Editorial

Another Development and Plant Genetic Resources

In the 1975 Dag Hammarskjöld Report, *What Now: Another Development,* it was emphasized that an alternative conceptual framework was needed for the future development of the world and that Another Development should be need-oriented, endogenous, self-reliant, ecologically sound and based on structural transformations.

In pointing up the need for strengthening the Third World's capacity for self-reliant development, it was, furthermore, stressed that this entailed 'Exercising the right of national economic sovereignty over resources and production, ending the drain of resources from the Third World to the industrialized countries' by, *inter alia,* reviewing 'contracts, leases and concessions entered into with transnational corporations under conditions of inequality' and 'regulations of conditions governing trade in technology including the revision of the present patent system'. In order to achieve these objectives, citizens must exercise their 'right to inform and be informed about the facts of development, its inherent conflicts and the changes it will bring about, locally and internationally', thereby promoting a process of 'conscientization' and ensuring full participation in the decision-making process.

The Dag Hammarskjöld Foundation has since the publication of *What Now* sought to contribute to this process of 'conscientization' by organizing a long series of seminars on the problems of establishing a New International Order on the basis of the ideas of Another Development. As readers of this journal are well aware, these seminars have dealt with sectoral issues such as Another Development in Health, Education, Science and Technology and Law as well as with such broader issues as the International Monetary System, the Automatic Mobilization of Resources for Development and the New World Information and Communication Order.

Since the late 1960s, the Dag Hammarskjöld Foundation has also taken an active interest in the problems of rural development and nutrition in Africa, Asia and Latin America, focusing both on pioneering efforts like the Bhoomi Sena movement in India and on the wider issue of Another Development with Women and particularly the role of women in the rural development of the Third World.

It is, however, striking that during the discussions of these subjects over the past decade, little attention has been paid to the 'seeds issue' and to the erosion of plant genetic resources until its global significance was brought up for discussion by the activities of the International Coalition for Development Action (ICDA), and by the publication of Pat Roy Mooney's book *Seeds of the Earth* in 1979.

In order to promote the public debate of this crucial development issue with its many controversial aspects and in order to assist the increasing number of non-governmental organizations taking an active interest in its outcome, we asked Pat Mooney to sum up his experience from seven years of indefatigable work under the auspices of ICDA. We also asked him—as a representative of the community of non-governmental organizations—to end his presentation with a set of Conclusions and Recommendations as to what in his view could be done in this field by applying in a 'Law of the Seed' the idea of the 'Common Heritage of Mankind' and the principles of Another Development.

There is little doubt that Pat Mooney, ICDA and other non-governmental organizations have made an important contribution to the debate about the future food security of the world. It should, however, be noted that quite a number of individuals inside and outside the FAO and the UN System have played an important part in bringing out the issues at stake in the politics of plant genetic resources. Pat Mooney has drawn on their experience and knowledge and their views are also reflected in this publication, which is issued in what we believe is the spirit of Linnaeus and which comes from the very town where he lived and worked and from which his disciples went out all over the world to classify and protect our plant genetic resources.

Introduction

In 1982, *the OECD Observer* reported that the South contributes US $500 million a year to the value of the United States wheat crop. If anything, this is a serious underestimate of the real contribution. Were it to be calculated for all major American crops, the economic impact of the Third World contribution would reach into several billions of dollars. And what the Third World does for the Americans, it also does for the Australians and the Europeans.

What is the nature of this contribution? Germplasm: the genetic characters added into new varieties of all the world's crops. Almost totally overlooked in the political and economic debate over the form and need for agricultural development and food security, germplasm is the absolute underpinning of the global food system. Without imports of the right genes, a wheat field might wilt from summer heat, a maize crop might succumb to mildew, potatoes might not process acceptably and tomatoes might bruise too easily. It is a simple but profoundly important fact of our biological and agricultural history that the substantial majority of this germplasm lies in the Third World. The North may be 'grain-rich' but the South is 'gene-rich'.

This fact points to our tremendous food inter-dependence. It has a number of immediate implications.

First of all, while most of the world's breeding material (germplasm) for all its major crops rests in the South, most of the plant breeding and plant breeders are located in the North. For some years now, a kind of gene drain has been underway, siphoning off the Third World's germplasm to 'gene banks' and breeding programmes in the North. The South has been donating this material in the belief that its botanical treasures form part of the 'Common Heritage' of all humanity. Meanwhile, the North has been patenting the offshoots of this common heritage and is now marketing its new varieties, at great profit, around the world.

A debate on the efficacy of all this is now underway at FAO in Rome in the form of a resolution passed in 1981 calling for a legally binding International Convention on the exchange of plant genetic resources (germplasm) and the creation of a system of internationally controlled gene banks.

Secondly, the new bio-technologies (recombinant DNA et. al.) highlight the fundamental importance of access to Third World genes. To date, the South has been an unwitting 'raw materials' supplier to this high-tech industry. UNIDO and other agencies have devoted their energies to advising Third World governments on how they might accommodate themselves to receive the new technologies. At stake, however, is a prize that may—in its agricultural applications alone—be valued at US $100 million by the end of the century. Genetically and climatically, the South has no need to be a bit player in this new technology. There are compelling practical as well as political reasons why much of this new technology should be based in the South.

Thirdly, the scientific community has become aware that the introduction of new plant varieties via the Green Revolution or commercial companies leads to the elimination of older varieties and the loss of often invaluable germplasm. Once gone, this germplasm cannot be recovered. 'Genetic erosion' is now seen as a profound threat to long-term world food security. The pace of genetic erosion in our crops almost defies exaggeration. Most of the crop germplasm in the Third World will be gone before this century is over. Left behind are a comparative 'handful' of modern High Yielding Varieties (HYV's) and hybrids bred from an ever narrowing genetic base. The risk of widespread crop 'wipe-outs' because of our vulnerability to plant disease attack is already alarmingly high. An urgent international effort is needed to preserve our crop genetic diversity. Existing international efforts appear to serve the needs of the North, are poorly financed and tragically myopic in approach.

Finally, this 'germplasm' poses for the South a political problem (germplasm exchange and control); an environmental crisis (genetic erosion); and an economic opportunity (increased breeding and work in new technologies). The scene is very much clouded, however, by dramatic changes in what has become known as the Genetic Supply Industry. A small number of very large transnationals—led by Royal Dutch/Shell, Ciba-Geigy and Sandoz—have acquired hundreds of seed companies over the last twelve years and are aggressively moving into the South. Most disturbingly, they have an opportunity to combine their leadership in plant breeding with their dominant position in pesticides manufacturing. At stake is the future of agricultural development in the South.

'Germplasm' gene banks and genetic engineering can seem a long way from the struggles of peasant farmers to find food and justice. They seem esoteric compared to the painful burning issues of land reform and rural credit or even national self-reliance. But germplasm is the raw material of seeds—and seeds are the first link in the food chain. Some governments and some chemical companies recognize this and a grab is being made for the control of germplasm. There can be no true land reform—no true agrarian justice of any kind—and certainly no national self-reliance, if our seeds are subject to exclusive monopoly patents and our plants are bred as part of a high-input chemicals package in genetically uniform and vulnerable crops.

Abbreviations

ASSINSEL	International Association of Plant Breeders for the Protection of Plant Varieties
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre of Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
FAO	Food and Agriculture Organization of the United Nations
FIS	International Federation of Seed Trades
IARC	International Agricultural Research Centres
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Centre for Agricultural Research in Dry Areas
ICD	Industry Council for Development
ICDA	International Coalition for Development Action
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IUCN	International Union for the Conservation of Nature and Natural Resources
PBR	Plant Breeders Rights
SIDP	Seed Improvement and Development Programme (FAO)
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UPOV	Union for the Protection of New Varieties of Plants
USDA	United States Department of Agriculture
WIPO	World Intellectual Properties Organization

The Common Bowl

The Not-So-Renewable Renewable Resource

For the industrialized countries, there is no such thing as a 'home-grown meal': in a typical Western salad, the tomatoes carry genes from Central America and the cucumber germplasm originates in Burma; the carrot and the onion were domesticated in Central Asia while celery and lettuce look homeward to the Mediterranean; the radishes and welsh onions are from China. Closer to the staples, the potatoes come from the Andes and most of our beans come from other parts of Latin America. Most cereals were first cultivated in the Near East and China. Even the fodder for our livestock traces its genetic origins to South America and Central Asia. Now the North is selling back 'modern' varieties of these same crops and the genetic security of the world's food supply is about to disappear.

In the sweat of thy face thou shalt eat bread. Genesis 3:19

Narrowing the food base

The world offers us almost a quarter of a million flowering plant species —virtually all of which might be edited by science and selection into an acceptable restaurant menu. At one time or another, many of these plants have been brought into service. In the days of hunting and gathering, the choice of foods must have been truly awesome. In an area of limited botanical diversity such as North America, Indians dined upon 1,112 different plant species and, even today, !King Bushmen in the arid regions of South Africa make a regular meal of 85 wild vegetables.

Cultivation has changed all this. Despite the wide use of diverse plants made by hunters and gatherers, humanity may have brought fewer than 1,500 into formal agriculture. Ninety five per cent of our global nutritional requirements are derived from a mere 30 plant kinds and a full three-quarters of our diet is based upon only eight crops. For those of us who confine our hunting and gathering to the super grocery stores that now stretch from Kansas to Kuala Lumpur, the neon cornucopia seems endless in its diversity. Late in the 1920's, a typical Canadian grocery boasted 900 different food products. By the middle of this decade, retailers confidently predict that such stores will claim 15,000 food items. The average store now has 12,000, including more than 50 dry breakfast cereals. Nevertheless, when the cans are open and the cellophane removed, we are left with the basic 30 crops—and 75 per cent of our cereal intake boils down to rice, wheat and maize.

The realization that our food choices are continuing to narrow is a frightening one. The refrigerated air transport that brings Europe pineapple from the Pacific, bananas from Africa and mangos from Asia (foods which play a very minor role in the Northern diet), is still more successful at globalizing the world's leading crops and their international varieties.

The mundialization of the menu is not new and not wholly attributable to modern transport or transnationals. True, agribusiness is now advancing the uniformity of the world's food system to new and alarming heights, but the basic reality that all humanity feeds from a common bowl has been with us almost since farmers first scratched the soil.

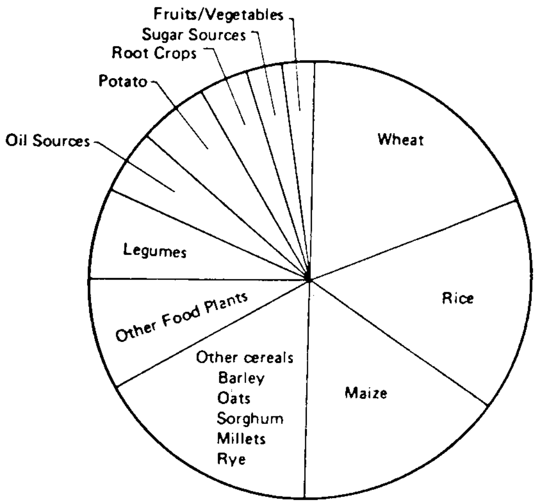
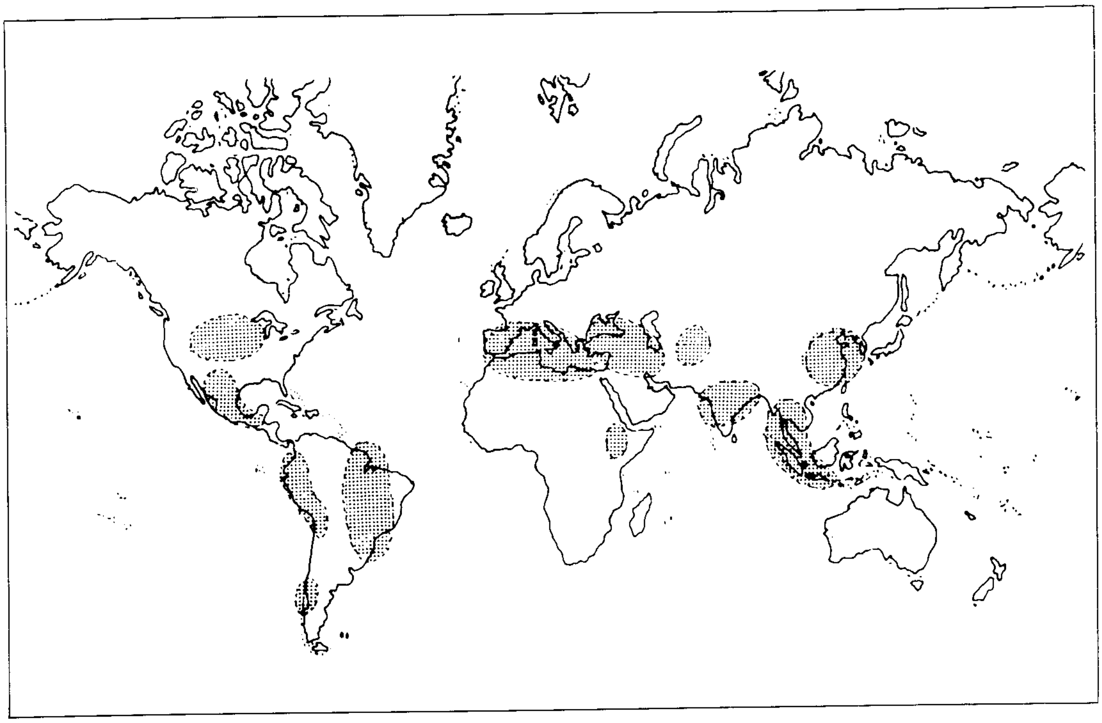


Figure 1 Human calorie sources from plants

Narrowing the gene base

If there is a culprit for the uniformity of the food system, it must be the Ice Ages. While the botanical diversity of tropical lands flourished, the temperate zones lost almost everything under the crushing weight of century-long iceflows. Agriculture, logically, began in areas of great plant diversity. These areas have been mapped and named after their discoverer, N I Vavilov, a Russian botanist who devoted much of his life to plant exploration and collection. The Vavilov Centres can generally be associated with areas of great early civilizations. The centre of origin of a food plant was often in mountainous tropical regions where survival conditions could change abruptly within a few metres and where the breeding orientation of the plant, abetted by climate, migrating animals, etc., stimulated inter-breeding. Often the centre of cultivation is slightly different—taking place in the valleys and lowland areas adjacent to the



Map 1 Vavilov's Centres of diversity [1]

centre of origin. The best food plants in each region of diversity were selected for cultivation.

As societies moved, so did successful seeds. Some crops proved remarkably adaptable. Today, Asian rice can be found from sea level to 2,200 metres and while some thrive in semi-arid climates, others withstand submersion under 6 metres of water. Sorghum does well in semi-arid parts of Asia and in the wet tropics of Africa. Potatoes grow from well below sea level to well above the Andean tree line and so far north in Sweden and Finland as to be inside the Arctic Circle. Wheat survives almost everywhere. Even the finicky tomato pokes its way along the Baltic Sea.

As a rule, when seeds of a crop move further and further from their genetic 'homeland', their gene diversity declines. Occasionally, the narrowness of the genetic base of the transplanted crop leads to disaster. Thus, the Irish potato succumbed to blight in the 1840's and Sri Lanka coffee was overwhelmed in the 1870's. Rusts constantly ravaged the North American wheat crop early in this century and the Caribbean banana and sugarcane industries have more than once tottered on the brink of extinction due to the narrowness of their gene base.

Plant disasters are also human disasters: two million Irish died with the failure of the potato and millions more fled to other parts of Europe and North America. The wheat losses during the First World War led to some serious deprivation in North America. Even if coffee and bananas are something less than food staples, crop wipe-outs can impose immense human hardship. Nor have we learned our lesson. The Great Bengal Famine of 1943 was due to the conquest of the rice crop by brown spot disease. At that same time, half a world away, Americans were losing their oat crop to Victoria blight. In 1970, southern corn leaf blight shook US agriculture to its very roots. Brown planthopper disease threatened to destroy the rice harvest in Indonesia and the Philippines in the mid-seventies. The risk to our food system has not gone away simply because we know about the uniformity problem.

In each of these cases the crop was a long way from home. In every case, emergency infusions of new genes from the original centre of diversity were needed to maintain the crop. Potatoes, for example, originate in the Andes region of South America. Be they Dutch, Irish or Canadian, potato breeders today depend heavily upon imported Latin American 'germplasm' to stave off new famines. Sri Lanka's coffee, on the other hand, has its genetic home in Ethiopia. Even today, the entire Latin American coffee industry looks to the Horn of Africa to guarantee its future. Wheat—while having a wide diversity in a large area of Asia—originates in Ethiopia and in the Fertile Crescent of the Near East. Bananas come from Southeast Asia ... as does sugarcane. Although the rice of the Bengali famine originates in Asia, the American oat crop once again looks to the Near East for survival. New maize introductions from Latin America assured the continuity of the US 'corn' crop after the 1970 debacle.

Agronomists are aware that genetic uniformity equals disease vulnerability and have, for some years, tried to diversify their varieties within the substantial constraints imposed by commercial breeding. In fact, our awareness of the problem seems to have done nothing to change the situation. Since the mid-sixties, for example, the concentration upon the semi-dwarf characteristic in wheat and rice in the Third World has not only erased much genetic diversity in the traditional homelands for these crops, but also left the world's two most important food sources more exposed than ever to wipe-outs from diseases and pests. At the close of the seventies, the Dutch breeding company, D J van der Have (now owned by Suiker Unie), identified a random sampling of crops wherein characteristics important to all the varieties of that crop were provided by either a single solitary gene or, at best, a complex of a few major genes: a prescription for crop wipe-out.

With occasional calamitous exceptions, the outward spread of the leading world food crops took place at a pace that allowed nature to bring along sufficient gene diversity to enable the plants to adapt to their new homes. About a century ago, however, the rediscovery of Mendel's Laws of Genetics created the science of modern plant breeding. In the space of a

Table 1 At risk: Examples of crop uniformity for single traits provided by single genes or a common gene complex [2]

Crop	Characteristic
Bean	Singleness
Maize	Male sterility; high lysine (opaque-2)
Onion	Male sterility for hybrids
Rice	Semi-dwarfism; photoperiod insensitivity
Sorghum	Milo source for male sterility
Wheat	Semi-dwarfism; male sterility; photoperiod insensitivity

few decades, the creation of a few high-yielding crop varieties wiped away the little genetic diversity that did exist in the North. The new varieties were scientifically 'engineered' to meet the tough requirements of machine harvesting, milling, brewing and baking. While the new varieties offered many advantages, their uniformity increased the danger of disease losses. Breeders found it necessary to journey back to the old centres of genetic diversity in Asia, Africa and Latin America in order to ensure the success of their varieties.

By the beginning of the Second World War, Northern agronomists awoke to a profound reality—a reality that had escaped them and continues to elude most governments and farmers: the so-called 'breadbasket' nations may be grain-rich but they are gene-poor and wholly dependent upon the Third World for the long-term survival of Western agriculture.

The need for Third World genes

The North's dependence upon Third World germplasm is almost impossible to exaggerate. Every Canadian wheat variety, for example, contains genes introduced in recent decades from up to 14 different Third World countries. American cucumbers find the genes for disease resistance from as far away as Korea, Burma and India. Modern lettuce varieties include genes from Israel and Turkey. Mexico, Syria, Turkey, Chile and El Salvador all contribute genes to North America's Common Bean varieties. Disease resistance in American peas has come from Peru, Iran and Turkey, while new spinach varieties are protected by genes from India, China, Iran and Turkey. The world's leading Hybrid Grain Sorghums are based upon Zera-Zera Sorghums from the Sudan and Ethiopia. Important new Alfalfa (Lucerne) varieties are based upon introduced genes from Afghanistan and Saudi Arabia. Egypt, China and Ethiopia have all contributed genes to maintain barley production in Europe and North America. The tomato canning industry would have long ago disappeared were it not for the constant introduction of wild and primitive tomatoes from Central America.

Table 2 'Wild' genes from the South [3]

Crop	Contribution	Comment
Banana	Resistance	Southeast Asian material saved the industry in the Americas in the 1960's
Brown Mustard	Quality	Pungency in British varieties comes from Nepal
Cassava	Quality	Raised protein content
Cherry	Yield	Chinese genes saved UK industry
Cocoa	Yield	From the upper Amazon
Cotton	Quality	Strengthening fibre
Grape	Adaptability	Caribbean and Venezuelan material have been used around the world
Groundnut	Resistance	From pests and diseases
Lupins	Adaptability	North African material used to extend crop in Australia
Maize	Resistance	From southern corn leaf blight in US through Mayorbela maize from Central America
Pineapple	Quality	Improved taste
Potato	Yield	European yields rose with use of wild potato from Mexico and Guatemala
	Quality	Improved processing
	Adaptability	Wild genes from Peru, Bolivia and Argentina
	Resistance	For frost hardiness from viruses and blights from diverse Latin American sources
Rice	Resistance	Grassy stunt resistance from Asian wild rices
Sugarcane	Yield	Doubled
	Resistance	Protection from 5 diseases
Sunflowers	Yield	Twenty per cent increase
Tomato	Resistance	Commercial production would be impossible without wild genes from Latin America and the Philippines

Usually, breeders use traditional varieties (called 'landraces') or the wild relatives of cultivated varieties only to isolate one or two specific genes that may increase yield, protect against disease, improve winter hardiness or strengthen the stalk against prairie winds. Sometimes, peasant farmers make a large and very direct contribution to a new variety. Such was the case with Marquis wheat in Canada at the turn of the century when a landrace known as Hard Red Calcutta, sown by Bengal farmers, was crossed with a Polish variety to create the Canadian breadbasket. In the 1960's, the Max Planck Institute in Germany made a major contribution to national barley production with its introduction of Volgersamen Gold —based upon a landrace cultivated in the Near East. The present-day Australian Alfalfa (Lucerne) variety, Swami, is simply a selection from wild material found in Libya. Feterita and Hegari Sorghum varieties were introduced more or less directly into US agriculture from the Sudan early in this century. More recently, Wad Rashir, another Sudan sorghum, was released as a finished variety in India.

While gene transfers from domesticated landraces are much easier to accomplish than from wild species, the wild botanical treasures of the Third World have also made a major contribution to modern agriculture. Perhaps the best documentation of this contribution has been provided by Robert and Christine Prescott-Allen in papers they have produced for the International Institute for Environment and Development, and the World Wildlife Fund.

As the genetic uniformity of the world's major crops increases, Northern breeders are forced to depend more and more on Third World genes found in peasant fields and remote forests. The North's dependence has been put best by Dr J P Kendrick Jr of the University of California at Davis: 'If we had only to rely on the genetic resources now available in the United States for the genes and gene recombinants needed to minimize genetic vulnerability of all crops into the future, we would soon experience losses equal to or greater than those caused by southern corn leaf blight several years ago—at a rapidly accelerating rate across the entire crop spectrum.' [4]

But every time we receive expert advice the warning bell is ringing in the more remote parts of the world. Genetic erosion is advancing at a rapid rate.

