Saving Lives Through Agricultural Research

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The Twentieth Century has been one of the most remarkable and significant periods in the history of man. One reason has been the tremendous growth and improved stability of food production, especially since World War II. This century, particularly the latter half, was the time when agriculture changed from a resource- and tradition-led enterprise to a science-based industry. The change to a science-based agriculture has meant higher and more stable production and a better way of life for millions of people. The most important development of the Twentieth Century has been our ability to produce larger harvests, thereby ensuring food stability and security for a constantly growing world population. This is the great story of our century, and it has gone largely unrecognized, partly because most people do not know just how insecure and unstable agriculture was in times past.

As the Australian Professor Derek Tribe (1987) reminds us, only 20 to 30 years ago "most well-informed commentators were predicting massive, worldwide famines before the end of this century". Professor Tribe goes on to quote Paul Ehrlich (1967), *a professor at Stanford University, who predicted:*

"In the 1970s and 1980s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now". Such predictions of massive starvation haven't come true, largely because agricultural production has performed much better than the more pessimistic observers ever

[1] Based on a paper presented at "American Agriculture in the World of the 90s", Hudson Institute, Indianapolis, IN, April 16-17, 1990. See also: Saving Lives Through Agricultural Research, In: Avery, Dennis, editor. Global Food Progress-1991. Hudson Institute, Indianapolis, IN, USA (in press).

expected. Scientific agriculture has been responsible in large part for many of the gains made.

Agricultural Yields

Before this century, and for most of the history of man, agricultural yields were low and unreliable (Evans, 1980). Agriculture was an uncertain business. Producers had to rely on their own experience and intuition for innovations. Options for change in production techniques or new ways to improve production were few indeed. The consequence was frequent crop failures and famine. Life for rural folk was difficult and unlikely to change. For example, Fourteenth Century wheat yields in England were about 450-500 kg/ha (8 or 9 bushels per acre) or about four times the amount of seed that was sown (Stanhill, 1976), as contrasted with 5,600 kg/ha (100 bushels per acre) today. Feudal agriculture just wasn't a very productive system.

About 900 AD, rice yields (brown rice) in Japan were about 1,000 kg/ha (25-30 bushels per acre). It took almost 1,000 years for those yields to double; for example, by 1868, at the time of the Meiji Revolution, yields had reached 2,000 kg/ha of rough (unhulled) rice. The introduction of controlled irrigation in Japan helped boost rice yields, and by 1930 yields had increased to 3,000 kg/ha. After 1930, chemical fertilizers began to be used, and by 1954 yields had reached 4,000 kg/ha; thus it had taken almost 100 years for Japanese rice yields to double again. Heavy nitrogen use after World War II led to improvements in variety, plant protection, soil improvement and cultural management (Yoshida, 1981). Today, Japan enjoys very high rice yields because of the integrated use of modern technologies. The highest farm yield of rice ever recorded in Japan was 13.2 tons/ha in 1960.

The slow steady growth of yields over time has been a feature of man's history. Medieval cereal yields in Europe and early yields of millet in China, for example, are about equal to yields obtained by Zohary (1969) when he harvested wild cereal relatives in Galilee. However, irrigated yields in the Middle East could be higher than those wild cereal yields; wheat yields of about 2,000 kg/ha (35-40 bushels per acre) were reported in Mesopotamia about 2400 BC, but by 1700 BC yields there were only one-third of those earlier, probably due to salinization of the irrigated soils.

Average cereal yields have increased steadily with the amount of fertilizers used (Evans, 1980). Cereal yields in the *United States* and the United Kingdom approached 4 tons per hectare by 1974, as a result of increasing fertilizer use, especially in the UK. Cereal yields in Japan exceeded 5 tons/ha by 1974, as a result of heavy fertilization, almost 500 kg of fertilizer/ha of arable land. Those trends have continued, as research continues to produce new crop varieties, finds ways to use inputs more efficiently, and improves crop husbandry practices.

The Rise of Modern Agriculture

Since the rise of agriculture perhaps 10 to 12 thousand years ago, most progress in production has been slow and halting. Farmers led the way in improvements, mostly by trial and error, and crop failure was frequent. Options for farmers were few and new information was hard to come by and slow to spread. Innovators and good observers were most likely to discover ideas that would improve crop or animal husbandry. Crop rotation, irrigation, use of legumes, manuring, and other practices were largely the discoveries of farmers. Farmers also developed almost all of the established breeds of farm animals, and were responsible for most of the selection that led to the crop varieties that we now consider landraces (traditional farmers' varieties).

