by the Food Aid Committee. The Food Aid Committee (membership of which is limited to contributor countries) does not have its own secretariat but is serviced by the IWC secretariat.

The Food Aid Convention (FAC): This was enlarged in 1980 and has a target of 10 million tons of food grains.

The International Monetary Fund Compensatory Facility: This was established in 1981 to provide assistance to nations which must import additional food grains to feed their population. This new financing mechanism has made credit up to $300 million available to 5 developing countries.

Other FAO Programmes: The Food Security Assistance Scheme, the International Fertilizer Supply Scheme and the Action Programme for the Prevention of Food Losses — these programmes also provide help to needy countries.

World Food Programme (WFP): The WFP was started in 1963 jointly by UN and FAO. Since it commenced operations 20 years ago, WFP has committed more than $5 billion of assistance to over 1,100 development projects in 114 developing countries. In addition, WFP has provided more than $1 billion of food aid to almost 600 emergency operations in 103 countries. In total, this assistance has helped 170 million people. Thus, WFP has become a very meaningful multilateral development assistance organization. WFP is not only helping to alleviate human distress, both in normal times and during emergencies, but it is also increasingly helping to prevent distress sales of food grains by small farmers by making purchases from its own resources in developing countries. However, the fact that WFP has been able to assist only about 170 million people during 1963-83, in contrast to an estimated 500 million people suffering from hunger today, underlines the urgent need for similar initiatives at the national and regional levels.

Regional Food Security: A good example of regional food security is the recently established ASEAN Food Security Reserve Agreement. Several other regional mechanisms to plan and establish food reserves are under discussion.

National Food Security Programmes: Food reserve programmes have been initiated in 72 countries, of which 60 are developing nations. The United States has established a Food Security Wheat Reserve of 4 million tons to meet emergency needs. The US farmer-owned reserve and large national buffer stocks of food established by major food-deficit countries such as China, India, Indonesia and Japan have also contributed to world food security. However, these reserve stocks are often below target levels. National early warning systems are slowly being improved and devices have been introduced into bilateral grains contracts to limit large-scale preemptive buying.

The preceding measures indicate a positive movement toward achieving world food security. A new General Agreement on Tariff and Trade (GATT) Committee has been set up to recommend methods of achieving greater liberalization in agricultural trade by 1984. If this Committee can devise a pattern of trade that will increase the flow of resources to the agricultural and rural sectors of developing countries, it will have done a great service, not only to the poor nations but also to the industrial sector of developed countries since agrarian and rural prosperity stimulates the demand for a variety of industrial products.

COMPONENTS OF A NATIONAL FOOD SECURITY SYSTEM

Regional and global food security is possible only if every country develops a strong national food security system. An effective system must include the following (Swaminathan, 1982):

- ecological security to protect the basic life-support systems upon which sustained agricultural improvement depends;
- technological security to ensure that yield improvement is coupled with production stability;
- grain reserves, safe storage and improved post-harvest technology;
- social security to provide purchasing power to the urban and rural poor through greater opportunities for gainful employment;
- drinking and irrigation water security;
- nutrition education;
- population stabilization.

An integrated National Food Security System should give concurrent, integrated attention to ensuring stable and adequate food production and supply, and security of access to supplies. Above all, a food security system must ensure that the short-term goals of agricultural development do not endanger long-term prospects for producing more food from limited land resources. Success in population stabilization will ultimately determine the fate of food security programmes.

ROLE OF SCIENCE AND TECHNOLOGY IN IMPROVING CROP PRODUCTIVITY AND AGRARIAN PROSPERITY

Until the beginning of this century, agricultural production increased largely through area expansion. In countries like Japan, there has been a steady improvement in the yield of crops like rice during the last ten centuries, thanks to the development of techniques for soil fertility restoration and enrichment as well as irrigation. During the present century, major advances have taken place in four broad areas — genetic improvement, chemical technology application, engineering (including irrigation water management) and above all, integrated systems of farm management. These scientific advances, when supported adequately with appropriate government policies, lead to sustained progress in food production. Prior to the modernization of agriculture, weather and pest epidemics were the major causes of undulations in production. However, after the introduction of science and technology, purchased inputs like improved seeds, mineral fertilizer and pesticides became important. With increased investment in farming, the cost, risk and return structure of cropping patterns had a dominant effect on farmers' decision-making. This is why public policies in the realm of land ownership and tenure, input-output pricing and marketing became important to enable the spread of scientific agriculture.

Taking mainly rice as an example, I would like to illustrate some of the major scientific ingredients which have gone into the improvement of yield coupled with stability of performance.

Increasing and Stabilizing Rice Production in Irrigated Areas

Developing countries are making considerable investments to bring more land under irrigation. Most of the rice cultivated in China is irrigated. In India, nearly 2.5 million hectares are brought under irrigation each year. In the Philippines, about 100,000 hectares are added to the irrigated area every year. Therefore, a priority area of research relates to the optimum use of water so that the yield per liter of water can be maximized. In this context, much research has been done on all aspects of water delivery and on-farm management of water. Methods of achieving equitable distribution of water in the head and tail ends of a command area have been developed.