J Trevor Williams, Executive Secretary, IBPGR

The pace of genetic erosion

In the spring of 1983 a Canadian prairie gardener planted Nantes and Chantenay carrots ... and so did another gardener in the highlands of Kenya. Across Africa, Congolese farmers were weeding their Bintje potatoes just as Swedish farmers were planting theirs. Palmetto soybeans were thrusting into the hot sunlight of Malaysia and curling against the night cool of Rwanda. A Philippines-bred rice, IR-8, was in cultivation from Taiwan to Benin. A Mexican wheat, Pitic 62, was being seeded from Canada to Cyprus, and a German sugarbeet was awaiting harvest in Chile.

Examples like this not only warn us of the world's growing crop uniformity, they tell us that the gene material upon which we all depend is fast eroding. A few stories are now in order ...

When Dr Jack Harlan visited the Cilician Plain in Turkey in the 1940's the area bore virtually thousands of flax landraces. When he returned in the 1960's, only one variety remained—and that was imported from Argentina.

In November of 1979, two ICRISAT geneticists, K E Prasada Rao and M

Table 3 Two Gardens: Vegetable varieties grown on a farm in Manitoba, Canada in 1983, also grown in Kenya during the 1982/83 season [5]

Crop	Variety	Crop	Variety
Climbing Bean	Kentucky Wonder		Red Cored Chantenay
Bobby Pro, Bean	Bush Blue Lake		Royal Chantenay
	Contender	Cauliflower	Snowball Group
	Top Crop	Cucumber	Long Fellow
French Bean	Vernandon	European Spinach	Bloomsdale
Beetroot	Detroit Dark Red		King of Denmark
Broccoli	Green Sprouting	Lettuce	Boston Group
Cabbage	Copenh. Market		Great Lakes Group
	Golden Acre		New York
	Jersey Wakefield	Melon (Cantaloupe)	Charentais
	Red Acre	Pumpkin	Connecticut Dield
	Red Rock	Spinach Beet	Ford Hock Giant
Carrot	Amsterdam Forcin		Lucullus
	Chantenay Long	Squash	Green Hubbard
	Danvers Half Long	Turnip	Purple Top White Globe
	Nantes Group		Globe
	Oxheart	Watermelon	Sugar Baby

H Mengesha set out for the Sudan in search of Hegaris and Zera-Zera sorghum cultivars and wild sorghum relatives. They travelled up and down the banks of the Blue Nile in their Toyota Land Cruiser, seriously hampered by a shortage of fuel and funds. In the end, they found no Hegaris at all and only rare samplings of Zera-Zera near Damazin, 'almost', they report 'on the verge of extinction'. Sorghum is a crop of major importance in tropical and subtropical countries and Zera-Zera sorghum is highly prized for a number of qualities including yield. It is the basis of most modern hybrid varieties. 'Germplasm botanists', say Rao and Mengesha, are 'alarmed at the magnitude of genetic erosion of primitive cultivars..... The situation is more alarming for wild sorghums.' [6]

Over the last half century, India has probably grown over 30,000 different landraces of rice. The situation has altered drastically in the past 15 years, however, and Dr H K Jain, Director of the Indian Agricultural Research Institute in New Delhi predicts that in another 15 years this enormous rice diversity will be reduced to no more than 50 varieties with the top ten accounting for over three-quarters of the subcontinent's rice acreage.

Late in 1978, Rafael Guzman brought a Christmas card up into the Sierra de Manantlan range in western Mexico. The card carried a drawing of Zea Perennis—a perennial wild relative of maize that had last been seen in the 1920's. When Guzman came back out of the mountains he had not only re-discovered Zea Perennis, he had also found another, vastly more useful perennial: Zea Diploperennis. The discovery might lead to perennial maize production. Since Zea Diploperennis is resistent to four of maize's seven most prevalent diseases, it may also contribute substantially to the reliability of maize yields.

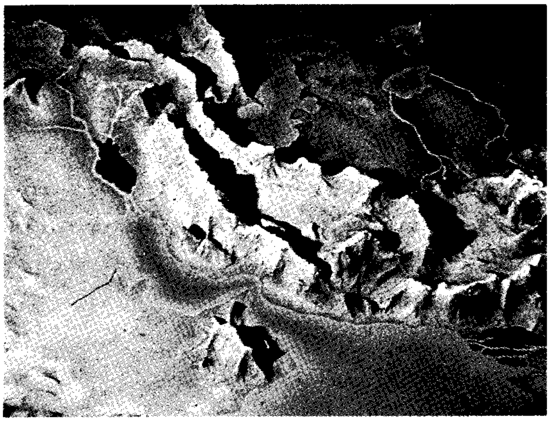
Zea Diploperennis was not discovered wild in the woods. Only one or two thousand plants are known to exist—all on less than two hectares of fenced ground—preserved and protected by an Indian farm family for generations. The family used the cereal, mixed with regular maize, as a cattle feed in dry seasons. 'Introduce ten Holsteins', one plant explorer commented, 'and this billion dollar resource is gone—forever.'[7]

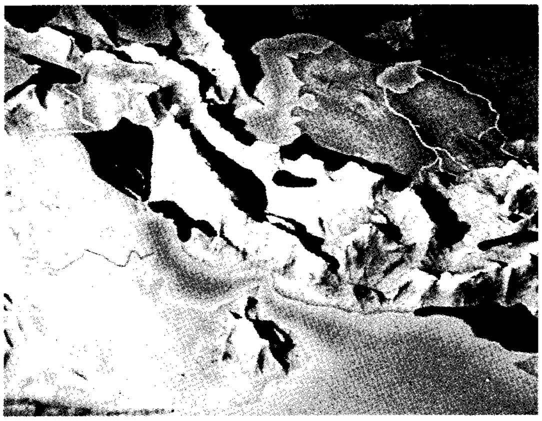
In August 1982, Roland von Bothmer of the Swedish University of Agricultural Sciences and Niels Jacobsen of the Royal Veterinary & Agricultural University in Copenhagen set out to explore North America. Their mission was to find—and bring back alive—wild barley species that might someday prove important to Scandinavian cereal breeders. For directions, they had the handwritten notes of an old school teacher named Pollard who reported seeing Hordeum Intercedens during the 1950's and 1960's on two locations in and around Santa Barbara, California. After many thousands of kilometres, the two scientists reached Pollard's first location which, '... is now the site of the "1st Presbyterian Church" and a connecting large parking place. H. Intercedens has certainly disappeared'. Pollard's second hunting ground had been the unkept Santa Barbara cemetery. Von Bothmer and Jacobsen report: 'The cemetery is today a highly-cultivated park with richly-cut lawns, where H. Intercedens has no possibility of growing'.[8]

Before the summer had ended, the two plant explorers had chased wild barleys from California to Newfoundland—with disappointing results. Not to worry for Hordeum Intercedens, however, there are rumours that it may still exist on some Pacific Islands ...

North American barley germplasm is not, in the global scheme of things, very important. Barley originated in the Horn of Africa. Potentially important wild material remains still to be found in this region, while a terrific diversity of traditional cultivars extends across the Red Sea throughout the Eastern Mediterranean and the Fertile Crescent.

Neither are cemeteries and parking lots a major threat to barley's survival. The real threat is the Green Revolution. Since the sixties, new 'High-Response' Varieties (a more accurate term than 'High-Yielding') have been spreading throughout this centre of diversity for barley, wheat and



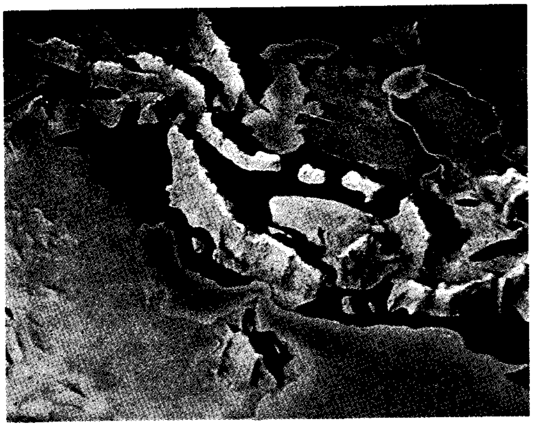


oats. The long-term threat to barley (and wheat and oat) breeding for Scandinavia and the world comes from new barley varieties like Beecher and OP25 that have taken over half of the traditional barley area in Saudi Arabia and the Lebanon. More than 70 per cent of the wheat genetic diversity in these same countries has been replaced by a handful of new varieties such as Mexipack and Sonalika sown over hundreds of thousands of hectares. Considered from an industrial point of view, cereal seed is a remarkable commodity—the means of production, seed, is the same as the end product for consumption: seed. As the American geneticist Garrison Wilkes pointed out a decade ago, when new seed is introduced to a centre of genetic diversity, the inheritence of ten millenia of plant selection can disappear in the morning bowl of porridge—gone forever.

This is what is happening in the Middle East. Several years ago, the Crop Ecology Unit at FAO produced a set of three slides depicting on maps the erosion of wheat in this region. The first slide, circa 1965, showed the marginal spread of the High-Response Varieties on the fringes of the wheat lands. The second slide, about 1970, showed that deep inroads had been made by the new varieties throughout the area. The third slide, in 1975, shows the domination of the new wheats with the old diversity shrunken and beaten back to the arid hillsides and mountain slopes deemed not worthy of new seed. At this point, FAO stopped producing slides but Erna Bennett, author of the slide set, states that the region's natural diversity for wheat will be gone entirely by the end of this decade.

The loss of this diversity can mean a lot to Scandinavia. The Second World War destroyed much of the material that had adapted to north European conditions. Both farms and barley varieties were abandoned along the Finnish border with the Soviet Union and much of this has never been recovered. It is ironic that the barley gene centre is now beset with the same problem. Wars in Ethiopia, Lebanon, Syria, Iran and Iraq have not only made a modest contribution to genetic erosion directly, but indirectly as well, through prevention of plant exploration and secure storage.

Genetic erosion is sweeping like a prairie fire across the world. As the Green Revolution burns off our remaining heritage of cereals, the germplasm essential to our vegetables and fruits are blown away by a storm of F1 hybrids. The temperate zones have already been devastated. The



Maps 2,3,4 Wheat erosion in the Near East centre. The dark areas show the spread of the High-Response Varieties in the period 1965–75[9]

Cornwall Brussels Sprout is gone forever—and with it, the genes for resistence to at least one major crop disease. The Dutch have lost the Zeeuwee Bruine onion (almost all the onions of western Europe are now based upon the Rijnsburger type) and the Americans have misplaced the Adam apple. In each case, invaluable and irreplaceable genes have disappeared with the variety. Left behind are an amorphous collection of highly touted, highly uniform hybrids.

Even in the case of vegetables, the prairie fire is licking at the diversity of the Third World. In Egypt, which has grown onions since at least 5,200 BC, the only remaining winter onion is now Giza 6 Improved. Germany's introduction of the Detroit Globe-type beet has single-handedly destroyed the genetic diversity of beets in Turkey, and the incursions of F1 hybrids in China—the last stronghold for many major brassica crops—has brought many traditional varieties to the brink of extinction.

And, yet, all of this is minor. We will never know what we have already lost. And most of what we are losing today will remain unknown. In many parts of the South, the overplanting of traditional tropical vegetables with cash crop vegetables from temperate zones goes unrecorded. Potatoes from Holland surplant cassava from Latin America, and wheat from Mexico takes over lands once held by millets in India. Vast botanical treasures—perhaps of the greatest importance of all—are torn away with the clearing of forests for fuel or furniture.

Ten per cent of the world's plant species are now regarded as 'endangered'. Each disappearing plant kind can take with it anything from 10 to 30 animal or insect species directly or indirectly dependent upon it. Biologist Thomas Lovejoy calculates that if the rate of loss continues, the world will be missing one-sixth of all its living species by the end of the century. The people of this earth—from Sweden to Singapore—depend upon 30 plants. You don't have to be a nature-lover to be concerned about disappearing species.

Old genes versus new technologies

Many technological determinists have argued that the crude scrounging for special genes in the Third World either is now or soon will be unnecessary. New technologies will make the 'needle-in-a-haystack' gene hunt a thing of the past as agronomists learn to 'make' their own germplasm.

Table 4 The urgent search for seed: A few recent samples of the rush to find more germplasm as documented in IBPGR reports and speeches [10]

Crop	Search location	Reason for search
Barley	Western USA	More studies of H. Arizonicum (wild barley) 'are urgently needed' (1982)
Brassicas (Cabbage etc).	China and worldwide	Collection is 'extremely urgent' in China but need to conserve leafy vegetables is widespread (1981)
Capsicum (Pepper types)	Latin America	Further collection 'as soon as possible ... before it is lost' (1981)
Cocoa	Worldwide	There are 'major gaps in the collections' (1981)
Coffee	Ethiopia	'Decisive action in Ethiopia is of crucial importance' (1979)
Onion	Europe and Central Asia	Collections needed due to rapid replacement by F1 hybrids (1982)
Pejibaya (Peach Palm)	Latin America	'Urgent need' to collect due to 'significant erosion' (1981)
Rice	Worldwide	IRRI collection 'is relatively deficient in wild material' (1980)
Sorghum	Africa	'We do not have a comprehensive active collection anywhere in the world.' (1980)
Sugarbeet	Europe	'Urgent action' needed to collect in France, F.R. Germany, Belgium, Portugal, Yugoslavia (1980)
Sugarcane	Southeast Asia	More collecting needed in Thailand, Burma, Iran, etc., partly to restore deteriorated collections (1982)
Sweet Potato	Northern Latin America	'Great concern' expressed over need to collect allied species as well as sweet potato (1981)
Tomato	Andean region	Since previously collected samples deteriorated, 'new collections are necessary' (1981)
Vigna (Pea-type)	Asia	'Urgent need for extensive exploration' (1982)
Wheat	Worldwide	Taxonomic range is 'completely inadequate' (1980)

These views were first expressed soon after World War II when agronomists became enamoured with the so-called 'peaceful' uses of the atom as well as other chemical means to induce mutations. Bombarding seeds with radiation, it was felt, would produce an incredible array of new plant types. These new plants would yield the gene diversity needed for breeding. From Vienna to Los Angeles, scientists adopted the theory with enthusiasm and expended large sums on new labs to make artificial genes. By December of 1975—after 25 years of intensive work—only 197 new varieties had emerged from the worldwide programme. Of these, only a handful achieved any commercial prominence. By the end of the seventies, one private sector study concluded that there was 'little cause for satisfaction' in the work and relegated the mutation strategy to the scientific backwaters.[11]

The enthusiasm for mutation breeding was quickly replaced, in the late seventies and early eighties, by a comparable faith in recombinant DNA research. 'Genetic engineering' is still held up as the solution to genetic erosion—even by a few scientists. Such confidence is sadly misplaced. The clearest reproof to this opinion has come from Miguel Mota, Chairperson of the Department of Genetics at Instituto Nacional de Investigação Agraria (INIA) in Portugal: 'To "make" new varieties, breeders have to look for the desired genes, which may exist in an old variety or in wild plants. If such material is not available the difficulties may not be overcome because Genetics, despite all the wonders it is now capable of doing, is not yet capable of "making" a gene "by measure". We can recombine genes, transfer genes from the cells of a species to cells of a very different species, we can mutate genes, we can even "multiply" a gene "in vitro". Some of today's genetics would be considered wild science fiction 20 years ago. But we do not know how to build up a gene to make wheat resistent to −5° C. below the present maximum resistence or to make it with three times more lysine in its flour. If we don't have these genes somewhere–-maybe in an insignificant weed or a very old variety—we just cannot make a wheat with those charactaristics.'[12] In the meantime, one might add, it hardly seems prudent for the world to place its future food security in the hands of an uncertain science.

There are times when it is wise to believe 'Big Business' and to take its concerns at face value. One of those times arose at a US State Department 'Strategy Conference on Biological Diversity' held in November of 1981. Dr James Murray, of The Chicago Group Inc., told the government, 'The importance of biological diversity to the future of genetic engineering cannot be overemphasized. Germplasm is the fundamental resource of the new biotechnologies, and it is conceivable that it could become a limiting resource ...'. Advising the United States to negotiate with the Third World for access to genetic resources, Murray added, 'However, many developing countries will have an advantage in that a large percentage of the germplasm resources of the world are located in developing countries'.[13]

The struggle for the collection and conservation of plant genetic resources—and the political and commercial control of these resources—is now taking place across the globe. The political debate is centred at FAO. Global responsibility for germplasm collection and conservation has been ceded to IBPGR. While there is much uncertainty about the work and effectiveness of both organizations, there is widespread agreement that time is running out.

If the work is not done in the next five to ten years, we're finished.
J Trevor Williams, Executive Secretary, IBPGR
(interviewed in Nature, 2 December, 1982)

Table 5 This meal is on the South: The genetic origins of some selected crops

Plants are grouped below in a way which we hope will convenience an easy search through menu or dinner plate and not in strict botanical categories. In some cases, anecdotal information on the history and genetic erosion status of the plant is provided along with the plant's origin.

Crop	Origin
The global salad	
Avocado	Central America (especially Mexico)
Broccoli	Southern Italy/Eastern Mediterranean (erosion risk from cauliflower)
Brussel sprouts	Belgium (F1 Hybrid erosion risk)
Cabbage	Near East/Mediterranean (F1 Hybrid risk)
Carrot	Central Asia
Cauliflower	Southern Italy/Mediterranean (Mark Twain said that cauliflower was cabbage with a college education—risk from exports)
Celery	Mediterranean
Chinese cabbage	China/Japan Centre (F1 Hybrid risk)
Cucumber	Central Asia
Garden cress	Horn of Africa (especially Ethiopia)
Leek	Near East (breeding for uniformity in Europe is narrowing genetic base)
Lettuce	European-Siberian region
Onion	Central Asia (erosion in Third World due to commercial imports and in North America to F1 Hybrids narrowing genetic base)
Radish	China/Japan Centre
Tomato	Central America (rare and extensive germplasm held by Campbell Soup Co., not freely exchanged)
Watercress	European-Siberian region
Welsh Onion	China
Other cooking vegetables	
Adzuki Bean/Red Bean	China/Japan Centre
Asparagus	Mediterranean
Broad Bean	Mediterranean Centre
Common Bean	Latin America
Lima Bean/Butter Bean	South America
Moth Bean	Hindustani Centre
Mung Bean/Green Gram	Southeast Asia Centre (urgent collection need)
Cowpea/Black-eye Pea	Horn of Africa (especially Ethiopia)
Chinese Kale	China/Japan Centre
Eggplant	Southeast Asia Centre
Globe Artichoke	Western & central Mediterranean
Jerusalem Artichoke	North America
Kale	European-Siberian region
Okra	Ethiopia & eastern Sudan
Pak Choi	China/Japan Centre (F1 Hybrid risk)
Parsnip	Mediterranean
Pea	Near East Centre
Pepper	Andean Centre (losses due to introduction of improved cultivars with narrow base)
Pigeon Pea	Horn of Africa (esp. Ethiopia)
Shallot	Near East
Spinach	Central Asia
Squash	Andean Centre
Rhubarb	Central Asia (Siberia to Tibet)
Turnip	China/Japan Centre (erosion due to potato introduction in 17th century)
Breads & basics	
Barley	Near East (2,000 known barley cultivars—new variations in North America facing erosion from urbanization, irrigation and pesticides)
Cassava/Manioc/Tapioca	Northern South America
Lentil	Near East
Maize/Corn	Central America (esp. Mexico/Guatamala)
Finger Millet	Horn of Africa
Foxtail Millet	China/Japan Centre
Pearl Millet	Horn of Africa
Proso Millet	China/Japan Centre
Oat	Eastern Mediterranean
Potato	Andean Centre (Bolivia/Peru)
Rice	Hindustani Centre (India's 30,000 varieties will drop to 50 within 15 years and 10 will occupy 75% of rice land)
African Rice	West Africa
Mountain Rye	Near East Centre
Rye	Near East Centre
Sorghum	Horn of Africa (Texas Hybrids have eroded diversity in southern Africa)
Sweet Potato	Central America (probably Mexico—is now being studied as an industrial alcohol)
Spelt Wheat	Near East Centre
Bread Wheat	Horn of Africa
Dwarf Wheat	Hindustani Centre
Einkorn Wheat	Near East Centre
Cultivated Emmer	Near East Centre
Yam	Horn of Africa (wild species used in pharmaceuticals also)
Potato Yam	Southeast Asia

Beverages & sweeteners	
Chicory	European-Siberian region
Cocoa	Amazon basin (germplasm often lost in transport)
Coffee	Ethiopia (all Latin American coffee originated from one tree imported to Amsterdam from Java)
Cola	West Africa (still used in cola pop)
Mate	South America
Sugarbeet	Mediterranean/Near East (erosion due to commercial import of 'Detroit Globe' varieties to Turkey by such firms as KWS)
Sugarcane	Southeast Asian Centre (erosion increased by maintenance, financial problems and transfers between banks)
Tea	Mountains of southern central China and northeastern India (taken from China by the British East India Company in mid-1800's)
Condiments	
Basil	Southeast Asia Centre
Black Pepper	Malabar region of India
Cardamon	Hindustani Centre
Carob	Mediterranean Centre
Cayenne/Bell Pepper	South America
Chive	China/Japan Centre
Cinnamon & Cassia	Southeast Asia
Clove	Southeast Asia (Dutch East India Co. attempted to monopolize cloves on the Moluccas by destroying other trees)
Dill	Mediterranean Centre
Fennel	Mediterranean Centre
Garlic	Central Asia Centre
Chinese Carlic	China/Japan Centre
Ginseng	China/Japan Centre
Licorice	European-Siberian region
Marjoram	North Africa
Mint (pepper, spear)	Mediterranean Centre
Mustard	Horn of Africa (Ethiopia)
Nutmeg	Southeast Asia Centre
Tobasco Pepper	Central America
Vanilla	Central America
From the fruit bowl	
Apple	Central Asian Centre
Apricot	Southeast Asia and China
Banana	Southeast Asia Centre
Blueberry	North America
Sweet Cherry	Near East Centre
Cranberry	North America
Date Palm	Horn of Africa
Desert Date	Mediterranean Centre
Fig	Near East Centre
Gooseberry	European-Siberian region
American Wild Gooseberry	North America
Grape	Near East
Common Grape	Central Asia/Mediterranean
Muscadine Grape	North America
Grapefruit	Caribbean
Lemon	Southeast Asia
Lime	Northeast India
Litchi	China/Japan Centre
Mango	Northeastern India
Muskmelon/Canteloupe	Horn of Africa
Sour Orange	Southeast Asia
Sweet Orange	Southern China
Papaya/PawPaw	Central America
Passion Fruit	South America
Peach	China/Japan Centre
Pear	China/Europa-Siberian region
Pineapple	South America ('Cayenne' or 'Kew' or 'Sarawak' variety is rapidly replacing others)
Plum	Near East Centre
Chinese Plum	China/Japan Centre
Pomegranate	Near East Centre
Pomelo	Southeast Asia
Pumpkin	Latin America
American Red Raspberry	North America
Black Raspberry	North America
Tangerine	Southeast Asia Centre
Mandarin Tangerine	Philippines or China
Virginian Strawberry	North America
Watermelon	Horn of Africa
Nuts	
Almond	Central Asia;
Indian Almond	Southeast Asia;
Cashew	South America;
Chinese Chestnut	China/Japan Centre;
Spanish Chestnut	Near East Centre;
Coconut Palm	Southeast Asia;
Groundnut/Peanut	South America;
Hazel Nut	Near East Centre;
Pecan	Central America
Oriental Sesame	Horn of Africa
Black Walnut	North America
Water Chestnut	China/Japan Centre
Oils	
Rape/Canola	Mediterranean Centre
Soya Bean/Soybean	China/Japan Centre
Sunflower	North America
Tung Oil Tree	Asia

That home-grown meat

The animals themselves

Cattle	Eurasia/North Africa
Chicken	India
Goat	Near East
Pig	Near East
Sheep	Near East
Turkey	North America

Our meat animals eat heavily from such cropss as maize, potatoes, barley, oats, soybeans, cassava and sorghum as well as the following fodder crops. Genetic erosion in fodder has been ascribed to such factors as improved pastures, irrigation and use of herbicides. In many cases, what was once a pasture grass has become a lawn grass. These, too, are included below.