For most of man's history, production increases came largely as a result of expansion of the area cultivated. Such expansion is still going on, although at a slower pace; for example, the world's arable area increased by 16 percent between 1950 and 1980 and the area in major food crops increased by 23 percent. Other than land expansion, however, there were very few means available to farmers to increase production per unit of land cultivated. Under such conditions, the productivity of an individual farmer was low, and many persons had to be employed in agriculture just to make a meager living and to provide small surpluses to feed the landless and a growing urban population.

Modern agriculture had its origins in the latter part of the Nineteenth Century, but especially during the Twentieth Century. The basis for this change was the advent of scientific agriculture. Discoveries in agricultural chemistry concerning the nutrient requirements of plants led to the development of the fertilizer industry and to a dramatic increase in fertilizer use, especially since World War II. Also, the rediscovery of Gregor Mendel's laws of genetics in the early 1900s established the basis for plant breeding. By then, agricultural research was on its way to improving farm life in Europe, North America, Australia, New Zealand and Japan, and its efforts would be felt in other countries in years to come.

Yields in Europe, North America, and Australia increased fairly slowly during the first half of the Twentieth Century. Most of the varieties used were traditional landraces, and plant nutrition needs were met mostly by animal manures and crop rotations. Fertilizer use increased slowly during this time, from about 2 million tons worldwide at the beginning of the century to 4 million tons at the start of World War I, to 9 million tons in 1938-39 (Wortman and Cummings, 1978). Fertilizer consumption in 1945 was 7 million tons; from there it increased sharply to 21 million tons in 1955, 31 million tons in 1965, about 90 million tons in the mid-1970s and 132 million tons in 1987 (IFDC, 1989).

So higher fertilizer use was one of the keys to improvements in developed country agriculture. And crop breeding advances were also beginning to make their contribution to crop productivity. An outstanding advance was the development of hybrid maize (corn) in the United States. First developed just before World War I, hybrid maize began to be used on farms in the 1930s. A specialized seed industry grew up to take advantage of the scientific gains made by the breeders. From the time of the Civil War (1861-1865) to the 1930s US maize yields were about 1400 kg/ha (25 bushels per acre). Since the introduction of hybrid maize in the 1930s yields have increased more than fourfold, to 6,700 kg/ha (120 bushels per acre).

The big gains in scientific agriculture were made following World War II. Indeed, David Grigg (1985) states, "During the last 40 years [since 1950] agriculture has undergone a revolution more profound than anything experienced in the past". Organic pesticides were developed to help control weeds, insects and plant diseases. Increasingly, new pesticides were selective in their effects. New machinery was developed to prepare and till the land and to help in harvest. Farmers began to take advantage of these new opportunities and thereby improved their productivity. Increased specialization of agriculture began. Agricul-

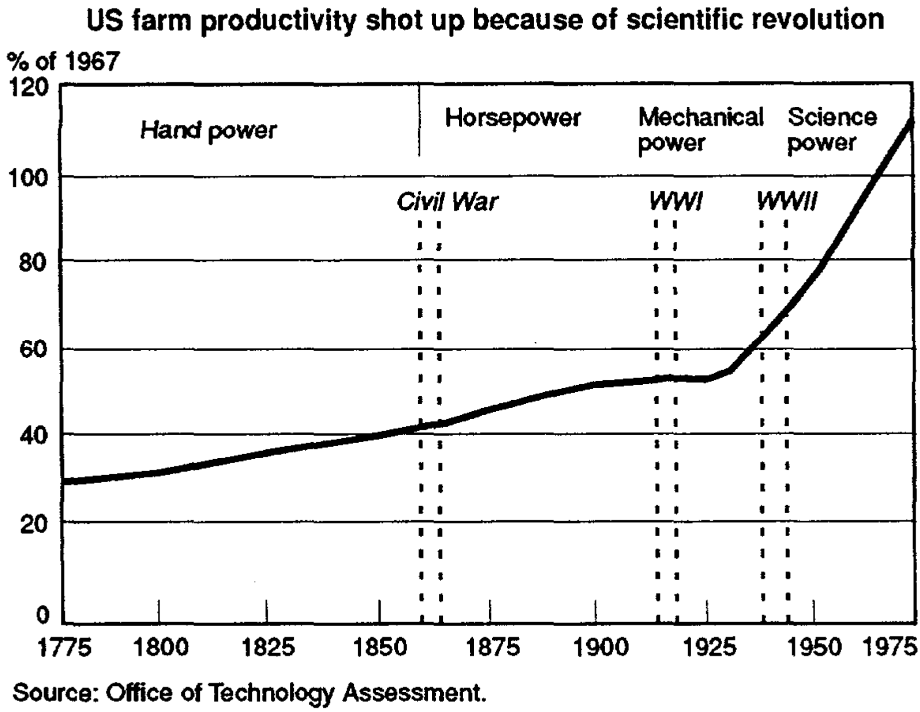

Figure 1. Farm productivity and scientific revolution in the United States (from Calvin, 1983).

tural research began to be seen as a good investment by governments as well as private firms (Figure 1).