Prior to the introduction of the Dee-gee-woo-gen and Norin dwarfing genes in rice and wheat respectively, lodging was a serious problem under conditions of good soil fertility. This is why varieties of rice and wheat possessing a semi-dwarf and non-lodging plant type became popular with farmers very speedily. The first high-yielding rice variety was developed by the International Rice Research Institute (IRRI) by crossing Peta, a tall strain from Indonesia, and Dee-gee-woo-gen, and resulted in the variety IR8. Soon it was found that when the ecology of the rice field is changed by the application of more water and fertilizer, the threat to yield caused by the triple alliance of weeds, pests and pathogens could become serious. Small farmers obviously can invest in inputs only when risks are low. Therefore, high-yielding varieties characterized by stability of performance were needed. IRRI, hence, introduced to its breeding programmes the following approaches in order to combine yield potential with multiple resistance to pests and diseases:

- continuous identification of new genes for resistance to each of the major diseases and insects;
- sequential release of improved germplasm with different major genes to combat new races of diseases and biotypes of insects;
- pyramiding of two or more genes into the improved rice germplasm using pedigree method or population-breeding approach;
- gene rotation to reduce the chances of development of races or biotypes;
- development of multi-line varieties;
- development of several varieties for a region with different genes for resistance;
- development of varieties with horizontal resistance;
- wide hybridization combined with disruptive mating to incorporate genes for resistance from wild germplasm;
- use of cell culture techniques to develop resistance to toxins produced by major fungal and bacterial diseases.

The pedigree of IR36, which is now cultivated in over 10 million hectares in Asia, is an index of the power of the breeding strategy designed to bring about a pyramiding of

TABLE 1
Disease and Insect Reactions of IR Varieties in The Philippines

Variety	Growth duration (days)	Blast	Bacterial blight	Grassy stunt	Tungro	BPH Biotypes 1	BPH Biotypes 2	BPH Biotypes 3	GLH	Stem borer	Gall midge
IR 5	140	MR	S	S	S	S	S	S	MR	MS	S
IR 8	130	S	S	S	S	S	S	S	MR	S	S
IR20	125	MR	R	S	MR	S	S	S	MR	MR	S
IR22	125	S	R	S	S	S	S	S	S	S	S
IR24	120	S	S	S	S	S	S	S	MR	S	S
IR26	130	MR	R	S	MR	R	S	R	MR	MR	S
IR28	105	R	R	R	R	R	S	R	R	S	S
IR29	115	R	R	R	R	R	S	R	R	S	S
IR30	110	MS	R	R	R	R	S	R	R	MR	S
IR32	140	MR	R	R	R	R	S	R	MR	MR	S
IR34	130	R	R	R	R	R	S	R	R	MR	S
IR36	110	R	R	R	R	R	R	MR	MR	MR	R
IR38	125	R	R	R	R	R	R	MR	R	MR	R
IR40	120	R	R	R	R	R	MR	S	MR	MR	R
IR42	135	R	R	R	R	R	R	S	MR	MR	R
IR44	130	MR	R	S	R	R	R	MR	MR	MR	S
IR46	130	R	R	S	R	R	S	R	MR	S	S
IR48	140	MR	R	R	R	R	R	S	MR	S	S
IR50	105	MS	R	R	R	R	R	MR	R	MR	S
IR52	115	MR	R	R	R	R	R	MR	R	MR	—
IR54	120	R	R	R	R	R	R	S	R	MR	—
IR56	110	R	R	R	R	R	R	R	R	MR	—
IR58	100	R	R	R	R	R	R	R	R	MR	—

major genes for resistance. IR36 includes in its ancestry 11 different varieties from 6 countries and a wild species, *Oryza nivara*. IRRI breeders have been able to combine in recent years multiple resistance to pests with earliness and good yield potential (Table 1). Earliness enables multiple cropping wherever there is irrigation.

To make broad-based breeding work possible, there is need for the collection, conservation and evaluation of rice genetic resources. IRRI has, therefore, established an International Rice Germplasm Centre. At present, over 65,000 strains are available in this collection — estimated to represent over 50 per cent of the world's genetic variability in rice. All the collections are systematically screened for nearly 40 different characters under a Genetic Evaluation and Utilization (GEU) programme.

A great advantage of regional and international collaborative research is the possibility of identifying breeding material suited to different ecological conditions. Under the International Rice Testing Programme (IRTP), the best available varieties from all rice-growing countries are tested in common trials at many locations. Consequently, varieties developed in one country have been found to be suitable for release in some others (Table 2). International co-operation also helps to screen segregating material at 'hot spot' locations for major pests and diseases, as well as

TABLE 2
Some Examples of IRTP Entries released in Different Countries

IRTP Entry	Country of Origin	Country where Released
IET1444	India	Nepal
IET2935		Nepal
IET2855		Mali
Pelita I-1	Indonesia	Burma, Vietnam
KN117		Burma
Kn-1b-361-1-8-6-10		Philippines
BG90-2	Sri Lanka	Burma, Nepal
BKN6986-108-3	Thailand	Burma
Biplab.	Bangladesh	Vietnam
BR51-46-C1		India
C22	Philippines	Burma
IR1529-680-3-2	IRRI (Philippines)	Burma, Mali, Niger, Upper Volta
IR36		Indonesia, India, Philippines
IR42		Cameroon, Nigeria, Philippines
IR2307-247-2-2-3		Vietnam
IR2053-57-3-1		Bangladesh
IR2793-80-1		Bangladesh
Cica 8	CIAT (Colombia)	Belize, Guatemala, Honduras, Panama, Paraguay
Cica 4//IR665/Tetep		Sierra Leone