All flesh is grass. Isaiah 40:6

The food they eat

Fodder Beet	Europe-Siberia region
Bermuda Grass	Hindustani Centre
Crimson Clover	Mediterranean Centre
Red Clover	European-Siberian region
Subterranean Clover	Mediterranean region
White Clover	European-Siberian region
White Sweet Clover	European-Siberian region
Fescue	European-Siberian region
Dallis Grass	South American Centre
Tufted Hairgrass	North America
Kentucky Bluegrass	European-Siberian region
Common Lespedeza	China/Japan Centre
Korean Lespedeza	China/Japan Centre
Perennial Lespedeza	China/Japan Centre
Blue Lucerne/Alfalfa	Central Asia
Yellow Lucerne/Alfalfa	European-Siberian region
Orchard Grass	European-Siberian region
Pampas Grass	South America
Veldtgrass	Horn of Africa
Common Vetch	Near East
Wheatgrass	North America

Industrial and medicinal plants

Camphor Tree	China/Japan Centre (industrial and fabric protection)
Castor Bean	Horn of Africa (medicinal)
Cinchona (Quinine)	Andes Centre (malarial drug—stolen by British for Asian estates)
Egyptian Cotton	Horn of Africa (cloth)
Short Staple Cotton	Horn of Africa (cloth)
Tree Cotton	Hindustani Centre and Horn of Africa
Upland Cotton	South America
Flax/Linseed	Central Asia (cloth, cigarette wrappers)
Luffa (Loofah) Gourd	Central America (rubber plant)
Guayule	Central America (rubber plant)
Hemp/Sisal	Central America (baler twine—surreptitiously removed from the Yucatan by German entrepeneurs)
Hemp (Cannabis)	Hindustani Centre (drug)
Manilla Hemp	Southeast Asia (rope)
Lavender	Mediterranean Centre (scent)
Opium Poppy	Mediterranean/Central Asian centres
Quinine	Andean Centre (drug)
Rubber	Amazon basin (surreptitiously removed from Brazil by British for Asian estates, only 22 seedlings reached Singapore and breeding has narrowed base further)
Tobacco	South America

Flowers on the table

Acidanthera	Southern Africa
Begonia	Central America/Andes Region
Camellias	China/Japan Centre
Chrysanthemum	China
Gladiolus	Europe (possibly Belgium)
Paeonia	Probably China
Rhododendron	China/Japan Centre
Rose	A cross of Chinese and Persian strains
Tulip	Near East (possibly Turkey)
Zinnia	Central America (probably Mexico)

Notes

1. This map has been reproduced from a slide show circulated by the FAO Crop Ecology Unit.
2. Sneep, J., and Hendriksen, A.J.T., *Plant Breeding Perspectives,* D.J. van der Have Company, 1979, p. 91.
3. See, for example, Prescott-Allen, Robert & Christine, *Wildplants and Crop Improvement,* World Conservation Strategy Occasional Paper No. 1, World Wildlife Fund (undated) and *What's Wildlife Worth?,* Earthscan, London 1982.
4. Kendrick Jr., J.P., 'Preserving Our Genetic Resources', *California Agriculture,* September 1977, p. 2.
5. As this article was being prepared, the Kenyan Government sent us a list of vegetable varieties in cultivation in that country. As we were engaged in planting our own garden in Manitoba, we were struck by the large number of varieties that were common to both lists despite the very different growing conditions.
6. Rao, K.E. Prasada and Mengesha, M.H., *Sorghum and Millets Germplasm Collection in Eastern Sudan,* ICRISAT Progress Report, 16th March, 1980, p. 9.
7. Dr. Hugh Iltis as quoted by Vietmeyer, Noel D., in 'A Wild Relative May Give Corn Perennial Genes', *The Smithsonian,* December, 1979, p. 72.
8. Von Bothmer, Roland and Jacobsen, Niels, *Hordeum in North America,* a report to IBPGR, 1982, p. 5.
9. These maps have been reproduced from a slide show circulated by the FAO Crop Ecology Unit.
10. The table includes material from several sources including letters from seed company officials and leading scientists such as Dr J R Harlan of Urbana, Illinois, but especially from the works of Robert and Christine Prescott-Allen, op.cit.
11. Sneep, J., and Hendriksen, A.J.T., op.cit., p. 110.
12. Letter to Vic Althouse, M.P. Canadian House of Commons, dated September 13, 1982.
13. Murray, James R. and Hiam, Alexander, 'Biological Diversity and Genetic Engineering', presented to the State Department Conference on Biological Diversity, November, 1981, copyright held by The Chicago Group Inc. and Policy Research Corporation.

Only the Seeds in the Sea

The Road to Resolution 6/81

As Third World governments observed the erosion of their botanical treasures under pressure from imported new varieties, they became aware that efforts to collect endangered material was leading to a flow of genetic resources to the North. Meanwhile, countries in the North were introducing Plant Breeders' 'Rights' (PBR) legislation and encouraging the development of genetic engineering in the private sector. When the 'genetics supply' industry and their governments began to talk about the need for a 'full and free exchange of germplasm' and called for the world to see plant genes as the 'common heritage' of all humanity, diplomats at FAO became worried. It seemed that their raw materials were to be exchanged freely while patents were to be placed upon the finished varieties. In 1981, Third World governments went to FAO's 21st Conference session to talk about it ...

Resolution 6/81 should not have been a surprise. There had been grumblings and rumours since at least the mid-seventies. The Association for the Advancement of Agricultural Sciences in Africa had spoken out forcefully in 1978, calling for the storage of germplasm as an 'invaluable national heritage' to be preserved 'within and for each state as well as for the world at large'. [1] Half a world away in Indonesia, scientists echoed the concern, noting that 'It is of prime importance that plant genetic resources be stored nationally'. [2] In 1977, the Ethiopian government had closed its doors to the further removal of coffee germplasm. In a score of other Third World countries, visiting plant explorers were finding local officials uncooperative; and their way often blocked by a clutter of administrative procedures. In the Near East, Western plant explorers reported being shot at by local farmers and an international team hunting fruits in South Asia demanded hardship pay and more protecion. In a five-year review of the IBPGR, a committee noted at ten points in its report the growing unrest in the Third World and the need to establish some form of legal arrangement regarding access to stored germplasm.

The clearest indication of all came at FAO's 1979 Conference when its Chairperson, Dr M S Swaminathan—then Director of the Indian Agricultural Research Centre and now Director-General of IRRI—pointed out the need for more action on genetic resources in his address to the plenary. By the spring of 1981, Third World scientists attending a special symposium on genetic resources convened at FAO were obviously becoming uncharacteristically militant. The Latin Americans wanted more say over regional crop collection priorities and they wanted to add a wider range of plants to the conservation drive led by IBPGR. In an exchange that grew decidedly undiplomatic, the Latin Americans were rebuffed by the IBPGR secretariat.

In November 1981, it was obvious to outside observers that FAO's 21st Conference session would see some kind of an initiative from the South on genetic resource control. If a clearer signal was needed, it was given by India's Prime Minister when she addressed the opening session and predicted a 'stimulating debate' on the origin of plant materials.

The leadership came from the Mexican delegation. While seeing all the wider issues, they moved from the point of debate at the Spring germplasm symposium and won unanimous Latin American support for the creation, under FAO auspices, of an International Gene Bank. The bank was to be the first step in the move toward greater Third World control over plant germplasm. Asian and African delegations were quick to support the draft resolution but urged Mexico to include its second step as well: the formation of a legally-binding International Convention to govern the exchange of plant genetic resources. The two-part package —wrapped in strong language—was then presented to the Conference.

Both the FAO Secretariat (who should have been advised by IBPGR) and Northern governments were taken by surprise. A great deal of diplomatic pressure was applied by the British and American delegations to kill the resolution. When the South proved too strong for a frontal assault, equally strenuous efforts were made to weaken the resolution and remove all offensive references to political germplasm embargoes and PBR (exclusive monopoly patent) laws. The 'war of words' embroiled the Secretariat and took up many long nights in the usual Contact group. Division within the Secretariat showed early. Some senior officials did their best to squash the resolution and it took the personal intervention of Edouard Saouma, FAO's Director-General, during a Contact group session, to reign in his subordinates and allow the resolution to slip through more or less intact.

The issues in 1981

A number of issues—or, more simply, 'gut' feelings—came together to make resolution 6/81 possible. Third World scientists and agricultural officials had been watching plant germplasm leave their countries for many decades. Recent years, however, had seen the formation of an international programme intended to systematically remove this material, as the threat of loss through erosion became better understood. This collection drive was led by IBPGR—an amorphous semi-UN, mostly autonomous organization that appeared both technocratic and aloof. Agricultural ministries were becoming aware that the material they were donating had considerable value—and that it was disappearing.

At the same time, the nature of the seed industry seemed to be changing.

Some of the old familiar names, Sutton's, Ohlsens, Burpees, etc., had either vanished or been transformed by their absorption into the corporate world of transnational enterprises. The new seedsmen were tougher, more aggressive; they wanted more money for their seeds, and they were reluctant to share breeding information.

This sense of growing discomfort was ignited by the information that plant genetic resources were becoming a political weapon and that the outward flow of germplasm was almost entirely to the North, to the advantage of that region's high tech genetics supply industry.

1. The 'Genedrain'

The overwhelming majority (the most conservative estimate is 70 per cent) of the world's plant diversity is located in the South. Yet the overwhelming majority (the most conservative estimate being 55 per cent) of the world's collected germplasm is banked in the North. The data is difficult to decipher, however, and despite the nine-year existence of IBPGR, the real extent of public and private collections and their national control are largely a matter of educated guesswork.

Table 6 The control of plant genetic resources between North, South and the International Centres [3]

Grouping of states	Percentage sub-total	Percentage total
Industralized market-economy states	41	
Industrialized centrally-planned states	14	
North		55
Group of 77	28	
People's Republic of China	3	
South		31
International Agricultural Research Centres		14

Although IBPGR has never made the calculations from its own data, a review of its crop germplasm publications makes it possible to consider the political control of 32 important crops. This data shows that a little more than half of the stored seed material is held in the North, while under one-third of the germplasm is under the control of Third World governments. The remainder—about 14 per cent—is located in the South but under the control of the International Agricultural Research Centres (IARCs) as part of the Consultative Group on International Agricultural Research (CGIAR).

The above figures pose as much confusion as they resolve. Missing are such significant crops as soybeans, cotton, coffee, tobacco and oil palm. Very little forage material is identified. Even more notable by their absence are the large private collections of international breeding companies. Although Shell Oil publicly admits to over 4,000 accessions of agricultural interest at its British breeding station, and Ciba-Geigy has confirmed that it holds several thousand maize accessions and several hundred sorghums (to cite two important examples), little has been done to incorporate genes into the data. Even in the public sector, considerable information on some gene banks is missing. Both the Chinese and the USSR collections, some scientists argue, are greatly underestimated.

Table 7 Leading germplasm holders [4]

State	Percentage of total
United States	22
Soviet Union	7
India	6
Malaysia	6
United Kingdom	4
IRRI (IARC)	4
China	3
ICRISAT (IARC)	3
Top 8	55

A few years ago, geneticists in the Soviet Union estimated that the world was storing in excess of three million accessions. IBPGR's 32 crops total only something over 1.9 million accessions Early in 1983, FAO itself operated on the basis that the world held a little less than 1.4 million accessions. Of these, FAO concluded, roughly 60 per cent were duplicates of other stored material.

To add to the uncertainty, in 1979, Dr E Hartmans, Director of the Agricultural Operations Division, addressed a meeting of European gene bank directors on behalf of the FAO Director-General. Hartmans told government officials that 'almost two-thirds of the world's seeds in collections are held by institutions in Europe'. Taking into account published figures for Europe, North America, and sketchy information on other industrialized countries, Hartman's comment leads to the striking conclusion that at least 92 per cent of the world's stored germplasm rests under the political control of the North. The remainder is divided more or less evenly between the Third World and the IARCs.

The lack of data and the confusion over figures does no disservice to the

Table 8 The control of major crop germplasm [5]

Crop	Percentage North	Percentage South	Percentage IARCs	Crop	Percentage North	Percentage South	Percentage IARCs
Cereals							
Wheat	75	21	4	Crucifers	74	26	—
Rice	22	44	34	Cucurbita	95	5	—
Maize	56	29	15	Tomato etc.	72	28	—
Barley	80	12	8	Eggplant etc.	72	28	—
Sorghum	52	27	21	Other vegetables	89	11	—
Millets	36	35	29	*Fruits*			
Food legumes	47	23	30	Avocado	84	16	—
Root crops				Banana	—	96	—
Potato	43	21	36	Citrus	75	25	—
Cassava (Manioc)	—	68	32	Mango	5	95	—
Sweet Potato	53	42	5	Pineapple	1	99	—
Aroids	29	69	2	*Industrial*			
Yam	—	92	8	Cacao	4	96	—
Vegetables				Coconut	1	99	—
Okra etc.	23	77	—	Pepper	—	100	—
Allium	77	23	—	Rubber	3	97	—
Amaranthus	16	84	—	Sugarcane	33	67	—
Capsicum	76	24	—	Tea	9	91	—

interests of the North which, by any count, was a net beneficiary of the gene flow. Nevertheless, some of the confusion undoubtedly arises from legitimate scientific uncertainty over the actual viability of some major collections in the Soviet Union (it is feared that much was lost during the Siege of Leningrad in the Second World War for example) and the profusion of duplicates likely to be found in the South. Still, by 1981, the conclusion reached by many Southern scientists and officials was that they had been 'ripped-off'.

Solely on the basis of the highly conservative IBPGR data, the breakdown of germplasm control crop-by-crop is disturbing. The genetic resources important to some of the world's most valuable food crops are clearly dominated by the North, even though each plant originated in the South.

As the practical consequence of this information, the Mexican Government was anxious to see FAO create an International Gene Bank under its own auspices. A 'UN' bank could be trusted by the Third World more than one controlled by IBPGR, whose allegiancies were unclear and whose Board was beyond their control. Third World governments unable to store their own material safely, could store it in the FAO bank. Further, the FAO bank could guarantee the full and free exchange of germplasm between countries.

Claiming that the costs of such a bank would be exorbitant (estimates run as high as US $6 million to build and another US $2.5 million per annum to maintain), the United Kingdom, United States and most Western governments opposed the measure.

2. 'Genegate'

If Third World diplomats needed any further reason to launch resolution 6/81, they found it in a letter from the US Government. Dated January 19th, 1977, the letter was from a T W Edminster, head of the Agricultural Research Service of the United States Department of Agriculture (USDA). It was to the Chairperson of IBPGR and it was in response to a letter from IBPGR asking the United States to formally accept global 'base' storage responsibility for a number of world crops. Edminster responded positively but advised IBPGR that any material the US received on the Board's behalf 'would become the property of the US Government'. While stating that it was the policy of the government to exchange material freely, Edminster felt obliged to add, 'political considerations have at times dictated exclusion of a few countries'. Among Third World delegates, the issue became semi-jokingly referred to as 'Genegate'.

Prior to the 1981 Conference, we talked on the telephone to Dr Quentin Jones of USDA (and an IBPGR Board member). Jones confirmed that the policy stated in the 1977 letter was still operational. The facts were not at Dr Jones's fingertips but he was able to recall that the grain embargo against the Soviet Union over Afghanistan had also included a germplasm embargo. Asked for a list of countries on the US 'black list' he denied any knowledge of such a formal list, but added that embargoes either had been or were in effect against a number of countries. These included Afghanistan, Albania, Cuba, Iran, Libya and Nicaragua as well as the Soviet Union. He did not know whether other countries who joined in the Soviet grain embargo also extended their embargo to germplasm.

The implications of the letter are considerable. A 1970 FAO study noted that the US Government has reasonably large stocks of wheat germplasm freely gathered in Afghanistan and Libya (for example) which did not exist in their national collections at that time. While the United States has obtained this useful breeding material free of charge, it is now applying political considerations to its exchange, even to the Third World countries that first made it available. IBPGR's own conservative data gives the US Government (excluding its large private sector breeding establishment) 22 per cent of the world's stored germplasm. The US control on a crop-specific basis is much more impressive.

AGRICULTURAL RESEARCH SERVICE

WASHINGTON, D.C. 20250

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF ADMINISTRATOR

Ref.: PR 3/11 IBPGR (CC-S/M)
PR 3/11 IBPGR (CC-Wheat)

Mr. Richard H. Demuth
Chairman, International Board for
Plant Genetic Resources, FAO
Via delle Terme di Caracalla
00100 Rome Italy

Dear Mr. Demuth:

The Agricultural Research Service will be pleased to cooperate with the International Board for Plant Genetic Resources in the conservation evaluation, and use of plant germplasm.

The National Plant Germplasm Committee represents Federal, State, and private sector interests involved with all aspects of germplasm collection, evaluation, documentation, distribution, and maintenance. This Committee also serves as the policy advisory body for our National Seed Storage Laboratory (NSSL), Fort Collins. It is now reviewing NSSL policy to determine what recommendations may be in order concerning the role of the Laboratory in an international framework.

Although the Committee has not yet submitted its recommendations to me, those policy considerations which relate to your inquiry seem to be firming-up as follows:

1. We are willing to accept selected collections for long-term maintenance at Fort Collins. They would become the property of the U.S. Government, would be incorporated with our regular collections, and made available upon request on the same basis as the rest of the collection. To do otherwise would entail extraordinary, and we think unjustifiable, costs.

   As you know it has been our policy for many years to freely exchange germplasm with most countries of the world. Political considerations have at times dictated exclusion of a few countries. We currently send out more than 10 times as many seed samples as we receive in our foreign exchange program.

2. We are willing to accept selected collections on an "emergency" basis to provide safe, short-term storage while arrangements for more permanent storage are being made. Such collections would not become U.S. property, would not be incorporated with our regular collections, and would be shipped out, packaged as they were received, upon request of the owner.

The proper maintenance of collections in category 1. (above) calls for accessioning, documentation, packaging, periodic viability tests, some distribution of stocks, and eventual regrowing for restoration of viability. If we were to receive 30,000 or more accessions at one time, several years would be required for the present staff of the NSSL to incorporate them into the existing system. We cannot guarantee that additional resources will be available for accelerating the operations involved.

We hope you will consider this a favorable response to your request and accept our good faith offer to provide storage for base collections of wheat, sorghum, and Pennisetum millets as recommended by your Germplasm Advisory Committees for these crops.

Sincerely,

T.W. Edminster
Administrator

Document 1 The American letter (Text re-typed from copy of original)

Despite their diplomatic dance, Rome's ambassadors are a realistic lot and do not blush easily at the sight of power politics. Many, in fact, expressed a certain admiration for the United States for the frankness of its letter. The view was widely held that the Americans were honest enough to put in writing what other governments do but would no dare to acknowledge in print.

But the letter pointed to two inescapable conclusions: first, the South had been naive in thinking that their botanical treasures were immune from international political events; and second, that existing institutions (notably IBPGR) had failed in their duty to inform other states of US policy and had even encouraged them to transfer germplasm to America. The need for a legally binding International Convention was manifest.

Off the record, US officials have responded to the criticism by arguing that every other state does exactly what they do and that no convention in

Table 9 The US gene arsenal[6]

Crop	Percentage of crop	Crop	Percentage of crop
Cereals		Amaranthus	14
Barley	17	Capsicum	23
Maize	11	Crucifers	39
Wheat	26	Cucurbita	84
Rice	1	Tomato etc.	40
Sorghum	31	Eggplant etc.	23
Millets	2	Other vegetables	12
Food legumes	18	*Fruits*	
Root crops		Avocado	45
Aroids	28	Citrus	18
Potato	5	Pineapple	1
Sweet Potato	25	*Industrial*	
Vegetables		Cacao	4
Okra etc.	23	Rubber	1
Allium	9	Sugarcane	23

the world will change the situation when 'hardball' politics come into play. With some passion, they also insist that their record of exchange is superb and that they annually distribute ten times as much material from their banks as they receive. Together with their Canadian and western European colleagues, they often claim that the real villains in germplasm embargoes are the Soviet gene banks. It takes years to obtain samples, they say, and often the sample, once received, is not what was requested. Sometimes requests are simply not answered at all.

All this may be true—but no data has been offered to substantiate the point. There is, however, an index of accessions received by the Canadian Government's Ottawa Gene Bank in its first five years of operation (1972–1977) which, coincidentally, runs to the time of the American letter. The accession list shows that the major contributors to the Canadian bank were the Soviet Union followed by China and the centrally-planned states of eastern Europe.

Table 10 Leading contributors to the Canadian gene bank[7]

State	Percentage of total	State	Percentage of total
Soviet Union	42	South Africa	5
China	10	Poland	4
Pakistan	9	United States	3

At the close of the 21st session

Many Third World representatives were frankly amazed to see Resolution 6/81 survive the final plenary of FAO's 21st Conference. Had it not been for the personal intervention of the Director-General and the tenacity of the Mexicans, the scientific, bureaucratic and political onslaught levelled by some of the Western states would have succeeded. The session drew to a close with the firm commitment to take up the issue again in 1983 when the Conference would review the work of FAO in drafting the 'elements' of a Convention and consider a report on the feasibility of an International Gene Bank.