Concerns for developing country agricultural development also grew after World War II. The question was how agricultural development in developing countries could grow and accelerate to meet the needs of growing populations. This is discussed later under "The Green Revolution".

Famines

Famines were frequent in the past. Probably the oldest record of famine is found on the 'Stele of Famine', found at the first Cataract of the Nile. This column was erected more than 5,000 years ago. An inscription on the stele states: "Plague stalketh through the land.... Towns are destroyed and Upper Egypt has become an empty waste.... He that layeth his brother in the ground is everywhere to be found". In an Egyptian tomb dated about 2000 BC was inscribed: "All of Upper Egypt was dying of hunger to such an extent that everyone had come to eating his children" (Scrimshaw, 1987). We also can read the story of Joseph in the Bible who stored grain from 7 years of plenty for use during 7 years of want (Genesis); that probably occurred about 1700 BC. Nine books of the Bible also refer to ten famines in Palestine from 1850 BC to 46 AD (Scrimshaw, 1987). The famines of Greece have been described by Plato, Thucydides, and Aristotle.

Famines were common in the Roman Empire after 500 BC, and increased again after 500 AD following Rome's collapse. Famine almost certainly played a role in the fall of Rome (Scrimshaw, 1987). Many of Rome's famines were transportation famines, since Rome was a city dependent upon transportation of basic cereals from distant production sites, usually North Africa and Spain. Little staple food was produced on the Italian peninsula. Also, it was in the Emperor's interest to transport food to the far-flung legions stationed abroad. Thus, any failure in transport to Rome or to its army elsewhere led to severe famine.

France experienced more than 75 famines between 501 and 1500. Famines were frequent in England, Ireland, Scotland, Wales, Germany, Denmark and Sweden. All of Europe was affected by the great famine of 1315-17, when more than one-fourth — some authorities say many more than one-fourth — of the population of Europe is thought to have died from a combination of plague, the Black Death and famine.

As Western Europe improved its food situation, Eastern Europe became more hungry. More than 500,000 people are estimated to have died in a 3-year famine that began in 1601 in Western Russia and neighboring countries. Frequent famines continued throughout Europe during the Middle Ages, the Renaissance and the Industrial Revolution. It is believed two-thirds of the population of Italy died of famine in 1347.

The Great Famine in Ireland began in 1845 and lasted for some 5 years. Best estimates are that perhaps one and a half million people died and another million emigrated to the United States.

In more recent times Asia has become a focal point for famine. China recorded 1,829 famines between 108 BC and 29 AD (Scrimshaw, 1987). This pattern continued, but most devastating were four famines in the nineteenth century, when in 1810, 1811, 1846, and 1849, some 45 million people died. In 1406 Prince Chu Su, a member of the Ming imperial family, published a book which translated means, literally, "Salvation-in-the-Midst-of-Desolation-Herbal". After 1382, the Prince had established a "famine garden" in which he collected and studied more than 400 wild plants which people had used or might use in time of famine (Christopher, 1985). Nine million died in the famine of 1875-78. A half million people starved in China in 1920.

India, too, has seen frequent famine over its history. The last great famine was in West Bengal in 1943, although smaller famines occurred in Bengal in 1960-61 and Assam as recently as 1974 (Table 1).

Table 1. Some major famines, numbers of victims in millions and precipitating factors (from Sustaining Agricultural Yields, Plucknett et al., in preparation).

		People (million)		Precipitating	
Year(s)	Location	Affected	Deaths	Factor	Source
1769-70	Bengal, India		10.0	Drought	Alamgir, 1981; Sen, 1981
1837-38	NW India	2.8	0.8	Drought	Alamgir, 1981
1845-46	Ireland	3.0	2.0	Plant Disease[1]	Alamgir, 1981
1876-79	China		9.5	Drought	Kane, 1988:33
1891-92	Russia	20			Edgar, 1925:63
1896-97	India		5.0	Drought	Alamgir, 1981
1920-21	N. China	20	0.5	Drought	Kane, 1988:36
1928-29	China		3.0	Drought	Cox, 1981
1943	Bengal, India	10	1.5	Flood, Plant Disease[2]	Uppal, 1984; Sen, 1981:52

[1] Late blight of potato.