En route to the 1983 Conference, Resolution 6/81 would be examined by a team of consultants who would prepare discussion papers for the March 1983 COAG (biennial Committee on Agriculture) and the June 1983 meeting of the FAO Council. The Resolution could be aided or abetted at any of these points along the way.

Throughout the Conference session, open criticism of IBPGR had been stilled for fear of introducing unnecessary conflict. The South harboured a grudge towards the Board, however, for remaining silent on the American letter until it was 'leaked' four years after its writing. Many were also dismayed by what seemed to be its high-handed style and its disregard for the national interests at stake in the banking of botanical treasures. These same diplomats were far from pleased to learn that the team designated by FAO to do its drafting work was to be led by Robert Pischell—a former IBPGR Executive Secretary—and backed by Dr K S Dodds—a longtime consultant and contractee to IBPGR. While the integrity of the two men was not at issue, there was legitimate concern that the perspective they would bring to the debate was unavoidably biased.

Preparing the 'Elements' of the Convention

I think that it is important that in all UPOV-countries the officials and the breeders agree and make sure that all national delegates vote against the whole thing. I repeat: the whole thing.*
F G Fajersson, AB Cardo, February, 1983[8]

In the aftermath of the 21st Session, FAO officials reviewed Resolution 6/81 with considerable trepidation. Within days of the passing of the

* UPOV is the Union for the Protection of New Varities of Plants, an intergovernmental agency based in Geneva.

resolution, the US Government made it plain to FAO officials that it would not be a signatory to any form of International Convention. The British Government expressed the same opinion. Nevertheless, FAO staff were of two minds on the need for a Convention. One camp conceded the need for some greater legal control over the disposition of germplasm and favoured the creation of an 'international arrangement' via a contract or an exchange of letters intended to reassure the world community. Another group felt that FAO had no alternative but to draft a legally-binding Convention, even though its hope of ever coming into force was slight. Only a few (all associated with IBPGR) felt that 'all was well' as things stood.

The proposal for an International Gene Bank was harshly attacked. Through the intense lobbying of IBPGR Board and staff (who are also FAO staff), FAO formed the view that a bank would be a practical and financial impossibility. Donor states simply would not allocate the monies needed to create an effective bank. On the basis of exaggerated and distorted data offered by IBPGR, FAO set out to convince member states to drop the Bank proposal.

The second round for the Resolution debate was to be the March 1983 COAG which gathers in Rome every second year. FAO's consultants and legal department set out to draft the working paper for that meeting.

The consultants were not the only ones at work. Among those wishing to take an active part in the resolution debate was ASSINSEL—the Nyon-based International Association of Plant Breeders for the Protection of Plant Varieties. ASSINSEL maintained a watching brief on the development of the working paper in FAO and kept its members closely advised on opportunities for national lobbying of governments. Seed companies in Scandinavia apparently succeeded at this, in a meeting with government representatives of the Nordic countries to discuss the Resolution in detail prior to the March meeting. A report of their session was forwarded to ASSINSEL by one of its Vice-Presidents, who is also on the staff of Cardo's seed subsidiary, Weibulls. ASSINSEL's Secretary-General forwarded the report to members and added, 'I also think that it is necessary for our members in different countries to convince Ministries to send competent and well instructed delegates to this meeting of FAO [COAG] and not let some secretary of the Embassy represent them, as is often the case'.[9]

International seed companies clearly saw Resolution 6/81 as a direct threat to their own germplasm activities and to PBR (patent) legislation. For this reason, ASSINSEL stressed the need to make the problems known to UPOV-member countries. Dr Heribert Mast, UPOV's Vice Secretary-General, was urged to attend COAG and address the Committee.

IBPGR was also active. Worried that the International Gene Bank and the Convention would disrupt the scientific basis for its own work, the Board prepared its own position and fortified its arguments at a round of meetings held outside Washington just prior to COAG. Its first ever information brochure was hastily printed for circulation to FAO delegates and moves were made to ensure an invitation from COAG to IBPGR Chairperson Lennart Kåhre of Sweden to address the Committee early in the proceedings. Kåhre determined to oppose the Bank notion with a frontal attack and to calm Latin American concerns by specifically listing IBPGR's contributions to genetic resource conservation in Latin America. IBPGR opposition to the International Convention would have to be more subtle, but Kåhre was urged to stress the success of the Board's own exchange-of-letters system and to hint that a more structured arrangement could unnecessarily politicize and delay germplasm exchange.

When the Committee on Agriculture got underway in mid-March, it was in an atmosphere of unusual diplomatic excitement. Resolution 6/81 had been relegated to the last half-day of the eight-day meeting just in advance of the closing plenary. The Committee Chairperson, a Canadian, quickly agreed to proposals that the topic be moved into the first week of debate and that more time be set aside if necessary. To no one's surprise, the opening round examining the working paper ran a full day and a half and then went on to occupy most of the closing plenary debate as well. By the Easter weekend, when delegates were finally able to board their planes and head home, more than 40 countries had joined in the often acrimonious debate. The North/South battle line had been bluntly drawn across FAO. Representatives were completely unable to agree on the final wording of the Committee report and, under threat of the imminent departure of the interpreters late the final evening, finally agreed to allow the draft committee report to pass without detailed debate. Country after country rose to state their opposition to the final document.

The debate at COAG

Unlike the FAO Conference where the public debate often avoided the underlying issues, the Committee on Agriculture was characterized by a much more open vetting of the concerns of both North and South. The possibility of conflict between an International Convention at FAO and Plant Breeders' 'Rights' at UPOV was bluntly recognized. Incensed by a speech from the IBPGR Chairperson, the South's representatives attacked the Board openly. 'Smokescreen' issues, such as whether or not germplasm exchange was a real problem, were swept aside and the challenge to the international seed companies through the monitoring of their gene banks and the requirements of 'full' exchange, was obvious to all.

The North: hard-liners & hidden-liners

Many delegates were surprised by the hard line taken by the Nordic countries as presented by the Swedish delegate. The spokesperson took the floor early in the proceedings on behalf of his group to argue that there existed no evidence that the fuss and bother of an International Convention was warranted. He claimed that such a formal Convention would have little meaning in the real world. The Nordic countries were also opposed to the International Gene Bank. With the circulation of the ASSINSEL memorandum in the Committee, some Third World participants felt that the Scandinavians were not accurately representing the best interests of their own governments but were acting instead as spokespersons for transnational seed companies. In debate, it was pointed out that Nordic opposition to a Convention on the grounds that it would be abandoned whenever the political need arose, was hard to reconcile with traditional Scandinavian support for conventions and treaties related to nuclear-free zones, test bans, etc. The difference, it was suggested, was that in the context of nuclear issues, countries such as Sweden were minor powers hoping to exert moral suasion. In the context of seed issues, however, Sweden was the home of three of the world's largest seed enterprises and boasted a lucrative trade with the Third World. The moral arguments for such a Convention were, therefore, less attractive.

The Australian position was also something of a surprise. Although the new Australian Government was presumed to be more sympathetic to the needs of the South than its predecessor, the Australian delegate took a leading role in opposing the Third World position and even rose to the defense of PBR, despite the fact that his government has yet to join UPOV and had yet to formulate a policy on exclusive monopoly plant patents.

The 'hidden-liner' among the industrialized countries was Great Britain. Chastened by an extended debate on the Convention and on PBR in Parliament, the delegate spoke almost enthusiastically about the desire of her government to participate in a Convention. Hidden in the positive speech, however, was the 'rider' that proof was still needed to show the need for a Convention.

Perhaps most surprising of all was the statement by the American representative. Obviously unaware of the wide circulation of the American

'Genegate' letter, she began by telling delegates that they already knew what the United States policy and practice were in this field. Oblivious to the arched brows greeting her comments, she then outlined the US programme and challenged the need for a Convention concluding her statement with the American farm homily: 'If it ain't broke—don't fix it'. She was to be haunted by those words for the rest of the meeting as Asian and Latin American delegates and other observers rose to repeat them and provide their own interpretation.

The South: a growing sense of injustice

The South's position was put forward with considerable force and clarity by the Mexican delegation ... as they had in 1981. Unlike 1981, however, public statements in support of the Mexican view were not confined to the Latin American bloc. Major contributions were made by a number of Asian and African states including Pakistan, Libya, India and Angola. Although some delegations outside the Latin American region had reservations about the financial implications of an International Gene Bank, all supported the need to keep it on the agenda and to undertake further studies.

Support was greatest for the International Convention. Every Third World delegation addressing the meeting gave the Convention its unequivocal support.

Displeasure with IBPGR was palpable. After the statement by its Chairperson, several Third World participants took the floor to directly criticize Dr Kåhre's speech and what they regarded as his 'biased' presentation of the case for a Convention and a Gene Bank. An interesting exchange arose between Ambassador Zehni of Libya and Dr Bommer, Assistant Director General, FAO, concerning the use of the term 'FAO/IBPGR' in meeting papers. Zehni, who has a science-based background in genetics and who had been a part of the IBPGR five-year review team, had never seen the 'FAO/IBPGR' designation before the COAG session. He wanted to know if it was significant. Testily and with some obvious embarassment, Bommer replied that IBPGR was a programme of FAO and that the designation was justified. Many delegates saw the term as an awkward move to protect IBPGR.

Most discussion—North and South—focused on three main issues:

1. The need for a convention

Representatives of industrialized countries set great store in a survey conducted by FAO to determine the extent of germplasm exchange constraints. In the committee working paper, FAO reported that it had encountered a number of constraints but that they appeared confined to either industrial crops or to non-staple food plants. The paper concluded that, 'authenticated instances of plant breeding programmes that are being seriously handicapped by lack of particular germplasm known to be held by any specific individual or institution have not been made known to FAO'. [10] Over and over again, Northern states cited the statement as evidence that a Convention was unnecessary.

Regrettably, FAO had determined not to attach its questionnaire to the COAG working paper and had also dropped Appendix 8 from its draft which offered a summary of the survey's results. These results showed that IBPGR (on behalf of FAO?) had sent out letters to 410 institutes in 98 countries but had received only 68 replies (less than 17 per cent). Of the 68, 37 respondents (more than 54 per cent) replied that they themselves imposed restrictions. Of the six private firms replying, five admitted to germplasm restrictions.

Beyond the poor response and the high ratio of restrictions, it is perhaps even more significant to note that the questionnaire sought only to know if the respondents themselves imposed restrictions; not if they had experienced restrictions to their own breeding work. [11]

When these data were finally made known to the Committee, it was also noted that, in the context of FAO's conclusion that there existed no evidence of a breeding programme harmed by the specific lack of access to germplasm from a specific source, a 'Nobel Prize' would undoubtedly await the scientist who could determine the potential value of a germplasm collection whose existence had been kept secret or whose contents were not publicly described.

The revelation of this data effectively ended the debate on the need for a Convention. It was still left for ICDA (International Coalition for Development Action) to wonder why, since it had been cited by FAO as a contributor to the survey, its data on germplasm embargoes had not been utilized. ICDA had surveyed IBPGR literature (and some other sources) and compiled a list of embargoes it felt to be noteworthy. That list (somewhat augmented from the time of its original submission) forms Table 11.

The ICDA table omits some restrictions—North and South—which appear to be attributable to quarantine regulations. It also excludes limitations imposed on the quantity of material that may be requested. Quarantine rules are, however, often used in the same way as health or sanitation

Table 11 Political or commercial constraints to germplasm exchange[12]

Crop	Country/Region	Holder	Discussion
All Crops	United States	Dept. of agriculture	USDA told IBPGR in a 1977 letter that access to its germplasm for some countries would sometimes be 'restricted for political reasons'
	United States	Private sector	A business counsultant told a US State Dept. Conference in 1981 that, 'secrecy is already being extended to private germplasm collections' in the DNA agricultural research field
	United Kingdom	Hurst. Gunson, Cooper, Taber	A 1981 FAO/UNDP survey indicates germplasm is not available except 'on an exchange basis by special arrangement'
	Poland	Government	1981 FAO/UNDP survey reports' 'may be some problems involved'
	Netherlands	Cebeco-Handelsraad	1981 FAO/UNDP survey says 'with the exception of a few accessions'
	Netherlands	Nunhems Zaden B.V.	1981 FAO/UNDP survey says, 'willing to discuss the possibility of exchange'
	Ireland	Semi-governmental	1981 FAO/UNDP survey indicates exchange of germplasm is restricted to UPOV members
Banana	Honduras	United Brands Co.	In 1981, an IBPGR consultant noted that the company had an 'important collection but its composition is not published and its potential value to the world at large unassessible. I can only note its existance and probable importance'
Black Pepper	India	Government	FAO COAG (1983) says, 'freely available within India only'
Cocoa	Central America	Companies & governments	Referring to United Fruit Co. and other clonal material, a 1981 IBPGR report states that, 'Some restrictions have been experienced in the availability of this material'
	Ecuador	Government	FAO COAG (1983) survey indicates restrictions
Coffee	Ethiopia	Government	Germplasm embargo in effect since 1977
Fruits	Thailand	Ministry of Agriculture	Report to IBPGR states that government 'imposed a ban on exportation of mango, durian, grape and pomelo'
	Malaysia	IBPGR National Rep.	IBPGR report describes as 'not too keen in sharing mango'
	Indonesia	Government	IBPGR report indicates authority 'was willing [to share mangos] but only on a limited basis'
Rubber	Liberia	Firestone Co.	IBPGR Booklet describes collection as 'Restricted' in 1980 consultant's survey
Sorghum	Africa & Asia	Unidentified	A 1981 IBPGR report notes that, 'In view of the difficulty of obtaining some of these [sorghum genes] from certain sources ...', although whether 'sources' are corporate or not is unknown
Sugarbeet	Europe	Companies	In 1980, the IBPGR secretariat wrote that, 'seed companies are reluctant to release germplasm of use in on-going breeding programmes' and noted their desire to see an 'embargo on the release of such seeds for five or ten years'
Sugarcane	China (Taiwan)	Government	FAO COAG (1983) survey says 'available ten years after release of a variety'
	Uganda	Government	FAO COAG (1983): 'Restricted'
	United States	Hawaiian Planters Assoc.	Brazilian officials have complained of need to pay royalties to sugarcane firms in 1983
	Worldwide	Public & private	Fijian representative to IBPGR regional meeting in 1981 noted 'political' problems with the exchange of germplasm
Tea	Kenya	Companies	The Tea Research Council of Kenya reported in 1981 that requests to firms for clones received only a 'fair' response
Tobacco	Turkey	Government	FAO COAG (1983) reports that Ministries of Agriculture and Monopolies must permit export
Tomato	Canada	Campbell Soup Co.	Some difficulties in obtaining samples noted by Ottawa Gene Bank
	Canada	Nestles Co.	Libby subsidiary has indicated reluctance to give some material to Ottawa Gene Bank (1983)
Vegetables	Tropics	Governments	In 1979, an IBPGR consultant reported, '... there are in addition political problems which limit the practical availability of material in existing collections'

regulations in the context of international trade—as a 'non-tariff barrier' to the exchange of germplasm. The real number of government-imposed embargoes may, in fact, be a great deal higher. Yet the most severe constraint to IBPGR's (and ICDA's) survey remains the lack of data on private sector respositories.

2. The categories of plant genetic resources

In its working paper, FAO provided delegates with a number of categories of germplasm and argued that none of these categories should be excluded from an international agreement. The categories were:

(a) 'Domesticated Plants ...
 (i) primitive cultivars or landraces, that have evolved under primitive agriculture during millenia of cultivation;
 (ii) obsolete cultivars, which are no longer under cultivation, and have been replaced by advanced varieties as referred to under (iii);
 (iii) advanced varieties (cultivars) in current use, which are the products of practical and scientific plant breeding during the last decades;
 (iv) material used in ongoing breeding programmes, such as parentlines, advanced breeding lines, mutants, inbred lines, etc.;

(b) Wild species ...
 (i) wild species that are either the progenitors of cultivars or are in an unimproved stage already of direct economic value, the latter group includes forest trees, pasture and range plants, some fruits and species that provide raw materials to the chemical industry;
 (ii) wild species of potential value to man: this is a wide category of plants that is difficult to define. It includes relatives of domesticated plants; species worthy of attention as parents for wide crosses and those of potential value which still have to be assessed for domestication and breeding.' [13]

It should be noted, only as a technical point, that weed species were omitted from this listing quite accidentally.

Virtually without exception, the representatives of industrialized countries, while calling for the 'full and free exchange of plant genetic resources' spoke against the inclusion of (iii) advanced varieties, and (iv) material used in ongoing breeding programmes. In the case of advanced varieties in the marketplace, delegates insisted that this material was already available and, at any rate, was well preserved by breeders and in no danger of erosion. With regard to breeding material such as advanced lines and inbreds (used in making hybrids, for example), the North argued that the inclusion of such material would rob commercial breeders of the fruits of their labours without compensation. Even where advanced breeding material is withheld, the North maintained, it is ultimately available to the world in the finished varieties reaching the marketplace.

Such arguments are not entirely devoid of logic. Certainly it is correct that cultivars in the marketplace are the least in danger of erosion. It is also true that breeders are learning to surrender samples of this material for long-term storage in gene banks as they lose their commercial viability. It is also true that the finished variety manifests the germplasm used from breeding programmes.

Yet to say this, as Mexico and other states pointed out, is to say very little. On several occasions in the past two or three years, the IBPGR has, in its crop advisory committees, noted the need to collect modern varieties and hybrids as well as landraces simply because of the rapid turnover in commercial varieties and the continued failure of the private sector to adequately conserve the material themselves.

While it is correct that most private and public breeders adhere to a UPOV requirement that finished varieties must always be made available to any *bona fide* scientist for the purpose of further research and breeding, this says nothing about the overwhelming majority of advanced breeding material which may never be used in a final variety—for any of a number of reasons ranging from the failure of a line to meet agronomic requirements (for the breeder's market—which does not mean that the material would not be useful to another breeder with another market); to the breeder's wish to stage the introduction of new varieties to the company's best profit advantage and so artificially delay the utilization of valuable material. In many instances, breeders jettison exotic material which they cannot use themselves without offering that material either to public gene banks or to other breeders. In any of these situations, agricultural development is the loser.

Yet these practical problems over the exclusion of advanced breeding material from a Convention, pale into insignificance compared to the real problem of giving this material a legal and scientific definition.

Late in 1982, the British Government moved a series of amendments to its Plant Varieties and Seeds Act (1964). The new Plant Varieties Bill, among many other changes, proposed the deletion of any legal definition of the word 'plan' and the word 'varieties' on the grounds that no acceptable legal definition for these terms existed in the international community. The government's view is also shared by UPOV (the Union for the Protection of New Varieties (?) of Plants (?)). Critics of the bill were free to quip, 'no "Plant"; no "Variety"; no "Bill" '.[14] As it is for 'plant' and 'variety', so much more is it so for 'advanced breeding line', 'parentline' or or 'inbred line'. What may be a 'primitive cultivar' or 'wild relative' in one breeding programme can be another programme's 'advanced breeding line'. The exclusion of any category of germplasm would allow private companies to decide for themselves what it is they wish to share.

The battle over the inclusion or exclusion of these terms is close to the heart of the Convention. A Convention that excludes final varieties and advanced breeding material would simply put under the force of international law the 'right' of the 'poor' to 'fully and freely' donate their botanical treasures to the 'rich' and affirm the 'right' of the 'rich' to receive such raw materials while having the option to withhold access to the technological improvements which arise from these materials. We are not, despite the terms being used, talking about copper and cars; we are talking about food and world food security—a basic Human Right.

The exclusion of finished varieties and advanced breeding lines amounts to the tacit acceptance by the world community of PBR (exclusive monopoly) legislation. Member states of UPOV see such a Convention as potentially beneficial to their private sector, and transnationals engaged in seeds regard such a Convention as tantamount to entrenching their exclusive monopoly interests. The inclusion of these terms within the range of 'full and free exchange' would force Convention signatories to dismantle or substantially restructure national PBR laws. Fearing that Third World countries will not give ground on the fundamental principles involved, most private interests and many governments would rather see the Convention killed.

Despite the best efforts of some countries in the drafting committee, the Committee on Agriculture held firm and the full range of germplasm categories goes forward to FAO's 22nd Conference session for further debate.

3. The inclusion of the private sector

The industrialized nations were almost equally concerned that private breeding companies be excluded from the Convention. The exclusion of the private sector would help to protect it from the problems related to the inclusion of advanced breeding lines. The Companies and their governments are particularly worried that a Convention might take the form of some of the proposals that have come forward in the British Parliament. These proposals call for the monitoring of private gene banks by appropriate national authorities as well as the full exchange of all categories of material in the private banks as a prerequisite to the licensing of a private variety for sale. British officials in London characterized this proposals as amounting to 'legalized industrial espionage'. [15]

At COAG, the FAO working paper admitted that it was 'frequently the case' for useful material to be in the hands of private breeders. [16] The paper also advised that the inclusion of private sector material in the Convention would have its difficulties. This is undoubtedly correct. Nevertheless, the sheer size and importance of the material held by private companies makes it absurd to allow their exclusion from a Convention.

There is impressive evidence that private firms cannot be allowed to exercise 'life-or-death' control over the resources in their gene banks. The exigencies of the profit motive; short-term market requirements; the rapid pace of seed company acquisitions; and sudden economic downturns conspire to make seed houses unreliable guardians for germplasm that should be saved for eternity. Hans-Ulrich Hege, for example, is a respected second-generation breeder in southern Germany. The company breeding station combines a gene bank and food locker in one cold room. This is not the way to eternity. Neither is it unusual. Many European breeders with whom we have talked feel badly that the logistics of money, time and space have often forced them to throw away germplasm they themselves collected as far away as India or the Andes.

Two recent cases show the problem. In 1980, an IBPGR contractee undertook a survey of the germplasm stocks held for rubber. This, as yet unpublished, report identified a very significant collection of at least 700 rubber cultivars in addition to an undisclosed number of wild accessions being held by the Firestone Tyre and Rubber Company. Access to the collection was cited as 'restricted' and the contractee added that no information was available on whether the germplasm was documented or evaluated. The report does disclose that the collection included material gathered in Southeast Asia, Brazil and Sri Lanka and that it was being held in Liberia. [17] On April 29th, 1983, we were informed by the Company that its germplasm research work 'has since been suspended'. [18] The fate of their rubber collection is uncertain.

On May 11, 1983, the President of the United Fruit Company (a subsidiary of United Brands) advised the parent company that he would soon close down the banana company's large germplasm conservation programme. IBPGR has provided some data which shows that United Fruit may have control of close to two-thirds of all the world's collected banana germplasm. In his notification letter, company president Warren G Breck commented, 'the company recognizes the major importance of this breeding effort to the long-term survival of banana and plantain agriculture ...'.