[2] Fungal epidemics in rice caused by excessive rainfall.

Some of the recent famines are geo-political in nature. Include here the famine in Bangladesh in 1974-75, and those recent famines in Africa, notably Ethiopia and the Sudan. The latter two were aggravated by a severe drought, but deaths would certainly have been lower had political considerations not ruled.

Experts classify causes of famine into five categories: (1) physical famines occur where the production environment is hostile but where the population develops methods to produce in all but the most extreme years [e.g. Egypt]; (2) transportation famines occur in highly urbanized areas dependent on food transported from distant sources [e.g. ancient Rome]; (3) cultural famines "occur in food surplus regions and are induced by archaic social systems, cultural practices and overpopulation" [e.g. feudal Western Europe after the fall of the Roman Empire]; (4) political famines "occur in food surplus regions, or those nominally self-sufficient in food but where regional politics or regional political systems determine the production, distribution and availability of food" [e.g. Eastern Europe during 16th to 18th centuries, Ethiopia in the 1980s]; (5) population famines "occur in economic systems where caloric availability of food per capita is perennially only slightly above the starvation level" [e.g. most famines in Asia during the last 200 years, especially in India and China] (Community Nutrition Institute, 1985).

Some famines take place even in the presence of food supplies that appear adequate. In these situations the lack of purchasing power of the poor is considered to be the major factor. However, in many famines, there is no doubt that food supplies generally were inadequate, or at least that basic agricultural production, especially of staple foods and income crops, was inadequate to meet human needs.

The Green Revolution

One of the reasons Asia did not succumb to famine and massive starvation this century can be attributed to the success of the Green Revolution. In a 1985 report, entitled "Modern Varieties, International Agricultural Research, and the Poor", Michael Lipton, then professorial fellow at the Institute of Development Studies, University of Sussex, made this opening statement, "If the farmers of the Third World today used the same cereal varieties as in 1963-64, and everything else were unchanged, then tens of millions of people would this year die of hunger". Lipton goes on to say that of course other things would have changed; however, he emphasized, the impact of the semidwarf or modern varieties could not be denied.

The term, Green Revolution, was not coined by an agricultural scientist. It was first used in 1968 by William S. Gaud, former Administrator of the United States Agency for International Development, in a speech to the Society of International Development, in which he described the dramatic wheat harvests that had been achieved in 1966 to 1968 in India and Pakistan. The term gained further publicity in 1970 when Norman Borlaug was awarded the Nobel Peace Prize for his research which produced the small-statured, high-yielding Mexican wheats that had performed so spectacularly in Asia and Latin America.

Specifically, the term Green Revolution was applied to the use and spread of semidwarf, nitrogen-responsive, early maturing wheat and rice varieties in Asia. The original wheat varieties used came from Mexico where they had been developed by a joint Mexican-Rockefeller Foundation program. When these varieties were planted in irrigated areas of India and Pakistan, dramatic yield gains were achieved, exciting farmers and governments and the public at a time when famine seemed inevitable and agriculture was considered as a stagnant, hopeless sector of each nation's economy.

About the same time as the semidwarf wheats were making their dramatic entry into Asia, semidwarf rices produced by the International Rice Research Institute (IRRI) in the Philippines were also being released. Like the semidwarf wheats the new rices were high yielding, producing much higher yields with modest inputs. Earlier maturing varieties of both cereals made double cropping possible in some areas where only a single crop had been possible before.

Some persons have used the term, Green Revolution, to describe any modern innovation in agriculture. This is much too broad a concept. To some it is synonymous with mechanization, high inputs, new technology and large farms. Mechanization had little to do with the Green Revolution; it might have been a consequence of the new production gains made in a few cases, but it certainly was not part of the origin of the new technology nor an important ingredient in its development and spread. The input question is also problematical here; the new varieties were developed to be input-responsive, but high input use was not a prerequisite for good performance.

The big innovation of the Green Revolution, as far as inputs are concerned, was developing new varieties of wheat or rice that would not fall down (lodge) when nitrogen fertilizers were applied to them. It was, of course, fortuitous that the dwarf lines also tended to be earlier maturing, to produce many shoots (tillers), to produce more seeds per plant, to be less sensitive to daylength, to have a higher harvest index and to have increased resistance to pests and diseases. Indeed, the semidwarf cereals became a new paradigm in cereal improvement.

The question of whether large farmers benefited more from the Green Revolution than small farmers has been argued considerably. There were differential adoption rates in some cases, but generally both large- and small-scale farmers benefited from the new, high-yielding wheats and rices. And it is certainly true that very large benefits of the Green Revolution were gained by millions of the urban poor because of lower food prices and wider availability of these staple cereals.