The company is apparently seeking outside financial support to continue its conservation facility in Honduras. [19]

The quality of germplasm storage is very important but no more important than the world's access to it. As FAO itself recorded, the holdings of private companies are extensive—if uncatalogued. To have these holdings outside an International Convention would be to make a mockery of the Convention. It is—as many Third World representatives at COAG were aware—striking to imagine that the British Government would regard disclosure of the contents of private gene banks as legalized industrial espionage even while they affirm the right of those companies to have access to the botanical treasures lying in the South. How is it that sorghum seed gathered without fee from farmers' fields in the Sudan in November is not industrial espionage whereas the same seed sought from a private gene bank in Basle a few months later is legalized espionage (if the Convention applied)? Given the history of some sorghum varieties, the movement from a 'primitive landrace' to an 'advanced breeding line' can be accomplished with a mere change of attitude.

The South did not compromise at the COAG meeting. When FAO gathers its members together in November, it will still be for that session to determine the 'elements' of a legally binding convention and to decide whether or not transnational corporations might be excused from the fray.

At the end of COAG

In the closing hours of plenary debate at the end of March, Colombia succeeded in forcing through its proposal that the Director-General be invited to form an advisory group of government representatives to help him take up the concerns that had emerged from the meeting and give direction to the staff work to be done for the FAO Council and Conference papers in November. The formation of the group entailed some procedural problems for COAG and led Dr Bommer (Assistant Director-General FAO) to reach the Director-General (who was away from Rome) by telephone. The Director-General cleared the hurdles and transmitted his selection of representative countries to COAG before it adjourned. The group includes most (but not all) of the leading protagonists. Some of the perhaps more experienced representatives from the South have not been included. The group contains the following industrialized countries: Australia, Cyprus, Spain (added at Mexico's request in summer, 1983), Sweden, United Kingdom and United States, while the Third World is represented by Cameroon, El Salvador, India, Kenya, Konga, Libya, Malaysia and Mexico.

It is not entirely clear at this point what role might be played by the group since the transmittal of a report from COAG normally goes unfettered to the FAO Conference. Given the acrimonious debate and the lack of support for the final document, however, the group may find itself with an unusual degree of responsibility. Then, too, the fundamental issues that lie behind Resolution 6/81 have not yet been openly discussed. Rome's 22nd FAO Conference session may be the scene of a much wider and more significant debate on substantive issues.

Only the Seeds in the Sea ...
The Question of Common Heritage

> *Mr. Chairman, we—countries from the South—know that the wealth of these resources, in their natural state, come from our territories. We must conserve this resource and allow its use in such a way that there will be no creation of greater dependence or risk for our development. That's why we're fighting ...*
>
> Mexican Representative to FAO (COAG), March 1983

No phrase is heard more commonly in a discussion of the control of plant genetic resources than 'common heritage'. Suddenly, a term that was almost hateful to some industrialized countries in the Law of the Sea debates has found a happy home with these same countries. If a little reluctant to share 'advanced breeding lines', the North has nevertheless been unstintingly generous in sharing its view that the South's seeds form part of the great common heritage enjoyed by all humanity. Beyond all else, the South has been told, plant genetic resources are an invaluable and irreplaceable resource crucial to world food security. For this reason, it would be mean and unworthy (except in the case of modern varieties, advanced lines and any property belonging to a private company) for anyone to withhold or demand payment for this resource.

Until recently, and to a very large extent, the South has accepted this noble view. They have believed it because, at least in the important respect that it is vital to world food security, it is true.

The course of human events have led us all to this common bowl of basic crops. We are caught together and dependent upon one another. It is not only North-South. Brazil needs Ethiopia's coffee germplasm and Malaysia needs rubber from Brazil. Australia needs Libya's wild medicagos (for example, lucerne) and Libya needs Australian seed technology. Seed is the raw material upon which our daily bread depends. There are other raw materials. Where would the world be without Gulf petroleum? What would the Gulf do without Northern technology to develop its oil? What of Bolivian tin, African cobalt and Canadian nickel? All raw materials. All essential. All dependent on outside technologies for their exploitation. All paid for.

But the economics of plant genetic resources are only a part of the issue. Unlike oil or copper or titanium, for ten thousand years seeds have been saved by peasants. In the wink of an eye, some of those seeds have vanished forever—and others can now only be visited in the cold, lightless rooms of a gene bank in Braunschweig or Lund or Bari. Most of us are only one or two generations removed from our peasant roots. The millenias which preceeded our most recent decades are still in our genes. Seeds still call from within us a sense of place and a sense of responsibility. At FAO in November, the North will have to deal with a South that feels it is losing something it should not have to lose ...

Repatriation: seeds as a cultural heritage

In 1981, when the British Government was downplaying the need for an International Convention and opposing Resolution 6/81 at FAO, it was also returning the Proconsul Africanus skull to the Government of Kenya. The return of the two-million-year-old skull had been requested in keeping with the Unesco Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (1970). [20] In the same year and in the same context, London's Wellcome Institute shipped a collection of Himyarite artifacts back to Yemen; the Australians sent home art treasures to Vanuatu; the New Zealanders returned relics to the Solomon Islands; and South Africa relinquished a collection of carved birds to Zimbabwe. In the last few years since the passage of the UNESCO Convention, France, Belgium, the United States and the Netherlands have joined the ranks of former colonial powers surrendering invaluable cultural treasures to the people and nations which gave rise to them.

The parallels between the fight for the 1970 UNESCO Convention to repatriate lost treasures and the fight at FAO are, if not complete, at least impressive. Most notable of the differences is that the South has only sought to have newly-collected material stored within their national borders and the issue of repatriation has thus far remained lurking below the surface. Secondly, cultural artifacts held by government museums cannot match the commercial importance of germplasm stored in government gene banks (although, obviously, art treasures represent enormous wealth

Table 12 Two heritages. Culture and crop: the arguments against repatriation [21]

Cultural heritage: the debate at UNESCO	Crop heritage: the debate at FAO
The legal argument	
The North In most cases, the removal of cultural objects from Third World countries has been perfectly legal in terms of judicial precedent and in the light of the geopolitical realities of the colonial and post-colonial era. There is no legal 'guilt' to be assigned and no legal reason to return cultural artifacts.	Although there are notable exceptions (such as the violation of national laws by the theft of comchona) most past and present transfers of plant genetic resources have also been perfectly legal and there are no legal grounds for demanding their return.
The South: The repatriation of cultural property taken by force, within Europe, has been well-established at least since the Congress of Vienna in 1815. The removal of cultural artifacts from the Third World during the colonial era should be viewed in the same light and the same morality should be applied.	The wholesale movement of botanical treasures during the colonial era was often undertaken without the agreement of local people and much of the material that has since flowed North has done so without the full implications thereof being made known to Third World governments. The issue of legality is a facade.
The safety argument	
The North Known as the 'Museological' argument, the North maintained that the 'deplorable' lack of facilities and shortage of trained personnel in the Third World meant that artifacts were more safely stored in the North.	Equipment breakdowns, power failures, fuel shortages and the lack of trained personnel are all cited as valid reasons for the concentration of gene bank resources in industrialized states.
The South Cultural artifacts can sometimes be better preserved in the climate (temperature, humidity, etc.) and culture that created them rather than in far-off climates among people who have to learn how to care for them.	There have been enormous losses in gene banks in the North—much of it related to improper rejuvenation of material beacause of the high cost of growing out accessions under their original conditions. It might be safer and cheaper in the long run to have the germ plasm banked in the country in which it was found.
The universalist argument	
The North Most of the countries laying claims to the return of cultural artifacts are a long way from the world's cultural centre, 'their cultural genetic property is better and more widely appreciated in the large museums of the industrialized countries'.	Most of the world's plant breeding takes place in the North. New breakthroughs for agriculture through genetic engineering, etc. will come from the North. It is important for these agronomists to be close to the materials in gene banks for their work and for the benefit of humanity.
The South This is 'arrogance'. The people best able to appreciate these cultural artifacts are those who bore them.	The plant genetic resources come from the South. The need is greatest in the South. Scientists concerned about world food security should be working in the South. Since stored material can be regenerated, it is also possible for duplicates to remain in the North.
The technical argument	
The North 'The return or restitution of cultural property to its countries of origin would be better ensured through direct and discreet negotiations between musuem professionals.'	Both the collection and the exchange of germplasm can be much more easily achieved outside a legally binding Convention, through exchanges of letters and via the collegial informality of the scientific community.
The South This is the system which has led to the drain of the Third World's cultural treasures. The issues involved are beyond the competence of experts.	This is the system that has led to the drain of plant genetic resources from the South. The issues involved are beyond the competence of technicians.

on the commercial market). No one seriously doubts that the South will want to have material now only available *ex situ* ulitmately in safe collections in national hands. No one seriously doubts that a major obstacle to this repatriation will be the commercial value of plant genetic resources.

The similarities in the debate over the two Conventions are much more striking. In a recent publication, UNESCO summarized the major arguments against its Convention. We have, in the table above, attempted to relate these arguments to those within FAO and have also indicated the counter-position posed by supporters of the Convention.

The legal ownership of plant genetic resources is particularly noteworthy. In the UNESCO debate, industrialized states were anxious not to be labelled as thieves or to labour under any implication that the artifacts in the Louvre or British Museum were obtained surreptitiously. As a consequence, the UNESCO Convention talks in terms of 'return or restitution' and attaches no guilt to the exchange of treasures.

The wording does not change the reality that the French under Napoleon, the British under Victoria and the Americans under the Dollar managed to buy or otherwise procure many of the world's most historic and important cultural artifacts. Nor does it change the fact that modern, enlightened governments and their peoples in the Third World now want the return of their cultural heritage.

The situation should be very similar for plant genetic resources. The Convention need not imply guilt. Nevertheless, the North should not confuse the 'legal' status of its collections as equivalent to an acceptable 'moral' standard. The botanical treasures of certain states were shifted about the various colonial empires with due legality but without any attention paid to the short- or long-term interests of the originating states. Given the enormous economic value of some ornamental material obtained freely from the Third World and now grown profitably in the North, the legal realities were hardly just.

Museum curators have also argued that had it not been for the storage of many cultural items in the North, those items would not have survived. The realities of temperature and humidity control and the technical skills needed for restoration continue to make storage in the North preferable to storage in the South. There are undoubtedly examples to substantiate this view. However, at a 'Lost Heritage' symposium held in London in 1981, Keith Nicklin responded to this argument from Dr David Wilson of the British Museum by commenting, '... the skin-covered masks from the Cross River area in Nigeria ... have tended to be rather better looked after in the field than in museums ...'. [22] In discussions with some UNESCO officials and museum curators we have learned that the success rate in the North is not as impressive as it first appears, and that much has been damaged or lost due to the unfamiliarity of the foreign museum with the materials used in the artifact.

As it is with Nigeria's masks, so it is with West African rice. This vanishing botanical treasure can and should be stored in West Africa where it can be safely and inexpensively multiplied, as it scientifically should be, in the regions from whence it came. Living collections should also be saved by peasants acting as farmer/curators. Small plots of land can be safely set aside for this purpose and farmers can be paid a small stipend to maintain the variety in conjunction with a national gene bank or botanical garden.

In the UNESCO debate, Northern governments attempted what became known as the 'universalist' argument. This position held that the Third World's artifacts formed part of a common heritage for all humanity and that they could be better and more widely enjoyed if they were located in the major centres of the world. This reasoning was considered spurious by Third World museum curators who—without denying the contribution of their cultures to world society—insisted that the peoples who created these artifacts had first right to have access to them ... and that the world was welcome to come and visit or to enjoy these objects as part of occasional international exchanges.

Once again, the relationship to plant genetic resources is almost complete. Many of the most important genetic treasures are the landraces and weeds which are the result of thousands of years of peasant farming. More than one modern breeder has admired the genius that created maize and selected wheat and potatoes over the millenia. Landraces exist because they meet both the environmental and the cultural requirements of the farmers. If the crops have become part of a common world heritage, it is still true that their original cultivators have first claim on their presence.

The final argument, the 'technical' as opposed to the Convention approach, is especially destructive. In essence, it agrees that the South should have greater access to its own heritage (be it cultural or agricultural) but it argues that the informal approach within the community of scientists will achieve the best results. Such an argument ignores the existence of certain political and economic attitudes that continue to influence the holders of these treasures and interpret 'bottom-line reality' as being that which is current and dominant within their own society. That the 'bottom-line reality' of Africa or Asia might be different never occurs to them. Both in the case of the UNESCO Convention and the proposed Convention at FAO, the South has maintained that a clear and fundamental break from the past is required at the international level before any true change can take place at the informal level.

This has been manifestly the case with regard to the UNESCO Convention of 1970. Prior to 1970, technocrats argued that it would not work; that only nations wishing the return of cultural artifacts would sign the Convention; that the political pressure from the South would simply toughen the attitudes of the professional community in the North and make relations more difficult; and that repatriated treasures would quickly go the way of Ozymandius.

They had other arguments as well. Many Northern museums had failed to maintain an adequate inventory of their collections and would have to incur considerable costs of time and money to document their resources. Likewise, few Third World countries had a complete list of what had been taken. Then, too, some artifacts posed geopolitical as well as geocultural problems. Either the exact national home of an object could not be ascertained beyond a certain geocultural area or the political boundaries had shifted so that the claiming country no longer possessed the exact region from whence the object was removed.

At least a few museum curators pleaded for a kind of 'Statute of Limitations' on the return of material. Was it necessary for Rome to return the goods it had taken from Carthage? How many years must pass before the forgotten treasure taken from one civilization can be viewed as a part of the fabric of another society? In germplasm terms, must the Soviet Union make copies of all the material collected by Vavilov in the 1930's—a half century ago?

The answer to the genetic question might be found in European treaties related to the return of art treasures. An 1866 treaty, for example, bound the Grand Dutchy of Hesse to return treasures taken from Cologne in 1794. In 1919, the Treaty of Saint-Germain forced the Austrians to return art works taken from Italy two centuries earlier (in 1718). It is difficult to see why a similar effort should not be made outside of Europe for commercially-valuable plant treasures.

In the first years after the signing of the Convention, the scepticism of the North might have seemed to be realized. Only Third World governments had signed the Convention and there hade been little or no movement of treasures. The Convention had had the foresight to establish an Intergovernmental Committee to promote its work, however, and that Committee had been successful in drawing public attention to the issue and applying political pressure. By 1977, the Belgian government (a non-signatory state) was sending home several thousand cultural artifacts to

Zaire and helping Zaire establish a network of regional museums for their display. Not long afterwards, the Netherlands (another non-signatory) sent a large number of icons and relics of very great importance to Indonesia, and the United States (an adamant opponent of the Convention) was making arrangements through four museums to return important artifacts to Peru and Panama. Harvard's Peabody Museum also agreed to give Panama assistance with its collections.

Eight years after the passage of the Convention, Italy and Canada were the first Western countries to ratify. This year, two of the most important opponents, France and the United States (long against the notion of a Convention), have passed the necessary national laws that will allow them to become signatories within a few months. In addition, France and Canada have both acted against private artifact dealers to return items to their rightful national custodians. What 13 years ago seemed absurd to even contemplate in both financial and practical terms is today becoming a reality.

The debate over the Convention and the return of cultural resources to the originating states stimulated national pride and respect for these resources and has led to cooperative international efforts aimed at preserving repatriated material in its homeland. Among those countries now most enthusiastically in support of the UNESCO Convention is Canada. Government officials told us, with some pride, of their own national experience ...

The Kwakiotl Indians live high on the Northwest Pacific Coast—in British Colombia. In 1922, the Kwakiotl held a Potlatch—an ancient and important ceremony. It was considered illegal by the Royal Canadian Mounted Police and the ceremony was broken up and the religious and cultural relics confiscated. For the following half century, the relics remained in storage (not on display) in an Ottawa musuem. Government officials resisted the efforts of the Indians to have their relics returned even after the law banning the Potlatch was removed from the books in the 1950's. Officials argued that the artifacts had been legally acquired; that they could not safely be surrendered to the Indians; and that, since the artifacts were part of Canada's cultural heritage they were better off in Ottawa where more would see them than in remote British Columbia. Finally, with the understanding provided by the UNESCO Convention, the Government returned the artifacts to their rightful owners in the late seventies so that the old people of the villages could see them again before they died. The Kwakiotl raised half the money for their own musuems and

Ottawa matched that amount. The Potlatch relics are now safe where they belong.

Remuneration: seeds as a raw material

Plant genetic resources—at least in the form of orthodox seed (such as cereal seed) are a remarkable material in that (as agricultural economist Jean-Pierre Berlan of INRA has observed) the means of production is also the end product for consumption. Thus, most of the world's major food staples are inseparable from the raw material for their production.

Are seeds then to be regarded as a raw material like minerals and fossil fuels—or as a fundamental human right above and beyond the clamour of the marketplace?

The scientific community has overwhelmingly argued that plant genetic resources must be considered in the context of Article 11.2 of the International Covenant on Economic, Social and Cultural Rights which binds signatory states to achieve 'freedom from hunger' through every possible means including the sharing of scientific information.

The deliberations in Rome have made it evident that governments in the North hold the view that wild species and primitive cultivars should be placed in the 'common heritage' or 'human rights' fold, while anything with immediate market value (modern varieties) should be treated as a commercial resource.

Third World countries are not so clear. Historically, developing countries have accepted the North's teaching that there are 'Sunday-School Seeds' which must be made available, fully and freely, for the greater benefit of humanity. It is their good fortune that they have the lion's share of Sunday-School Seeds and thus have the privilege of giving these seeds to the world. Through genius and the Protestant 'work ethic', scientists and companies labouring outside of the Garden of Eden have succeeded in converting primitive Sunday School Seeds into new engines of agricultural progress. In doing so, they are helping to feed the world.

Yet some Third World diplomats and agronomists have long held the suspicion that somebody is making a lot of money out of their Sunday-School Seeds. To those contributing germplasm for ornamental and industrial crops, the link to the world's breadbasket seems a little tenuous. For these countries, there is a growing feeling that UN General Assembly Resolution 1803 (XVII) on Permanent Sovereignty over Natural Resources should not go undiscussed. Then, too, some would say that whenever the major economic powers and transnational corporations talk about Human Rights and our Common Heritage, the Third World had best check its wallet.

Given their widely-recognized importance, remarkably little work has been done to document the economic advantage contributed by specific accessions from the Third World to modern agriculture. Some of the best work in this regard has come from Robert and Christine Prescott-Allen, and Dr Jack Harlan. The table below cites a few examples:

Table 13 The economic worth of genes

Crop	Contribution	Source
Wheat	US Plant Introduction No 178383 has saved farmers in the American Northwest an estimated US $3 million per annum from losses due to stripe rust.	Collected in Turkey in 1948
Hops	Wild hops have made a major contribution to the high alpha-acid content that makes British beer 'bitter'. The estimated annual value to the British brewery industry is approximately US $20 million per annum.	Wild hops from Manitoba, Canada, and California, USA, are the source of most British 'bitter'.
Cherry	Wild cherry material 'virtually saved' the US $10 million cherry industry in the United Kingdom.	Wild material was obtained in north China.
Maize	Perennial form of teocinte (wild relative of maize) has been estimated by agronomists in the United States to be 'worth billions' to future breeding programes.	The only known form of this wild maize was found in Mexico.
Lucerne	New material collected in late seventies has been judged by one Australian breeder to be 'worth millions' to the national livestock industry.	Lucerne types were collected in Libya in late 1970's, some of it in violation of agreements.

Far beyond these few examples, it would be entirely correct to attribute the continued survival of whole crops such as potatoes and tomatoes to the constant infusion of Third World germplasm. All crops rely upon occasional introductions of exotic germplasm but some root and vegetable crops are grown in the North on an extremely confined genetic base and are particularly beholden to the original centre of diversity. Even crops such as wheat and maize have—in recent decades—been forced back to the Near East of the Amazon in order to continue in a certain growing area. Without fear of exaggeration, the annual value of specific Third World genes can be calculated in billions of dollars.

The water basin and the gene pool

FAO's Legal Department devoted considerable time to the preparation of discussion documents related to Resolution 6/81. Logically, the laywers looked to comparable FAO experiences, and particularly at The Law of

International Water Resources—a legislative study undertaken by the Legal Department shortly before the seeds issue commanded their attention. [23]

International agreements related to water resources offer a number of important parallels: (a) both refer to a largely 'renewable' natural resource: (b) both are vital to the sustaining of life; (c) both are distributed in unequal proportions about the globe; (d) both water basins and gene pools often lead to a situation in which sovereign states are dependent upon one another; and (e) both water and germplasm can be exported in a 'processed' form.

Despite these many obvious connections, no reference to the international legal experience with water resources finally appeared in discussion documents.

Plant genetic resources—as we have already noted—are concentrated in gene pools in identifiable areas known to botanists as the Vavilov Centres. In the same way, the world's great waterways tend to originate in certain concentrated areas such as the highlands of East Africa, the Alps of Europe or the Himalayas of Asia. Major rivers such as the Congo, the Niger and the Nile in Africa or the Rhine and the Danube in Europe have transnational significance for transportation, agriculture and industrial purposes. Any man-made initiatives that affect access to water or the flow of water can have a massive impact on the quality of life (and survival) of peoples using the water.

Likewise, any disruption of the flow of genetic material from the gene pools to their 'downstream' users can have a massive impact upon agriculture in other areas.

In the case of water resources, governments have recognized their interdependence for a very long time. At least in the past two centuries, states have attempted to avoid wars and to look to international agreements and arbitration over water disputes. The trend is clear that states accept that negotiations and an agreement should be reached before one state diverts the flow of water sufficiently to affect water levels downstream in another state.

There are limitations to this sense of international responsibility. In an 1895 dispute over a diversion to the Rio Grande, US Attorney-General Harmon advised the protesting Mexican Government that '... the fundamental principle of international law is the absolute sovereignty of every Nation as against all others within its own territory ... all exceptions, therefore, to the power of a Nation within its own territory must be traced up to the consent of the Nation itself. They can flow from no other legitimate source.' [24] The US decided it could do as it wished to the Rio Grande since the river was not covered by an international treaty.

Even where the flow of water between two states is covered by an international agreement, the right of the downstream state appears to be severely limited. When the French Government proposed to divert water from a lake wholly within French territory and then to re-introduce a portion of this water (after use, in a hydro-electric project) into a river system flowing into Spain, the Spanish Government protested that the net effect would be a reduction in the natural flow of water out of the French Pyrenees into Spain in violation of an international treaty. France replied that the treaty only covered a flow of water sufficient to meet the needs of a specific Spanish irrigation system. An international tribunal upheld the French view and the water flow to Spain was accordingly reduced. Interestingly, the tribunal held that France, by treaty, was obliged not to interfere with the 'human need' for the water. The tribunal was not prepared to accept that Spain's potential 'human need' might lead to other irrigation projects, etc., requiring the original flow of water.

While germplasm does tend to 'flow' from South to North following a rather traditional trade route, plant genetic resources are not part of any international treaty and, in the context of the water resources parallel, 'gene-rich' states are under no obligation to share their raw materials with the 'gene-poor'. It is greatly to the credit of the Third World that it has, by and large, acted with a very deep sense of the global good and made its resources widely available to all.

Water and seeds as 'processed' materials

Where nature has dictated water to flow, governments seldom intervene with a tollgate at the border to exact profit from what is seen as a 'free' raw material. The occasions where human intervention conspires to increase the flow of water across national boundaries are still relatively rare, and the right of one nation to charge another nation for the privilege of using such water is not clear. There are occasions (between towns on the Canada/US border and between Dominica and the Middle East, for example) when an exchange of cash or favours is demanded but these are few.

This situation is expected to change. The scarcity of water in some parts of the world compared to its abundance in other parts is expected to stimulate massive diversions across some international boundaries. The United States, for example, is anxious to obtain access to the huge surplus of water north of their border. Beyond payment for the costs of the massive engineering works required, there is little doubt in the minds of all concerned that Canada will exact some 'gain' from its resource (if not in cash then in trade concessions). Since a primary purpose of such a diversion would be to irrigate American farmlands, the parallel to the transfer of germplasm is complete.

It is common practice, however, for nations to profit from 'processed' water. When trasmitting hydro-electric power, the exporting state expects not only to recoup the costs associated with site construction and environmental damage but also to earn a profit. True, only a minor portion of such energy might go to drive irrigation pumps or even to transport and process food, but few would deny the life-or-death importance of a continuous flow of energy to metropolitan centres—particularly in the temperate zones.

Plant genetic resources are also often 'processed' by farmers and gardeners. It is to the advantage of the North to speak of 'primitive' landraces or cultivars. In fact, many of these 'primitive' varieties display a high degree of sophistication and some have made the transition to 'modern' varieties merely by crossing a border into the National List of another country. 'Primitive' cultivars may not have an identifiable inventor but they are the product of human genius and their survival has depended upon the caring hand of national agriculturalists down through the generations. Because they have already been adapted to formal agriculture, these landraces tend to be much more useful to modern breeders than their wild relatives.

'Weeds' also fall into the area of 'processed' germplasm. Weeds are dependent upon the intervention of farmers for their survival. In some cases, farmers actively protect weeds where they have found that the natural cross-breeding of their crop with weedy species contributes to the vigour of the crop.

Occasionally, wild species are also protected by agriculturalists. The perennial teocinte found on a Mexican hillside a few years ago existed under the active protection of a single farm family. In the Third World, numerous fruit, nut and medicinal plants—for whom no breeding has been undertaken—have nevertheless been protected by local peoples who occasionally make use of them. It is difficult to understand why the South should not obtain some benefit from germplasm both as a raw material and, especially, as a processed product derived from the genius of their citizens.

This viewpoint is unquestionably strengthened in the context of PBR legislation, which awards an 18-year exclusive monopoly patent to anyone (in a UPOV-member state) who happens to 'discover' a new plant variety of accidental mutation of an old variety. It has been estimated that the substantial majority of varieties monopolized under the US Plant Patent Act of 1930 are, indeed, accidental discoveries—several of them made by Northerners while travelling in the South.

Beyond regulating the flow and environmental impact of North Sea oil within their borders, the Norwegians have done little to warrant the flow of cash to their economy created by this crucial world resource. Beyond regulating the harvest rate of fish floating around their island, the British have done little to warrant the benefits they receive from a natural food resource that just happens to pass through their sovereign waters. Beyond modest pollution control efforts, the Canadians will have done little to justify the income they will receive for their water from American farmers. Yet the South is being asked to donate the basic materials for a multi-billion dollar industry—an industry which seeks the patenting of food plant varieties. The poor are being asked to give away their national botanical treasures as an act of charity to the rich.

Setting the price of germplasm
'OGEC' and 'GCDC'

In its COAG discussion paper, FAO posed the possibility of attaching a mechanism to an International Convention that would support the conservation of germplasm resources. In other word, signatory states would pledge themselves to financing the conservation of plant material through, perhaps, the formation of a special fund administered either by FAO or by IBPGR. Since there already exists a mechanism for countries to contribute to conservation work directly through IBPGR, this new proposal must be interpreted as tacit recognition of the South's right to benefit from its botanical treasures.

How and in what way the South might benefit has been a source of considerable speculation. Some analysts have suggested that the Third World could form a genetic OPEC and bargain collectively with the North for access to their raw materials. While the imagery may be appealing, the resource is hardly suitable. The accessibility of oilfields and slight differences in the physical properties of petroleum (i.e. sulpher content) have often made it difficult for OPEC with what, nevertheless, remains a highly homogeneous product. The accessibility of plant resources is similar but their variability defies human imagination. Further, the profit in oil relates to the quantity exported, whereas the profit in seed depends upon the quality exported. Begonia seed can far exceed its weight in gold on the commercial market while a pocketful of maize seed encasing 'perennial' genes can surpass the value of an entire oilfield.

If an 'OGEC' is unrealistic, the potential for 'GCDC' is entirely credible. Indian scientists are already examining ways in which Genetic Cooperation among Developing Countries might be achieved by combining the botanical wealth of the Vavilov centres with the breeding experience of some Third World countries. China, India and Brazil, for example, have access to both a highly-skilled scientific community and to Vavilov Centres. Parts of Africa and Asia lack the same experienced personnel but also have Vavilov Centres. The common dependence of many of these countries upon a few staple food crops and some export crops could form the basis for effective cooperation. Then, too, the potential to use exotic germplasm has multiplied the value of the Vavilov Centres spectacularly. There is a real possibility for the South of taking a significant share of the market for this booming high-tech industry.

These are longer-term considerations but ones which Convention negotiators at FAO must bear in mind. Their immediate priority must be genetic conservation. The benefits they require, however, could be established to either meet the specific needs of adequate 'conservation' and/or to further their agricultural 'development'. Since the promotion of agricultural development in the Third World is central to FAO's own objectives, the creation of a financial system that would benefit the South could be seen as a worthy goal within the Convention. Development that increased the technical competence of Third World personnel, provided additional agricultural research facilities and equipment, and otherwise improved the capacity of Third World agriculturalists to monitor, document and utilize germplasm in breeding programmes, should be regarded by Northern countries as a net benefit to world food security and should be supported. The surest means to effective conservation is effective utilization. Scientifically speaking, the wisest place to utilize botanical diversity lies in the Vavilov Centres. There should be no conflict between an international campaign to conserve plant genetic resources and national development strategies.

Conservation support

Discussion concerning the exact form of a financial initiative confined to immediate conservation needs is at a very preliminary stage. Some elements, however, seem both logical and likely. It is, for example, fairly certain that if a Convention is finalized in FAO, the South will confine the exchange of germplasm exclusively to those states that are signatory to the Convention. Non-signatory states will either be denied access to germplasm (since they have refused to be party to a system assuring free exchange) or they will be obliged to arrange bilateral agreements which will undoubtedly impose both financial obligations and some equitable agreement giving the gene-donor state access to 'finished' varieties resulting from the genetic resources they have contributed. States having exclusive monopoly legislation such as PBR may face additional obligations in obtaining Third World material.

Within the Convention itself, provision would be made for a Conservation Fund administered by FAO. Signatory states would support this Fund in the same proportions in which they now contribute to other UN programmes. There is already wide agreement that the Convention should be open to non-FAO member states and, likewise, the Conservation Fund.

It is more difficult to perceive the kinds of purposes for which the Fund would be used. At present, IBPGR undertakes support for emergency collection work but appears to have little capacity to support the formation of national and international facilities for germplasm conservation and documentation. If this continues to be the case, the Fund might be expected to give priority to, first of all, the realization of an 'International Gene Bank' and, secondly, support for national gene banks, biosphere reserves and botanical gardens.

Given the mounting feeling that IBPGR must be made directly responsible resources will be incorporated into the Fund and disbursements will include the full range of conservation efforts including personnel training and documentation.

It should be noted that many states now look upon the 'International Gene Bank' more as a system of regionally-located, internationally-controlled gene banks than as one centrally-located cold room. However the concept is finally put into practice, the 'International Gene Bank' will always be seen as a 'back-up' in support of national conservation efforts.

No calculations have been made on the total funding required for even a minimal conservation programme at national, regional and international levels. It is clear that the next ten to twenty years represent an emergency situation and that, while funding must be high now, it may not need to remain high towards the end of this century. It is tragically ironic that the crisis period for the conservation of germplasm has arrived at the same time as the worst global depression in half a century. Be that as it may, the world's governments cannot afford to lose their perspective. Extinction is forever. If we do not act now, there will be no need to act later.

By way of priorities, it is interesting to note that the four major municipal zoos in one state, Canada, receive more than twice as much money from their local government than is now accorded by donor governments to the IBPGR. Without downgrading the contribution of zoos, it is impossible to compare their limited place in the conservation of species with the crucial mandate given to the IBPGR. Seeds may not have dewy eyes and wet noses but neither the zoo animals nor ourselves can live without them.

Development support

Increasingly, Third World States recognize that the preservation of biological diversity can go hand-in-hand with the proper utilization of genetic resources in new crops and in new varieties for old crops. In this context, it should be entirely reasonable for an International Convention to recognize the need of conserving countries to obtain benefit from their resources in order to further their own agricultural development. Accordingly, a Development Fund could be part of an expanded Conservation Fund associated with the Convention. Alternatively, national governments could establish their own revenue system independent of the Convention.

Northern diplomats claim that any effort to 'charge' for access to national germplasm *in situ* would be technologically and administratively self-defeating. The costs of guarding material would exceed any financial benefit that might be available. In other worlds, a high fee for germplasm would merely encourage smuggling. Given that sufficient breeding stock for most crops could be transported in a explorer's pocket, any idea of effective policing is unrealistic.

This is partly correct. Germplasm smuggling is rumoured to be already well established for Ethiopian coffee. Yet it must be recognized that even the most knowledgeable breeder cannot be sure that the sample snatched from a farmer's field or woodlot will bear the characteristics she or he has journeyed many thousands of miles to find. A systematic approach to collection is required, involving careful observation and note-taking in the field. Such work is difficult to disguise. Normally, seeds can only be collected at specific times of the year. Government officials need to vigilant only during these short and very predictable periods. Vegetatively-propagated material (cuttings) require special care and is much more detectable at international borders than is orthodox seed.

But the prevention of unlawful collecting and smuggling is probably a minor part of the exercise and governments faced with scarce human and administrative resources need not dwell upon this negative approach to their botanical treasures. A much more constructive approach can be taken which is directly beneficial to world agricultural development.

1. Development of quarantine standards.

It is axiomatic that the centres of plant genetic diversity are also the centres of disease and pest diversity for the same plants. The Danish Institute for Seed Pathology for Developing Countries (funded by DANIDA) has been deeply concerned with this problem for many years now. Its retiring director, Paul Neergaard, has won international admiration for his exhaustive work in training Third World scientists in the identification of seeds and their diseases. The work is important, as an Institute-sponsored symposium held in New Delhi late in 1980 demonstrated. [25] The gathering learned of new cotton and sweet potato diseases introduced into China from material originating in the United States and Japan respectively. Bangladesh reported the introduction of wild oats with imported wheat seed. In Libya, new diseases had spread with the import of cucumber seed. New diseases have recently come to Mauritius in imported papaya, squash, groundnut, rice and vegetable seeds. Officials in Nepal reported new diseases in wheat, rice and fruits 'due to haphazard introduction in the name of development'. [26] Smuggled cassava seeds have created new disease problems for that crop in Nigeria. Thailand has also faced new problems in cassava as a result of seed-borne diseases.

Reviewing the problem of seed introductions at the beginning of the 1980's, Neergaard emphasized the 'paramount importance of gene centres' as disease centres and concluded, 'There is now a growing appreciation of the vital importance of the spread of diseases by international exchange of plant genetic resources'. [27] In one survey of 4,500 plant introductions in the United States, government researchers found that an average of 2 per cent carried foreign diseases. For some crop seeds, the disease ratio was over 20 per cent.

It is to the benefit of global agriculture that strong quarantine programmes be established in the gene-exporting countries of the Third World. This involves buildings, equipment and personnel training. Through the international cooperation of exporting and importing countries (who share a mutual interest), it is possible to both protect the importing state from potentially disastrous new diseases and allow the exporting state to monitor the flow of germplasm out of the country. Through the cooperation achieved with the International Convention, it should, in fact, be possible to (initially and until resources are developed at the exporting end) monitor the flow from the established quarantine programmes of the North.

2. Development of seed quality standards.

Virtually without exception, industrialized nations have seed quality control programmes in place for major agricultural crops. Most Third World countries also have at least pilot quality control programmes operational and approximately one-fifth of all states in the South have advanced seed quality regulation. Thirty seven states now participate in the OECD Schemes for the Varietal Certification of Seed Moving in International Trade. The approval of seed for the marketplace is generally based upon performance testing accompanied by a description of the 'pedigree' of the variety including a detailed presentation of its parents and grandparents, etc. FAO's Seed Improvement and Development Programme (SIDP) actively encourages seed certification and financially contributes to the equipment and personnel training required to enforce such government regulations in the Third World.

The spread of pedigree regulations to more countries and the circulation of information on the ancestor lines used in new varieties would provide another means of monitoring the flow and utility of Third World germplasm.

In both examples (1) and (2), the effort of Third World gene-exporters to monitor the movement and usefulness of their botanical resources in perfectly compatible with development objectives identified by FAO and already supported (albeit with extremely limited resources) by FAO's SIDP or by bilateral foreign assistance programmes. In both cases, strengthened capacities in the Third World would also assist Northern governments in protecting their crops and farmers. Such initiatives could and should be supported through the Conservation Fund under the Convention.

Alternatively, quarantine and seed quality control measures can be implemented outside the Fund as part of a larger national agricultural development strategy. Remuneration for a nation's botanical treasures could be required at three and/or four points:

(i) through germplasm exploration licenses (based on territory and/or) species);

(ii) through export licenses;

(iii) through bilateral contracts ensuring additional revenues dependent upon final incorporation of the germplasm into finished varieties (either on a flat fee or crop area basis) supported by the monitoring of ancestor lines, and/or;

(iv) access (on acceptable terms) to the finished variety for national use.

Again, Third World countries can be expected to drive a particularly hard bargain with those industrialized countries having PBR legislation.

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In monitoring the debate over the FAO Convention, the single most striking feature of the discussion has been the reluctance of Third World diplomats and agronomists to treat their botanical resources as a saleable commodity. Their acceptance of the importance of plant genetic resources is profound and their belief in the 'common heritage' argument is genuine. But there is also a sense of having been robbed. It is the industrialized countries that are patenting plant varieties. And it was the industrialized countries that fought against 'common heritage' in the Law of the Sea Conference where the reasonableness of the principle should have been clear to all. Following one bitter sidelines discussion at the COAG meeting in March, an African delegate walking angrily away from the exchange remarked, 'If this [patents] is Common Heritage then we will give them all the seeds in the sea'.

Notes

1. IBPGR Newsletter (further data unreadable from photocopy available).
2. Ibid.
3. Data derived from IBPGR Directories of Germplasm Collections (Volumes 1–5) and untitled and unpublished 'Red' Book draft, 1980, relating to other crops cited.
4. Ibid.
5. Ibid.
6. Ibid.
7. Data derived from 'Canadian Plant Gene Resources Inventory Accessions received by The Central Office for the Plant Gene Resources of Canada during the Period 1972–1977: Accessions PGR1 to PGR2408 Report PGRG-78-1 February 1978, Agriculture Canada.

8. From a memo to ASSINSEL members dated 22 February 1983 from Hans B. Leenders, Secretary-General of ASSINSEL.
9. Ibid.
10. FAO COAG 83/10.
11. Appendix 8 'Proposals for the implementation of FAO COAG Conference Resolution No. 6/81 on Plant Genetic Resources' (deleted from) FAO COAG 83/10. Note particularly the table titled, 'Data on Vegetable Seeds' from *replies to a world-wide questionaire (IBPGR).*
12. Data derived from a variety of published and unpublished reports by IBPGR, FAO or UNDP.
13. FAO COAG 83/10.
14. Information provided by Stevė Godfrey, War on Want, UK.
15. Ibid.
16. FAO COAG 83/10.
17. IBPGR (unpublished) 'Red' Book, page 122.
18. Letter of this date to Vic Althouse, M.P. Canadian House of Commons.
19. Ibid.
20. 'Backgrounder: Return or Restitution of Cultural Property' UNESCO, p. 15 (undated)
21. Ibid.
22. ' "Lost Heritage": The Question of the Return of Cultural Property', Common wealth Arts Association, Report on the Symposium held in London, 1981, p. 26.
23. *The Law of International Water Resources,* FAO Legislative Study No 23, 1980.
24. Ibid. No. 25, p. 7.
25. *A Collated Report on Quarantine for Seed Based on Individual Reports From Delegated Participants of the Seminar,* Danish Government, Institute of Seed Pathology for Developing Countries, November 1980.
26. Ibid.
27. Neergaard, Paul, *A Review of Quarantine for Seed,* Danish Government, Institute of Seed Pathology for Developing Countries, 1980.

The Keys to the Kingdom

The Emerging 'Global' Network

Finding themselves uncomfortably in the midst of a growing political debate are an obscure group of agronomists and bureaucrats associated with an institutional misfit known as the International Board for Plant Genetic Resources (IBPGR). Located in Rome, IBPGR is the step-child of both FAO and the Consultative Group on International Agricultural Research (CGIAR). Its mandate is to establish a Global Network of base crop collections at national or regional gene banks for the safe keeping of the world's botanical heritage. For the life of them, these scientists cannot see why their work is regarded as political.

We don't want to duplicate the IBPGR—We want to plant the UN Flag on it!
Permanent Representative of Colombia to FAC, March 1983

The parentless hybrid

Agronomists have been trying to convince diplomats that genetic erosion is a threat to food security at least since FAO's first Committee on Agriculture (COAG) back in 1946. During the sixties, FAO had established its own Crop Ecology Unit and had developed an effective working arrangement with the International Biological Programme. With the advent of the seventies and the bulldozing drive of the Green Revolution, geneticists became genuinely alarmed that the measured pace of studies, reports and incremental budget increases were being overwhelmed. In some desperation, leading scientists joined forces at the 1972 Stockholm Conference on the Human Environment and pushed through a resolution they hoped would attract the world's attention.

In the scientific community, the 'world' consists of other scientists. What to them seemed like a primal scream and to non-scientists had all the force of an academic cough, attracted a modicum of attention from fellow-scientists and governments. Some of the ringleaders were invited to Beltsville, USA, just outside Washington, to participate in an inter-agency working party on the resolution. Sitting around the meeting table were officials from FAO, the World Bank, United Nations Environment Programme (UNEP) (the unwelcome offspring of Stockholm) and the fledgling but powerful CGIAR (itself an offshoot of the Green Revolution and disputed child of FAO and the World Bank). The scientists lobbied for a network of nine regional gene banks to be located in the Vavilov Centres of genetic diversity. The UN system would establish a special body of scientists to collect and preserve plant germplasm in these internationally-controlled banks. There was a surprising degree of agreement. The scien-

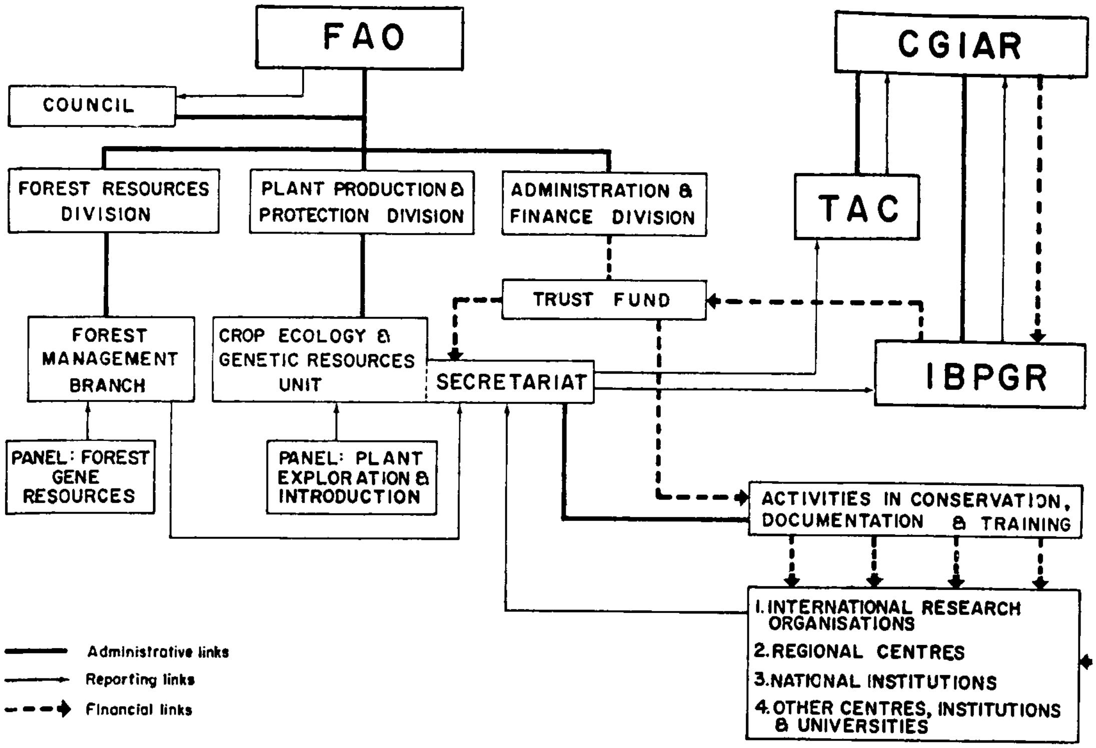


Table 14 Tracing control of IBPGR

tists returned to their laboratories and test plots optimistic that their world was finally waking up and that a crisis would be averted.

But, from the outset, the new institution was destined to be a hybrid without parents. Since the sixties, industrialized donor countries had grown disillusioned with FAO and had opted to back the agro-technological 'fix' proferred by Norman Borlaug's Green Revolution. The creation of CGIAR in 1971 had been a blunt move by these donors to wrest control of agricultural development from FAO and place it in the hands of a manageable scientific élite. Although the CGIAR system recognized the importance of genetic conservation, it did not want to see the work continued under FAO control. Taking pardonable offence, FAO was equally reluctant to surrender the work it had begun in its Crop Ecology Unit. Influencing both sides was the shortage of agricultural dollars. FAO was witnessing financing that should naturally have gone to its work, being channelled instead to CGIAR. For its part, CGIAR had an ambitious institutional growth plan underway and little flexibility to admit a newcomer. On the fringes of the debate stood UNEP, reminding the others of the Stockholm Resolution and the need to act urgently. A compromise was achieved.