There have been many benefits from the Green Revolution in rice and wheat, and a major benefit has been increased food production and yield stability of the crops. During the period 1961-80, average wheat yields in all developing countries rose from 944 kg/ha to 1,300 kg/ha; the area planted rose from 76 million to 102 million ha and production doubled to 143 million tons. At the same time population in the developing countries increased by only 50 percent. During the period 1971-1980, record wheat harvests were recorded every year except 1977 and 1980. During that 10-year period production grew by some 80 million tons, spurred especially by dramatic production gains in Asia. Figure 2 shows continuing but slower gains through 1986 (CIMMYT, 1989).

Rice too saw tremendous gains in production. Annual growth rates in production for the periods 1946-55 to 1976-80 were 3.11 percent for Southeast Asia, 2.55 for South Asia and 2.54 for East Asia. Production for Southeast Asia increased from 41 MT in 1956-65 to 57 MT in 1966-75 to 72 MT in 1976-80. For South Asia the figures were 67 MT, 84 MT and 101 MT, respectively. Both Southeast Asia and South Asia have doubled

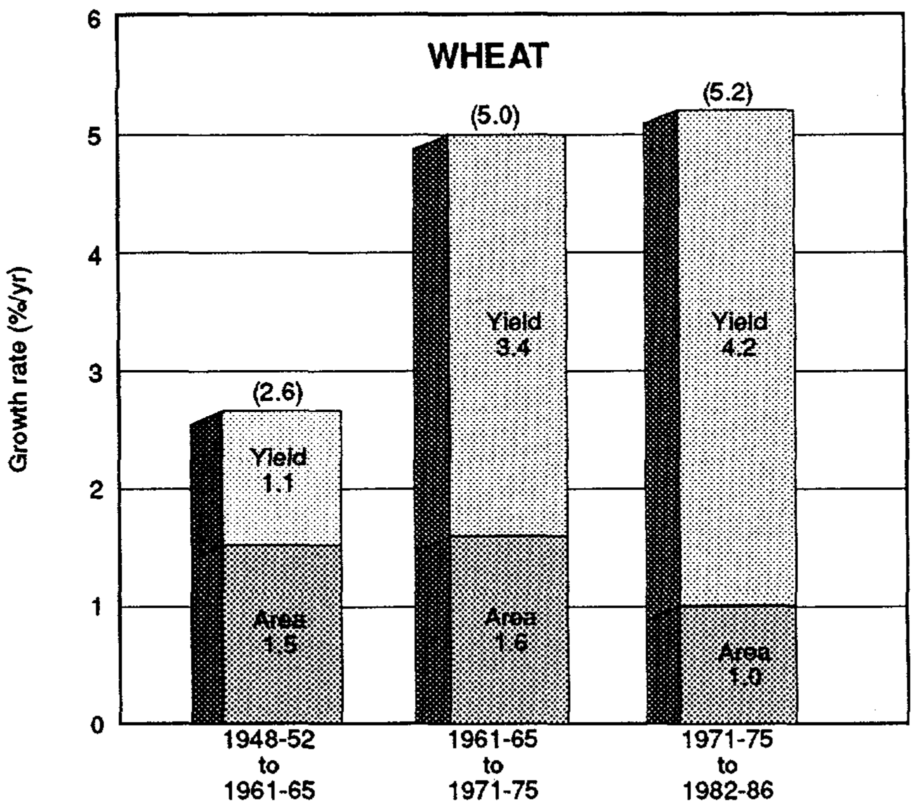

Figure 2. Growth rate of area, yield and production (in parentheses) in developing countries for wheat, 1948-86 (CIMMYT, 1989).

rice production since 1956-65. Indonesia has almost tripled its rice production during that time.

"Today, rice production in Asia is twice that of 25 years ago; average yields have increased 72 percent. The land area planted to rice has increased only 17 percent, while population has grown by 67 percent. The increased production from semidwarf rices is conservatively estimated to feed 700 million people" (IRRI, 1990).

The new wheats and rices were not accidents, nor "miracles". They were developed by agricultural scientists who benefited from many years of good research in several countries. Continued improvements in production have been possible only because improved varieties of both wheat and rice are being bred at research stations. Breeders must find ways to improve yield potential of food crops as well as new and more resilient forms of resistance to pests and diseases — to do that requires better knowledge of the pests themselves as well as the genetic makeup of the potential parents-to-be used in breeding. If the necessary genes cannot be found in the primary gene pool for the crop involved, scientists must turn to the wider gene pool, either wild relatives or species not closely related to the crop. As the search widens, new and more powerful tools are needed.

CHALLENGES TO AGRICULTURAL RESEARCH

So agricultural research has been a good investment. Is the job done? Are there still challenges left? Is agricultural research still a good investment? To the first question, the answer is no. The job is not done. To the other two questions the answer is yes. There clearly are important challenges facing agricultural research, and the returns to investment in agricultural research are still high and achievable.

Maintenance Research

As yields rise, more and more research effort is required to protect the gains made. Such research is called maintenance research, although the term does not describe adequately the high quality research needed to sustain such gains. Effective maintenance research requires in-depth knowledge of diseases and pests of crops and animals and strategies for their control, of genetic traits and sources of resistance to biotic and abiotic stresses on crops and livestock, of breeding strategies that maximize yields with reduced losses due to pests and diseases, and improved management systems that exploit both crop and livestock genetic potential as well as the natural resource endowment (Plucknett and Smith, 1986).

Yield Stability, Dependability

Farmers need stable, dependable yields. One benefit of modern plant breeding has been the development of robust, high-yielding genotypes of crops that produce stable and dependable yields under stress conditions. New crop plants with high-yield potential and multiple resistances to pests and diseases are available for most major crops in most countries. Agricultural researchers constantly search for new sources of resistance or tolerance to biotic and abiotic stresses and work to incorporate these into crop plants.

Yield Potential

Scientists need to know the upper limits of yield for each crop. This gives them targets to shoot for in production systems. Also, where yield potential of a crop appears to be reaching some limit, special attention needs to be focused on finding ways, if possible, to increase yield potential.

Rice is one crop where yield potential has not changed much over the past 25 years or so. Yields of rice are more stable and dependable now, because of multiple genetic resistance to diseases and pests, but yield potential has not increased. Improving yield potential of rice is one of the highest agricultural research priorities today. A global effort on rice yield potential that links outstanding researchers in many countries is urgently needed.

Pest and Disease Problems

Pest and disease problems are always with us, even when those pests or diseases are not currently causing damage in a particular crop. Lurking pest and disease problems must be dealt with either through resistance breeding or crop management practices. Wise researchers build knowledge about pest biology, ecology and damage to crops and animals, so control strategies can be devised and implemented. Better diagnostic tools are needed to improve diagnosis and surveillance; biotechnology can help a lot in obtaining better diagnostic tools. Global databases for pests and diseases are needed to help researchers in their understanding of the ecology and etiology of diseases and pests in the crop environment. Especially needed are databases on known major pests and on incipient pests.

Breeding for Pest and Disease Resistance

Breeders have been able to find numerous sources of resistance to pests and diseases. To do this has required considerable effort to screen and study global germplasm collections for each crop. Sources are first sought in landraces and other segments of the primary genepool. For some more difficult diseases and pests, however, it has been necessary to search more widely in secondary and tertiary genepools — wild relatives and even unrelated wild species — to find those sources of resistance. Results have been quite promising, and much more needs to be done here. This is another area where the tools of biotechnology are going to be useful.

Improving the Use of Fertilizers, Pesticides

As agriculture becomes more intensive, increased fertilizer and pesticide use is often required. The eminent Dutch scientist, Professor C. T. de Wit, has pointed out that in large parts of the world the soil releases a meager 30 kilograms of plant nutrients/ha/yr, sufficient for a 1,000-1,500 kg/ha grain yield (de Wit, 1968). Therefore, to produce the higher yields required to meet human needs, nutrients must be applied as chemical or organic fertilizers from sources external to the farm.

World fertilizer needs and requirements assessed by Sanchez et al. (1983) showed that about one-third of total increases in food production in developing countries could be attributed directly to use of chemical fertilizers. Also, chemical fertilizers were estimated to provide about 40 percent of nutrients for the world's crops, with other sources being released from soil reserves (46 percent), organic fertilizer (6 percent), biological nitrogen fixation (10 percent of nitrogen supply) and atmospheric deposition.

Derek Byerlee (1989) of CIMMYT worries that, at current levels of fertilizer efficiency, diminishing returns to applied fertilizer are being experienced in Asia. The ratio of grain harvested/fertilizer nutrients applied (= grain: nutrient ratio) has fallen in Asia from more than 10 during the early years of the Green Revolution to about 5 to 7 today.

de Wit et al. (1979) point out that fertilizers have aided greatly in increasing the biomass of crops, which, when coupled with a fairly high harvest index, can help to increase yields. Here, provided a reasonable supply of water is available for the plants, fertilizer can be a main generator to realize a high proportion of attainable yield.