By June 1974, the new organization was on the flow-charts and holding its first meeting as the International Board for Plant Genetic Resources. Inter-agency wrangling, however, had wiped away all of the regional gene banks and most of the money and authority that had been hoped for at Beltsville. Remaining was an unlikely administrative anomaly staffed by

FAO's Crop Ecology Unit and funded at less than a million dollars by FAO and a donor consortium organized by CGIAR. In the three-way fight to own IBPGR, UNEP was left with a position on the Board, FAO surrendered its own programme to the new structure, and CGIAR won a significant slice of the pie. Control was given to ... well, nobody was quite certain. Board members were appointed for three-year terms and allowed to serve two terms before nominating their own replacements. Board members were to act as individuals and not as representatives of governments. In a 1980 review [1] of IBPGR, its donors were to describe its structure as 'a historic anomaly'. Kinder words have never been spoken.

The net effect of all the gamesmanship was to disrupt and then usurp FAO's ongoing genetics conservation programme without providing any notable increase in support. Nine years after the birth of IBPGR, it is possible to identify a growth in funding (to almost US $4 million) but it is difficult to believe that FAO's work would have been less well-endowed had it proceeded under its own steam. At least at the international level, control of the collection and storage of the world's botanical treasures had slipped from the member governments of the United Nations to an ill-defined grouping of Northern governments, scientists and private foundations.

All this structural ambiguity has hardly bothered IBPGR. As appropriate, it has donned the mantle of an inter-governmental agency and answered its critics from the lofty heights of the United Nations. At other times, it has stood properly aloof of the 'goings-on' in FAO and the UN and asserted its independent status. In reality, control has been exercised by the handful of Northern donors that are also the donors for the Green Revolution. Substantial policy and programme power has been executed by British and American Board members and by an 'Old Boys' network of (largely British) agronomists.

IBPGR's structure has not enamoured it with the South nor with many non-Anglophiles, who find the germplasm club a little too exclusive. The dissatisfactions grew until a five-year review panel in 1980 noted ten times in its report the need to bring a more formal legal structure to IBPGR's proceedings.

By the time FAO's Committee on Agriculture met in March 1983, many Third World governments were in open rebellion, calling for the control of plant genetic resources inside the UN system. When Lennart Kåhre, IBPGR's Swedish Chairperson, addressed the Committee, he was immediately and publicly rebuked by Latin American states for what they regarded as a biased and self-serving presentation of the work of the Board.

The 'emerging' network

IBPGR has undoubtedly been stung by this political attack. Although some of its policies have been challenged at the technical level by some of the more discreet members of the environmental movement for several years, and challenges to its politics from development groups have been in the public eye since the late seventies, opposition from the Third World itself had been kept to a manageable scientific level (concern for the effects of IBPGR storage policies in Indonesia and Africa, for example) until Mexico's call for an International Convention in 1981. Even then, criticism of IBPGR had remained behind the scenes until the March COAG, and Lennart Kåhre's ill-fated speech.

The abuse was particularly hard for IBPGR to understand since it had just published its first-ever promotional brochure outlining its impressive achievements over the past nine years. The *Facts About The IBPGR* [2] had been made available to all government delegates to the FAO meeting. In less than a decade, IBPGR had risen from nothing to a position, it claimed, of considerable international repute. Fully 250 collecting expeditions had been organized with over 100,000 new plant accessions gathered. IBPGR was collaborating with institutions in 100 countries and had conducted expeditions with 70 nations. Work was underway to conserve 50 major crops and global 'base' collections had been established in 29 countries at 38 centres for 30 of these crops. In 1982 alone, IBPGR had worked with 336 scientists around the world. Neither has the Board neglected its educational role, having trained 610 people in short and longer-term courses on genetic conservation and having published more than 130 books and reports.

Third World countries, the Board contends, have been the major beneficiaries of their work. Virtually all 610 trainees have been from the South. Equipment has been provided to gene banks in 20 developing countries (and another four have received funds for vegetatively-propagated crops). Among those 336 agronomists who worked with IBPGR in 1982 were 295 scientists from the Third World. Of the 38 'base' collections in 29 countries, 23 are located in 18 Third World states and, according to the Board's Executive Secretary, by 1986 there will be more gene banks in the South than in the North. Over the years, IBPGR has catalyzed genetic conservation with a strategic infusion of more than US $8.6 million. As a firm principle, every IBPGR-funded collecting expedition has left a complete duplicate of its acquisitions in the country of origin. The base centres acting as repositories for the world's invaluable crop germplasm are held to agreements with the Board that assure both a high quality of storage and the free exchange of materials.

All this has been accomplished from a few tiny offices in a corner of the seventh floor of FAO's C Building in Rome. IBPGR's entire staff complement consists of 15 professionals and 16 general staff (including six regional offices).

The holes in the net

Far from downplaying these achievements, the South has usually been at pains to congratulate IBPGR for those scientific initiatives that have worked well. Their greatest concern has been that the Board is not responsible to a representative grouping of the world's governments and that the agreements reached by IBPGR with national gene banks do not have the force of international law.

As the debate intensifies around the need for an International Convention and—more immediately for IBPGR—the value of an international gene bank, the South has also begun to look more critically at the scientific and administrative sides of IBPGR. They have not liked what they have seen. Much of their concern stems from what now appear to be misleading data and misleading statements provided by the Board and its secretariat over the years.

When FAO's 22nd Conference gets underway in Rome this November, not only Third World politicians but also Third World agronomists will have a number of tough questions for the Board and FAO to answer.

1. Limited access

Third World governments are now painfully aware of 'Genegate' and IBPGR's quiet acquiescence to the American letter stating plainly that their 'base' collection would not be always available to all countries. Many of the Permanent Representatives to FAO, while not surprised or even offended by the blunt honesty of the US letter, are offended by the IBPGR's failure to make the problem known to other governments shipping germplasm to American gene banks for safekeeping. Despite this, IBPGR's Lennart Kåhre told COAG in March, 'to the present, we have found no documentary evidence that there is reluctance to exchange seed of staple food crops, nor have we found any difficulty in storing the materials'. Angered by the events at COAG, Richard Demuth, IBPGR's former Chairperson, condemned the 'politicization' of genetic resources at COAG. Demuth, a Washington lawyer with Surrey and Morse, was the person to whom the 1977 American letter was addressed. Following COAG, Lennart Kåhre sent a letter to all past and present IBPGR Board members asking them to lobby Third World governments regarding the Convention before FAO's conference in November 1983. Kåhre offered Board members travel funds and honorarium for their lobbying efforts. Some Board members have accepted Kåhre's invitation and extensive lobbying has taken place in South East Asia and Africa. Travel and honorarium funds have come from IBPGR's budget with approval by Dr Bommer, the officer responsible in FAO for IBPGR finances. This raises an important question over the use of IBPGR funds and the acceptability of the Boards diversion of funds from its genetic conservation work to lobbying against an FAO resolution.

Both FAO and IBPGR have clung to the notion that, while it is lamentable that some 'cash crop' germplasm may be embargoed on occasion, there are no known cases of 'staple food crops' being embargoed. Such logic has some currency in the North where the image of 'our daily bread' is usually just that—wheat, oats, barley, rice and maize. It has less attraction for the South where embargoes of even non-food germplasm such as rubber can do severe damage to the national economy and, hence, the 'daily bread' of poor smallholders. Even then, the nutritional and economic significance of mangos, bananas, durian, rambutan and breadfruit—for which there is ample documentation of embargoes—counts for something in the South. Then again, IBPGR officials tend to forget that the Americans are a 'base' for no fewer than ten important food crops including New World maize and wheat.

Although the United States is not releasing details, an American member of the Board and senior scientist in the US Department of Agriculture, Quentin Jones, has admitted that some germplasm shipments to the Soviet Union were halted during the grain embargo.

The Board's delicacy with embargo data and its seeming cover-up of 'Genegate' have left an atmosphere of mistrust. Third World diplomats at FAO can be pardoned for wondering what other problems are being withheld.

2. A shortage of agreements

Speaking in opposition on the proposal for an International Convention, Lennart Kåhre told the March COAG that all funding contracts devised by the Board contain a 'clause' guaranteeing the free exchange of germplasm. Later he added, 'The IBPGR has discussed the necessity for clear legal agreements for nine years, much work has been done through the IBPGR and its 'legal umbrella' is provided by FAO. ... I also point out that not one of the governments holding the designated base collections have queried the validity of our contract'.[3]

Dr Kåhre's statement gave support to a belief much encouraged by the IBPGR Secretariat, that the designation of 'base' repositories is accompanied by a formal exchange of letters between IBPGR and the appropriate legal authority guaranteeing the full and free exchange of germplasm. In the Secretariat's view, such a letter not only offers a genuine legal framework for exchange but also provides the moral pressure necessary to see to it that both the spirit and the letter of the document are obeyed. Additionally, IBPGR's Agreement has the advantage of a certain apolitical informality that helps stimulate an environment of mutual trust within the germplasm community. To replace this perfectly adequate device for a legal convention would not only amount to shooting mosquitoes with a shot-gun but might also rent the fabric of scientific cooperation.

Such an argument has great merit. No smoothly working system ever gains by the pressure of a new layer of international bureaucracy. However, this argument does not apply to IBPGR. According to Board members, IBPGR has been attempting to clarify its Agreements with its 'base' banks for some time. The Secretariat has been attempting to clarify its legal relationships with base collection for the last two years without much success. By the time of COAG, probably no more than a sixth of base collection centres were covered by final agreements. Not only the larger number of institutes—but an overwhelming proportion of plant germplasm—remains outside even the Board's definition of an acceptable agreement.

Even if all base collections operated within the IBPGR Agreement and remained steadfast to its conditions for full and free exchange, it is far from certain that the Agreement would cover anything but those accessions listed as part of the Global Network. This would—at best—cover no more than a fifth of the world's stored germplasm. At worst, it might be defined to cover only the 100,000 accessions actually gathered under IBPGR auspices—a mere 5 per cent of the world's banked germplasm.

Third World delegations to FAO will, at the very least, regard the dubious state of IBPGR Agreements unhappily. It is difficult to see how such an uncertain exchange of letters covering a small portion of the world's botanical treasures can take the place of a proper International Convention. Indeed, IBPGR's failure to deal openly and squarely with the realities of its own situation call into fundamental question the Board's own ability to serve the international community.

The value of any legal agreement for Third World countries is also extremely dubious. Although Lennart Kåhre told COAG that the legal weight of FAO backed IBPGR and gave substance to any exchange of letters, this is probably incorrect. In fact, IBPGR has been so ambiguously constructed that its only legal status is as a *de facto* corporation by its own precedents and a kind of international 'common law'. There is no recourse to FAO or any other greater or more answerable legal entity. The other party to the exchange of letters is also dubious since the agreements are seldom if ever with the government of a country but with a university or institute inside the country. None of this assures donor states in the South that the 'common law' relationship entered into by a parentless hybrid on the one hand and semi-public institutes on the other will guarantee them future access to their own botanical treasures.

3. A problem with numbers

The concern is at least as great over the fact that the Board has somehow obscured the truth with its tables and charts showing the extent of IBPGR-sponsored germplasm activity in the South. We have already discussed the political control of germplasm and seen that a substantial—if uncertain—majority of collected germplasm is held in the North. IBPGR Executive Secretary, Trevor Williams, compounded the confusion over these figures when he told the Directors of the IARCs in mid-1982 that, 'Within five years we expect that there will be more gene banks in the developing world than in the developed world, a fact that might refute some of the arguments made by anti-plant breeders rights groups that most of the germplasm of the world is in the developed countries—this is no longer true'.[4]

The comment is illogical and only adds to the suspicion that much of IBPGR's data is defensive and possibly suspect. There is no correlation between the numbers of gene banks and either their quality of storage or quantity of material. For Third World banks to surpass the North, it will be necessary for them to double their accessions over the next five years while the North halts its own acquisitions. This is hardly likely.

Equally dubious is the relevence of IBPGR's assertion that 23 institutes in 18 Third World States bear 'base' crop collections. Some of these centres are actually part of the CGIAR/IARC network and are as much under the sovereignty of a Third World government as is FAO ruled by the Italian Government. Still other institutes have yet to be built and there are

Map 5 IBPGR's gene bank network

reasons to doubt if some will ever be built, given the economic downturn.

Yet it is the data that IBPGR does not describe that is the most significant. IBPGR figures provided to FAO for the March COAG indicate 42 (not 38 as IBPGR suggests) 'Global' or 'Base' collections (including duplicate collections) for major crops. Of these, 21 are held in the North, 12 are held in the IARC network—and only nine are under the sovereign control of Third World governments. Two other crops—maize and cotton —appear to have no global base as designated by IBPGR but by far the most important collections are held in the North.

Most importantly, IBPGR's own figures show that half of the crops held in base collections in the North have no duplicate under either IARC or Third World control while eight of the nine base crops held in the South are duplicated in either the North or in the IARC system. The single exception—and there are efforts afoot now to change this—remains the Winged Bean of Southeast Asia.

4. Safety in numbers?

At the centre of almost all IBPGR planning has been the gene bank ... a relatively modest but nevertheless tricky piece of high technology. The gene bank puts seeds 'on ice' in cold storage vaults that are not unlike (and sometimes actually are) meat lockers. Superior gene banks put at least as much emphasis on reducing the moisture content of seeds as they do on reducing the storage temperature. The combination of low temperature and humidity can add up to many years—even decades—of safe keeping for what geneticists are fond of calling 'orthodox' seeds like wheat or maize.

Table 15 Where crop germplasm is 'banked': The responsibility for 'global' or 'base' repositories as designated by IBPGR [5]

North	IARC	South
Rice	Rice	Minor Millets
Wheat	Sorghum	Capsicums
Maize*	Pearl Millet	Crucifers
Barley	Minor Millets	Eggplant
Sorghum	Barley	Pigeonpea
Pearl Millet	Potato	Vigna
Oats	Sweet Potato	Winged Bean
Rye	Groundnut	Tomato
Sweet Potato	Pigeonpea	Sugarcane
Allium	Chickpea	
Amaranthus	Vigna	9
Capsicum	Vicia Faba	
Crucifers		
Eggplant		
Phaseolus	12	
Vigna		
Pea		
Lupins		
Okra		
Tomato		
Beet		
Sugarcane		
Cotton**		
23		

* Maize: 'New World' collection in USA but no 'global' facility has been identified.
** Cotton: No 'global' base has been identified but major collections appear to be in the North.

On the surface, it is all rather simple. Collected seed is brought to the gene bank for identification and cataloguing. Key genetic information is computerized and the new accession is assigned a number. The sample is then carefully dried (a tricky part of the procedure since heat could damage the vitality of the seeds) until the moisture content is brought down to something well under 5 per cent. Placed in air-tight containers, the accession is then placed on a shelf in a vault where the temperature is maintained at minus 18° Celsius. There the seeds remain undisturbed except for rare germination tests intended to ensure that all is well inside the vault. When the level of germination drops too low (anything from three years to many decades after storage, depending on the species and the facilities), a part of the accession is 'grown out'. Then the next generation of seeds go through the same process of drying and cooling. In this way, according to some experts, barley seed could be stored for 33,500 years.

'Saving seeds' is a tradition among gardeners and farmers the world over.

Table 16 Found ... and lost [6]

Crop	Gene repository	Description
All Crops	United States	1982 study suggests private sector is doing a poor job of storage and documentation
	United States	Government study in 1981 warned of storage problems at NSSL in Fort Collins
Banana	United Brands	Warns it is closing what is probably world's most important banana germplasm repository (1983)
	Jamaican Banana Co.	Concern in 1983 that world's second most important collection might be losing material
Bean types	Brazil	Half the collection banked at University of Vicosa was destroyed by 'fire caused by an electricity failure' according to a 1976 IBPGR report
	United States	Duplicate of Vicosa collection was held at Purdue but same 1976 study says they are 'now of doubtful viability'
	Honduras & CIAT	For many of the 4,000 accessions in Honduras and also duplicated at CIAT (Colombia) 'the seed is poor and the germination low' says 1976 report
	Norway	Dr Wisalk's collection at Oslo University may have been lost with his retirement according to 1976 study
	Sweden	Death of Dr Lambrecht at Weibullsholm (now a Cardo subsidiary) may have ended the collection: 1976 study
Capsicum sp.	Europe	1981 study notes that 'considerable variability maybe lost at each rejuvenation cycle'
	Americas	Rejuvenation losses 'may still be unacceptably high' said 1981 study adding that Mexican approach seems safest
Cereals	United States	1981 US Govt. study warned that equipment problems at Beltsville were causing losses
Cocoa	Ecuador Latin America	1981 report says need to duplicate is urgent; 'valuable short-lived germplasm has all too frequently been killed in transit' says a 1981 IBPGR report
Crucifer sp.	Netherlands	The European collection at Wagenigen ... is in urgent need of multiplication,' said IBPGR in 1981
Maize	Latin America	During 1960's, a base collection was lost in transit and its duplicate was destroyed in a flood
	Latin America	Another maize collection was harmed because it was grown out at the wrong altitude
	Latin America	Equipment breakdowns and power failures harmed several collections in 1960's
Potato	United States	One year's collection lost at Wisconsin bank due to power failure in late seventies
Sugarcane	Worldwide	1982 IBPGR report states, 'there has been a loss of clones in existing collections due to maintainance problems'
	India United States	Losses reported in 1982 for 'maintainance and financial' reasons; Some losses resulted when material was transferred in 1973 from Beltsville to Miami
Sweet Potato	Japan	Almost half of a vegetative collection was lost 'due to local viruses' according to a 1980 IBPGR regional report

Stories are commonly told of a younger generation discovering Grandma's speciality beans in a basement jar and growing a new crop long years after Grandma has passed away. Many breeders have done very well saving orthodox seeds in kitchen cupboards even in tropical climates—as long as the high temperatures were matched by equally low humidity. Stories––quite untrue—are told of wheat seed found in Egypt's pyramids miraculously brought to a new harvest thousands of years after being entombed. In truth, the oldest recorded case of cereal seed regenerating comes from Nuremburg, Germany. A theatre bombed during the Second War revealed—on excavation in the 1950's—a time capsule containing oat and barley seed placed there when the theatre was built in the 1830's. After 120 years, the seeds grew again.

IBPGR and the world's gene banks have not been so fortunate. In May of 1979, IBPGR's Working Group on Forages looked at the question of genetic loss in existing collections. The experts concluded, 'It is estimated that even in developed countries such as USA and Australia from half to two-thirds of accessions brought in over several decades have been lost'.[7] Their report also notes, 'The members of the Working Group are aware that enormous losses of valuable material have taken place in past collections and are continuing. The principal causes are the lack of organization and continuity in research programmes, contamination in the case of cross-breeding species, and the lack of resources (staff, funds, and facilities) to enable effective conservation to be achieved. The problem is not confined to developing countries'.

The report of this Working Group is not among the 130 books and other publications touted by IBPGR. Nor is the study of *in situ* conservation options to the gene bank approach, undertaken for IBPGR by Robert and Christine Prescott-Allen (unpublished). As part of their review of options to the gene bank concept, the authors examined the shortcomings of the present system. Among others, they identified extensive losses in Third World gene banks often related to student unrest (gene banks are usually on campus) preventing the monitoring of temperature and humidity gauges. Power failures and equipment breakdowns were also cited. Frightening examples were given of material being lost in the original gene bank and then fires or floods destroying duplicate collections in other gene banks. In some cases even the log books were lost, leaving geneticists to wonder exactly what they were missing.

All negative references to gene banks were crossed out of the study by the Executive Secretary. Only with the help of UNESCO and the London-based International Institute for Environment and Development have the Prescott-Allens managed to make their story known.

Table 17 The quality of gene bank storage (as identified by IBPGR reports) [8]

Quality of storage	Per cent	Quality of storage	Per cent
Unstated quality	17.9	Medium-term only	18.0
Active collection only*	29.7	Medium and long-term	20.9
Predominantly short-term**	2.7	Long-term only	10.8

* 'Active' collections are normally breeders' collections whose storage may be excellent for their purpose but where germplasm containers are being opened, interfering with long-term storage needs and sphere material is also sometimes discarded.
** IBPGR indicates facilities having only short-term (9,360 accessions); short- and medium-term (21,500 accessions); and short- and long-term (22,047 accessions). We believe that the majority of this material is actually in short-term storage.

Beyond gene bank 'disasters', there is reason to be concerned for the general quaiity of storage offered. A review of IBPGR's records indicates that a third of the almost two million accessions listed are either in 'active' or 'short-term' facilities and their place in eternity is far from guaranteed. In fact, only about a quarter of the total appear to be in 'long-term' storage. Thus three-quarters of the germplasm collected into storage have still to find a safe haven. In their case, IBPGR's work is not yet done.

It is hardly within the financial capacity of IBPGR to upgrade all the world's gene banks to optimal storage conditions. There are good reasons, however, why the Board should be concerned that 'base' repositories entrusted with the long-term security of global and regional collections should be of the highest quality. By its own reports (but not by its own count, since the Board has avoided such calculations) only about 27 per cent of the accessions assigned to 'base' banks are clearly offered long-term protection.

Even these figures may be unduly optimistic. Among those banks described by IBPGR as offering long-term storage is the National Seeds Storage Laboratory at Fort Collins in Colorado. In 1979, Fort Collins was visited by the CGIAR's review team. The team was charged with reporting on the Board's first five years of operation. Discreetly, its report notes that much of the seed material at the bank was stored in 'warehouse' conditions. Two years later, in 1981, the US Goverment's own General Accounting Office (GAO) undertook a survey of the American gene bank network. Its conclusions were devastating. The GAO concluded that the overall system offered 'inadequate storage facilities' as well as 'incomplete or sporadic evaluations' resulting in 'the permanent loss of some genetic stock'.[9] At Fort Collins itself, fully 100,000 seed samples were found to be improperly stored. A *New York Times* reporter described Fort Collins thus, 'In this innocuous and unguarded facility subject to power failures and so crowded that the seeds are piled on the floors in brown cardboard cartons and sacks, the germplasm on which all global agriculture is based is supposed to be preserved forever'.[10]

IBPGR has designated the Fort Collins bank as a 'base' collection point for ten major agricultural crops and advised Third World governments to entrust their botanical treasures to its keeping.

The GAO also examined the American Government's largest domestic gene bank at Beltsville in Maryland: the scene of the original planning meeting that eventually gave birth to IBPGR. The official report to Congress notes, 'The facility's climate-control practices may also contribute to damage of the collection. Research on storage methods has shown that the total of temperature and humidity should not exceed 100°. Although Beltsville does not routinely keep records of its storage temperature and humidity, the limited recordings we found ranged in total from 120° to 130°. (Other reports indicate that these levels have reached 170°.)'. Almost as an afterthought, the GAO adds that Beltsville lacks the ability to even test the germination level of its seeds and, anyway, lacks the resources to grow out endangered samples.