Both fertilizers and pesticides can be used to increase and protect crop yields. Improving the efficient use of fertilizers and pesticides can raise and stabilize production, lower costs of production and reduce possible negative environmental effects.

Improving the Use of Water Through Irrigation, Dryland Agriculture

For many areas the main limiting factor for crop and livestock production is water. Competition for water between urban and agricultural uses almost always winds up with the urban areas winning. Humankind simply must find more efficient ways to use water, both for domestic use as well as in agriculture. Research on irrigation and dryland farming to improve water use will help save lives, especially in semiarid and arid areas. Another need will be to improve and protect water quality. Without doubt, water management is a research area which has experienced under-investment in the past. That will need to be addressed soon.

Improving the Management of Crops, Animals, Natural Resources

For some developing countries, existing or available crop varieties are robust and productive enough to meet current production needs, if only their management in the field was better. In such situations, crop management research is needed, so the full genetic potential of those varieties can be realized. Also, even where new crop varieties continue to emerge from plant improvement programs, crop management research may be inadequate to gain the full genetic potential of the seeds planted. The same could be said for animals.

Coupled with the need to improve crop and livestock management research in general is the need to ensure that production systems are sustainable, and that natural resources are used wisely and well. In some situations the integration of crops and livestock is likely to help improve sustainability.

Improving the Practice of Sustainable Agriculture

Agriculturists have always known that if agriculture was to secure its future, it must manage and protect the production environment. The Consultative Group on International Agricultural Research (CGIAR) has adopted the following definition of sustainable agriculture: **the successful management of resources for agriculture to meet changing human needs, without degrading the environment or the natural resource base on which agriculture depends.**

Research can, and does, play a significant role in sustainable agriculture. Improved crop varieties with resistance to pests and diseases and increased tolerance to environmental stresses play a significant role. Research to improve soil and water management, gain more effective use of all types of fertilizers, develop innovative and traditional crop management practices and other related topics will also contribute to better sustainable practices. Crop modelling is being used as one of the tools to understand global warming and climate change. Natural resource management research needs support and encouragement at a time when people in both developed and developing countries are seeking ways to measure and evaluate rapid and often profound changes in our environment.

Building and Strengthening the Global Agricultural Research System

The global agricultural research system grew out of efforts after World War II by the Rockefeller and Ford Foundations, the United States and former colonial powers to improve agriculture in developing countries. Many other countries and donors have joined the effort especially in the last two decades.

Today the global agricultural research system includes international agricultural research centers, developed country research institutions and national agricultural research systems in developing countries. The system is of benefit to all parties, and it provides an especially powerful tool for improvement of developing country agriculture. The global system is a world asset with demonstrated ability to bring about significant change for the benefit of millions of people. It is clear that agricultural research can help development by generating new technology to improve agriculture, and it has earned the continuing support of collaborating nations and donors.

SUMMARY

For most of the history of man, agricultural production was low and unstable, leading to poor crops in some years and sometimes resulting in crop failures in some places. Famines were common, and most people did not have an ensured food supply. Agricultural development was slow and incremental for centuries until the advent of modern agriculture, especially during the Twentieth Century, and more especially since World War II. Agricultural development worldwide since 1950 has improved at a phenomenal rate and can be considered as one of the great achievements of this century.

Most people are quite unaware, however, of the significance of this development since they know little about the relatively slow pace of agricultural development before this century and about the contribution agricultural research has made to their own well-being. The Green Revolution in wheat and rice from the mid-1960s on in Asia saved millions of lives at that time and still continues to save lives. Other, less dramatic, research achievements in other staple crops are helping to make incremental and significant gains in productivity for those crops. Agricultural research is a good investment for all countries that want to improve their agriculture and an essential investment for all humankind as we prepare to enter the Twenty-First Century with its long list of population, food, and natural resource problems.

REFERENCES

Akroyd, W. R. 1974. The Conquest of Famine. Chatto and Windus, London.

Alamgir, M. 1981. An approach towards a theory of famine. In: Famine: Its Causes, Effects and Management, J.R.K. Robson, ed., Gordon and Breach Science Publishers, New York.

Byerlee, D. 1989. Food for Thought: Technological Challenges in Asia Agriculture in the 1990s. Paper presented at the Conference of Asian and Near East Bureau's Agricultural and Rural Development Officers, USAID, 19-24 February, 1989, Rabat, Morocco.

Calvin, M. 1983. Basic chemical research and future food supplies. In: Chemistry and World Food Supplies: The New Frontiers Chemrawn II. Perspectives and Recommendations, G. Bixler and L.W. Shemilt, eds., pp. 107-124. International Rice Research Institute, Los Banos, Philippines.

Christopher, Thomas. 1985. The famine garden of Prince Chu Su. Garden 9(3):18-20, 22-23.

CIMMYT. 1989. 1987-88 CIMMYT World Wheat Facts and Trends. The Wheat Revolution Revisited: Recent Trends and Future Challenges. Mexico, DF: CIMMYT.

Community Nutrition Institute. 1985. Hunger and starvation; cycle of world famine. Nutrition Week 15(36):4-5.

Cox, G. W. 1978. Famine symposium—The ecology of famine: An overview. Ecol. of Food and Nutr. 6(4):207-220.

Cox, G.W. 1981. The ecology of famine: an overview. In: Famine: Its Causes, Effects and Management, J.R.K. Robson, ed., pp. 5-18. Gordon and Breach Science Publishers, New York.

de Wit, C.T. 1968. Plant Production. Instituut voor Biologisch en Scheikundig Onderzoek van Landbouwgewassen, Misc. Papers Landb. Hogesch, Wageningen, No. 3, pp. 25-50.

de Wit, C.T., H.H. van Laar and H. van Keulen. 1979. Physiological potential of crop production. Chapter 2, In: Plant

Breeding Perspectives, J. Sneep and A.J.T. Henriksen, eds. CABO Publication No. 118, Pudoc, Wageningen, The Netherlands. pp. 47-82.

Edgar, William C. 1925. The Story of a Grain of Wheat. D. Appleton, New York.

Ehrlich, Paul. 1967. Paying the piper: There is no longer any hope of feeding the population of the world. New Scientist, December 14.

Evans, L.T. 1980. The natural history of crop yield. American Scientist 66(4):388-397.

Grigg, D. 1985. The World Food Problem. Basil Blackwell, Oxford. 276 pp.

Hanson, H., N.E. Borlaug and R.G. Anderson, 1982. Wheat in the Third World. Westview Press, Boulder, CO.

IFDC. 1989. Global Fertilizer Perspective, 1960-95. International Fertilizer Development Center, Muscle Shoals, Alabama. Technical Bulletin T-35.

IRRI. 1990. IRRI Rice Facts. International Rice Research Institute, Manila.

Kane, P. 1988. Famine in China, 1959-61: Demographic and Social Implications. St. Martin's Press, New York.

Lipton, Michael with Richard Longhurst. 1985. Modern Varieties, International Agricultural Research and the Poor. Consultative Group on International Agricultural Research Study Paper Number 2.

Plucknett, Donald L. and Nigel J.H. Smith. 1986. Sustaining agricultural yields: As productivity rises, maintenance research is needed to uphold the gains. Bioscience 36(1):40-45.

Plucknett, Donald L., Nigel J.H. Smith, Michael Collinson, Kerri Wright, Mary E. Horne (in preparation) Sustaining Agricultural Yields. Critical Reviews in Plant Science.

Robson, J. R. K.(ed.). 1981. Famine: Its Causes, Effects and Management. Gordon and Breach, New York.

Sanchez, P.A., J.J. Nicholaides III and W. Coutu. 1983. Physical and chemical constraints to food production in the Tropics. In: Chemistry and World Food Supplies: The New Frontiers Chemrawn II Perspectives and Recommendations. G. Bixler and L.W. Shemilt, eds., pp. 89-105. International Rice Research Institute, Los Banos, Philippines.

Scrimshaw, N.S. 1987. The phenomenon of famine. Ann. Rev. Nutr. 7:1-21.

Sen, A. 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Clarendon Press, Oxford.

Stanhill, G. 1976. Trends and deviations in the yield of the British wheat crop during the last 750 years. Agro-Ecosystems 3:1-10.

Tribe, Derek. 1987. International agricultural research. Proc. Australian Academy of Technological Science and Engineering. p. 2-3.

Uppal, J.N. 1984. Bengal Famine of 1943: A Man-Made Tragedy. Atma Ram, Delhi.

Wortman, S. and R.W. Cummings, Jr. 1978. To Feed This World. The Johns Hopkins University Press, Baltimore.

Yoshida, S. 1981. Fundamentals of Rice Crop Science. International Rice Research Institute, Manila. 269 pp.

Zohary, D. 1969. The progenitors of wheat and barley in relation to domestication and agricultural dispersal in the Old World. In: The Domestication and Exploitation of Plants and Animals, ed. P.J. Ucko and G.W. Dimbleby, p.47. Duckworth, London.

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