For years now, Third World diplomats and scientists have been told that gene banks were the only safe means of securing the world's germplasm —and that the technology of this kind of storage could only be serviced in the North, a good distance from the equipment and power failures always attributed to developing countries. This is manifestly an exaggeration. The world's base bank for beans resides in a converted meat locker. At least one private gene bank in Germany stores its germplasm in the same cool room as it keeps the station's food supplies. Austria's most important gene bank lies in a cave high in the Tyrol mountains. Private surveys conducted by the International Seed Pathology Institute in Copenhagen on the quality of material in American gene banks indicates that as much as a third of the stored seed is diseased, due either to inadequate phytosanitary testing or, more likely, to a disregard for legal quarantine procedures. (Other seed pathologists have privately suggested that the level of disease in banks could reach two-thirds of the material.) It is now clear that gene banke storage is not so secure and that the true extent of its shortcomings have been withheld from the Third World by IBPGR.

The Board is aware of the problem and feels, undoubtedly, that it is doing the best it can under the circumstances. Given that IBPGR has been entrusted with the task of monitoring and preserving the food security of this and future generations through the creation of a global gene bank network, the tragedy is that it has never seen fit to even try to change its circumstances.

5. Money to catalyse who?

Not only were collection and conservation moved out of the hands of FAO's member governments, but the mandate of the new organization was altered in a way that could only benefit industrialized gene-poor countries. The Board decided that it was a 'catalyst' and that its role should be to encourage others to act rather than to employ its limited resources in its own initiatives. This may have all the appearances of wise money management but its effect has been—in the ongoing emergency of rampant genetic erosion—to give most of the 'seed' money to those in the North who are already most aware of the problem and best able to take advantage of the money. Less than a third of all IBPGR grant monies have actually gone to governments and scientists in the South.

Table 18 IBPGR grant allocations from inception to March, 1983 [11]

Recipients	US Dollars	Per cent
Industrialized market-economy states (public inst./govt.)	4,879,177.23	56.5
Public and private enterprise (North)	136,435.00	1.6
IARCs	966,455.00	11.2
Industrialized centrally-planned states	19,471.00	0.2
Group of 77	2,634,118.99	30.5
Total disbursement	8,635,657.22	

The largess was not widespread. In excess of 2.25 million dollars went directly to the US Government and its public universities (making that country, in most years, a net beneficiary of foreign aid from IBPGR). Another 1,100,000 dollars went to British scientists and universities. Among those private enterprises sharing in the benefits were a consortia of the London Cocoa Trade and its American counterpart (including Mars, Nestles, Cadbury-Schweppes, etc.).

Whose interests are being served?

The vagueness of the IBPGR structure combined with its selective use of data and funds have contributed to a widespread feeling that the Board not only fails to service the needs of the Third World but may effectively be servicing the interests of some parties in the North. Indeed, some diplomats at FAO have gone so far as to liken the Board to the infamous Industry Cooperative Programme (ICP) that was expelled from FAO in the late seventies.

Table 19 IBPGR and agribusiness[12]

Crop	Agribusiness link	Relationship
Banana	United Brands Company	United Brands encouraged formation of working group in IBPGR and sits on committee
Cocoa	London Cocoa Trade ACRI (American Cocoa Research Institute)	IBPGR's cocoa involvement was initiated by cocoa companies. Three industry reps. attended first session including Hershey official
Coffee	'Industry'	IBPGR Board planning documents only indicate that it is working with industry officials; German & American roasters are rumoured to be involved in collection efforts
Cotton	Cotton Development International	Leadership has come from this Association which appears dominated by major firms;
Maize	Pioneer Hi-Bred International	Chairman of the Board of Pioneer also chairs IBPGR Maize Working Group
Rubber	'Industry'	Firestone appears involved
Soybean	INTSOY	International Soybean Association has pushed IBPGR involvement; major breeders are actively involved
Sugarbeet	Institut Internationale de Recherches Betteraves (IIRB)	IBPGR work was initiated by Europeen sugarbeet firms through IIRB; KWS took active part in early meetings
Sugarcane	Hawaiian Sugar Planters' Association	Private firms have taken lead in encouraging IBPGR work; Hawaiian group has been criticized by Brazilians for charging royalties

Such a comparison is, perhaps, unduly harsh but the Board's relations with the private agribusiness sector and its posture on some economic and political issues have fuelled distrust. The Board has worked closely with the private sector with reference to a number of specific crops.

Not that the Board should avoid contact with the private sector. In the case of many of the crops cited in Table 19, the private sector has a dominant role. Some Third World agronomists are concerned, however, that agribusiness has not merely been 'cooperating' but has actually been 'directing' collection and conservation work to its own interests and benefit. The 'UN' badge sometimes worn by IBPGR has been helpful to these companies in gathering germplasm.

While some of IBPGR's own Board members have been disturbed by the role of private firms in germplasm work, open concern for the orientation of the Board arose only in the 1980's when the Board debated both the merits of supporting a Cuban gene bank and the impact of PBR on genetic erosion.

The Cuban Government approached IBPGR for supplementary financial support to complete a long-term gene bank. Cuba indicated its willingness to receive material from other states in the region and to make its own material freely available to other governments. Although the sum involved was modest and the proposal was far from a precedent, the Board debated the issue over two days and finally held the only vote it has ever held. During the debate, British and American Board members as well as senior IBPGR staff opposed the grant, first on the grounds that Cuba might not be relied upon to make its material available. When other Board members recounted their own positive experience with Cuba, the grounds for opposition were shifted to a concern that other states in the region would not cooperate with Cuba. When this too was disputed, opposition was moved to the grounds that Cuba's existing medium-storage facility was probably adequate and that upgraded storage may not be necessary. Eventually, the awkwardness of such politically-inspired opposition grew to be a manifest embarrassment to other Board members and the decision was taken to go ahead with the grant.

International agencies are obliged to be realistic about the realities of regional politics. It was not unreasonable for the Board to review any grant to a regional body on the basis of whether or not area politics would compromise the banks' usefulness. What is disturbing is that there appears to have been no similar concern when the Board approved three separate grants to another regional programme for tropical vegetables—in Taiwan.

The Board's role in the international debate surrounding the link between PBR and genetic erosion is also disturbing. Although FAO (in general but especially its Plant Production Division and its Crop Ecology Unit) had demonstrated considerable sympathy for the argument that PBR hastened the pace of genetic erosion and increased crop vulnerability by imposing the patent requirement of extreme genetic uniformity, IBPGR was, from the beginning, hostile to such a view.

IBPGR devoted a Board meeting to the issue in 1981. An effort was made to pass a resolution condemning the argument that PBR influenced genetic erosion. In preparation for the debate, the Board commissioned Dr Ewert Åberg of the Swedish University of Agricultural Science to study the question. Åberg ridiculed the concern. Yet, the Board debate did not go smoothly. Third World representatives refused to endorse a resolution disclaiming any connection between the two issues even when Dr Bommer, an FAO Assistant Director-General strongly in support of PBR, was brought in to lead the debate. [13]

The failure of the resolution has not prevented the IBPGR Executive Secretary, Trevor Williams, from continuing to actively support PBR. Williams has spoken and written in favour of PBR and publicly ridiculed the notion that such legislation could harm genetic resources. He has even addressed the annual Council of UPOV.

IBPGR's protection of PBR was, therefore, especially remarked upon by Third World scientists when, in June 1982, a joint meeting of the Directors of the International Agricultural Research Centres issued a report on PBR containing the following statement: 'The Centre Directors recognized that the introduction of PBR may entail some danger of genetic erosion'. [14]

If such a conclusion could be reached by CCIAR centres heavily dependent upon UPOV-member governments for their financial survival, diplomats and agronomists wondered, why was it beyond the ken of the one CGIAR agency especially charged with genetic conservation?* When Resolution 6/81 was passed at FAO's 21st Conference in November 1981, Third World Ministers of Agriculture were careful to tread softly around IBPGR's turf and to add words of praise whenever conflict loomed on the horizon. Two years later, at the 22nd Conference, the same Ministers may be gunning for IBPGR as the new ICP.

* In the summer of 1983, IBPGR released a short document entitled 'Plant Variety Rights' which begrudgingly conceded a connection between PBR and genetic erosion. The document appears to have been prompted by the Centre Directors' statement a year earlier.

Notes

1. For a general overview of IBPGR's first five years, see *Report of the Quinquennial Review of the International Board for Plant Genetic Resources (IBPGR),*TAC Secretariat, Rome, 1980, AGD/TAC:IAR/8072 Rev.
2. The following information on the positive work of IBPGR comes from *Facts About the IBPGR* published by IBPGR in 1983 (unnumbered and undated due to shortness of time), and from the Statement to COAG by IBPGR Chairperson, Dr L Kåhre, on March 28 ,1983.
3. Ibid.
4. 'Presentation at Centre's Week 1982', Dr J T Williams' Presentation (undated and unpublished), p. 2.
5. Document FAO COAG 83/10.
6. From a variety of FAO and IBPGR documents, particularly from Crop Advisory Committee reports, and *The Department of Agriculture Can Minimize the Risk of Potential Crop Failures,* Report to the Congress of the United States by the Comptrollar General, CED-81-75, April 10, 1981.

7. 'Interim Report of the Working Group Convened by the Board (IBPGR) to Advise on Action Needed on the Genetic Resources of Forage Plants', Townsville, Australia (unpublished), 6–11 May, 1979, p. 3.
8. Data gathereed from IBPGR Crop Genetic Resource directories covering 32 crops.
9. *The Department of Agriculture Can Minimize the Risk of Potential Crop Failures,* op.cit.
10. Crittenden, Ann, 'US Seeks Seed Diversity As Crop Assurance', *New York Times,* August 1981, pp. 1 and D3.
11. The data for this table are drawn from IBPGR's various Annual Reports as well as additional file information where the annual reports are incomplete. The data cover exactly 399 project grants. Three additional projects have been discounted in that the files indicate monies were provided by non-IBPGR sources. Although most figures for projects are given in US $, some British projects were cited in sterling and some small discrepancy between these figures and those of IBPGR may arise in the translation into US $.
12. This table is drawn from two sources: internal IBPGR Board discussion papers and discussions with past and present Board members.
13. Internal information on IBPGR Board discussions are based upon conversations with past and present Board members. In every instance, internal documentation supporting these conversations was provided. The Board members, however, have asked not to be identified.
14. *Report of the Meeting,* 29th Meeting of the Technical Advisory Committee to the Consultative Group on International Agricultural Research, CIMMYT Headquarters, Mexico, 22–29 June, 1982, p. 5.

From Green Revolution to Gene Revolution

Since the beginning of agriculture, nations have struggled to monopolize certain plants of commercial importance. This struggle was most obvious and at its greatest height during the colonial era of the last century. Then, new scientific tools and a network of botanical gardens brought about the transformation of world agriculture. Today, the struggle to monopolize specific genes in the development of agriculture is leading to the development of other scientific tools and institutions: chief among them, the gene bank and the International Agricultural Research Centres. Now, as in the last century, scientists are largely pawns in a much larger scheme.

The early treasure-hunters

Agriculture was old in China before it had begun in Europe. No doubt the Chinese rulers of antiquity were as militant in their plant collecting as any such activity recorded elsewhere in history. Yet the first report of 'government-directed' plant collecting can only be traced back 4,500 years to Sankhkere, an Egyptian pharoah, who sent ships down the Red Sea to the Gulf of Aden in search of cinnamon and cassia. Some historians, who regard Sankhkere's feat as more culinary than botanical, give credit for the first plant 'exploration' to Egypt's Queen Hatshepsut. A thousand years after Sankhkere, the Queen sent a fleet down the coast of East Africa in search of new flora and, especially, the frankincense tree. Within the space of another hundred years, the acquisition of botanical treasures became an integrated part of Egyptian military campaigns with armies bringing back plants from as far away as Syria.

Efforts to monopolize and to smuggle botanical treasures also have an early history. Suleiman the Magnificent's attempts to control tulips in 16th century Constantinople were matched by the energy of the Viennese ambassador to smuggle bulbs into Western Europe. Once 'free', it was not long before tulips found their way to a welcoming new home in the Netherlands. Stories—many of them hardly credible—abound of everything from coffee to saffron being smuggled out of Arabia, by monks with hollowed-out walking sticks. Early plant smuggling, at any rate, focused on spices, beverages, medicinal plants (often the same spices and beverages), dyes and ornamental plants. Food crops drew less interest. The grains of the Fertile Crescent had long since moved into Europe with migrating tribes.

To the surprise of no one, history shows that the growth of botanical interest and variety at home directly corresponds to the spread of conquest and empire abroad. Thus, by the beginning of the 17th century, Europe's gardeners could be found haunting the markets of Leyden and

Harlem in Holland for the spoils of the East Indies and Southern Africa. The Dutch monopoly had its rewards: in 1611 the Leyden market was selling rose rootstock for the princely sum of 3 pounds sterling. In the 1680's British gardeners complained bitterly that the Dutch were refusing to allow the export of any economically significant seeds or plants from any of their colonial possessions.

The botanical empires

Lucile H Brockway, the unsurpassable historian of the impact of botanical monopolies on the colonial era, has provided a shocking account of the lengths to which some European powers went to maintain their control over the plant treasures they encountered. [1] In an attempt to monopolize the production of indigo (used as a blue dye for textiles) in the western hemisphere, the French Government made export of a live plant from its tightly-held Caribbean islands punishable by death. American traders still managed to move plants from Antigua to the Carolinas and destroy the attempted monopoly.

As a defense against smuggling, islands were seen to have a definite advantage. In 1621, the Dutch did irreparable damage to the genetic diversity of clove and nutmeg by destroying all of the trees found on the Moluccas except those on three well-guarded islands. Fully three-quarters of their plant diversity was lost on the Moluccas. When it became Britain's turn to dominate the East Indies, the spice trade was carefully shifted to the islands of Penang and Grenada and, later, to Zanzibar—which leads the world's clove production even today.

Hardly a dozen years after the Dutch had cut down spice trees in Asia as a protection against smugglers, they were hard at work in Caracao breaking the Spanish monopoly of the South American cacao trade. They succeeded. Later, cacao beans were shipped to the island of Sao Tome, then under Dutch control. When the Portuguese regained control, beans were smuggled by an African labourer to Ghana. In this way, a plant that originated in the Andes became a major export crop in West Africa.

The history of the colonial era is, to an amazing degree, a history of plant transfers: South to North, or from Latin America to Asia, to Africa to Latin America. Like living pawns in the imperial chess game, coffee, tea, cocoa, rubber, bananas, sugarcane, cotton, and spices, were shifted back and forth over the surface of the globe. Although few could have anticipated it at the time, the botanical chess game has had long-term implications for the development and underdevelopment of the Third World that simply cannot be exaggerated.

According to Lucile Brockway, the chess game's most notable loser has been Latin America. Let us consider its major agricultural export. Coffee originated in Ethiopia. Arab traders moved it east into the Yemen and from there across Asia as far as Java. In 1706, one coffee tree arrived at the Amsterdam Botanical Garden (where, we have been told, its descendents can still be found today). Seeds from this single tree were sent to Surinam in 1715 and to Martinique in 1723 via the Jardin Royale in Paris. From Surinam and Martinique, seeds spread throughout Latin America. The rust and other disease problems afflicting the continent's entire coffee production can be traced to the genetic uniformity imposed by the introduction of this one tree.

Exporting the export crop

Perhaps the world's most famous incident of plant smuggling is the removal of wild rubber from Brazil in 1876 by botanists from Britain's Kew Gardens. The precise illegality of the removal is not clear but it is plain that the botanists knew their act would not be welcomed since the exploit was undertaken under cover of darkness and the tale has been told and retold in England as 'high adventure'. The effect of this theft by Kew, a government agency, is well known. From controlling 95 per cent of world rubber exports, Brazil's share plummeted to 5 per cent. Less well known is the impact of the theft on the recipient estates in Sri Lanka, Singapore, and Malaysia. Seventy five per cent of Britain's Asian rubber production is based upon 22 seedlings that survived the circuitous journey from Brazil to London and then onwards through Sri Lanka. The problems and conflicts associated with this extreme genetic uniformity remain with these countries today.

Less famous but more telling is the theft of cinchona from the Andes. The bark of the cinchona tree is harvested to make quinine—the malaria drug. The tree is found only in a few Andean areas. Its properties known to the ancient civilizations of the region, the bark was routinely harvested and exported to the colonial powers. By the late 1850's, however, the British in India were looking to have a drug source closer to their Asian colonies. Kew Garden botanists were dispatched to the Andes to acquire the necessary seedlings. Although the illegality of cinchona removal from Peru was not explicit, British government officials were aware that it would not normally be allowed. In the case of Bolivia, they were aware that a state export monopoly existed. In Ecuador, seedling removal was flatly against the law. Kew Garden botanists struck up an association with a counter-revolutionary group and succeeded in collecting and then smuggling cinchona out of the region.

Back in London, officials defended their theft by arguing that it was undertaken in the best interests of the tree (genetic conservation?) since the method of harvesting the bark was threatening the survival of the medicinal tree. Kew provided the scientific backup for this excuse. It was also implied that the quantity of the medicine required was such that it could not be safely met by production in the Andes. Both arguments, as both the diplomats and the scientists were aware, were incorrect. An earlier Kew study had actually recognized that the harvesting method employed in Latin America supported conservation of the species. As far as access to sufficient quantities of the drug is concerned, the region's cinchona exports climbed to about 9 million kilograms a year before being destroyed overnight by the new plantations in Asia. The region lost an important export crop.

The transfer of Mexican sisal out of the West Indian region to East Africa, according to Brockway, is another example of, if not exactly theft, unwelcome removal. The Mexican Government refused to part with sisal bulbils when a request was made by a Hamburg businessman. With the aid of Kew Gardens, however, a source was found and Tanzania (then a German possession) became a major rival to the Mexican estates.

The thin green line—the botanical gardens

The plant transfers of the colonial era benefitted the European powers enormously. Huge commercial empires were created from coffee, tea, rubber, etc. While the profits from these new plants fuelled the industrial revolution, many less famous plants also played a major role. Europe's diet improved directly with a host of new food plants such as potatoes and tomatoes and, indirectly, with the introduction of new pasture plants from Africa, and Latin America. The new plants had an impact in the textile industry and in every facet of the fledgling chemicals business ranging from paints, dyes and resins, to medicinal preparations. A substantial commercial trade also developed around the provision of exotic flora for the gardens and greenhouses of Europe's aristocracy. The pace of plant introductions can always be linked to the spread of political power.

Table 20 A history of British plant introductions[2]

Period	Introductions
Sixteenth century	84
Seventeenth century	940
Eighteenth century	8,938

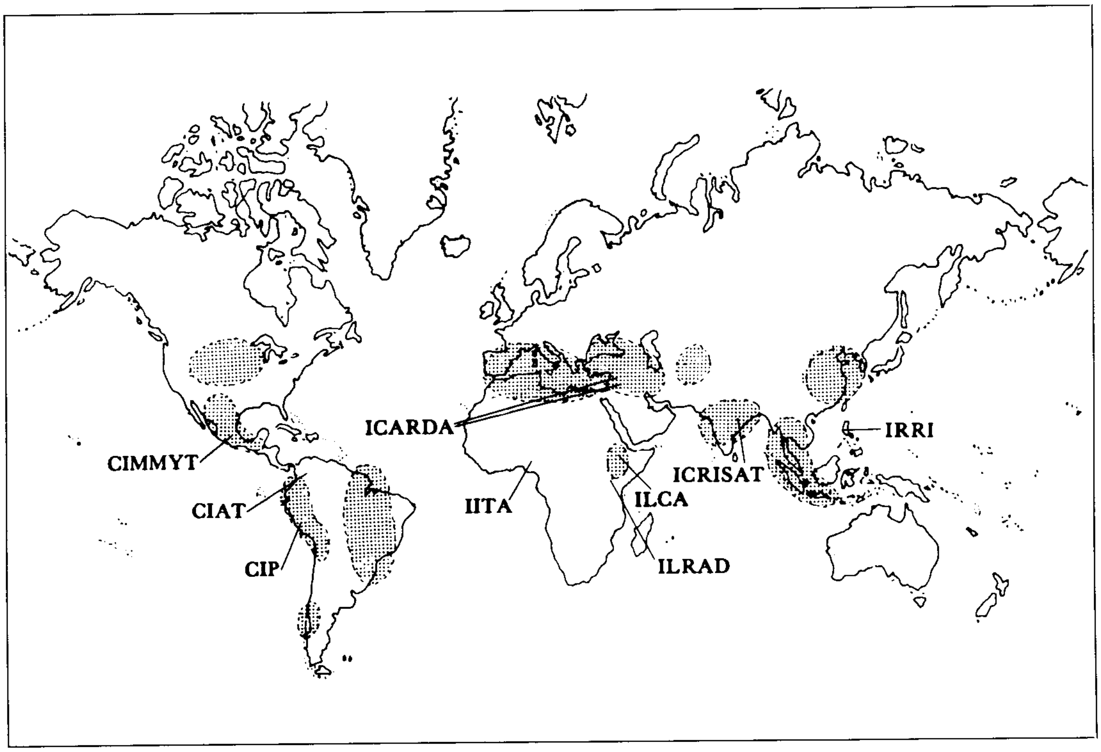
Historian Kenneth Lemmon directly relates the increase in plant accessions to specific events such as the take-over of the Cape from the Netherlands, the colonization of New South Wales and Nova Scotia, and, most of all, the Treaty of Utrecht provisions that gave England the right to trade in Spanish territories. Between 1731 and 1763, the number of exotic plants entering Britain doubled and, on the eve of the coronation of Queen Victoria, the British Isles were growing 13,000 species of exotic flora.

Two developments—one scientific, and the other institutional—were essential to the practical exploitation of the Third World's botanical resources in the last century. The first was the invention, in 1829, of the Wardian case which, for the first time, allowed the relatively safe transfer of living plants from one corner of the globe to another. With the aid of the Wardian case, British botanists were able to transfer six times as many plants in 15 years as they had in the preceding century.

The institutional development was the spread of a thin green line of botanical gardens girding the globe from Kew to the Bahamas to Trinidad, to Hawaii and Australia, to Singapore, Calcutta, Colombo, and onward through Africa. From these strategically located institutions, a small band of altruistic scientists went forth and collected, analyzed, forwarded and received the world's flora, both beautiful and beneficial. The great knowledge they gained is available to any scientist today but the profits they made possible have long since accrued to their homelands. Almost as a by-product to their scientific pursuits, they utterly transformed the agricultural economy of the world.

The new thin green line—the IARCs?

Today's Wardian case may be a gene bank. The technological concern is no longer the safe transfer of living plants but the transfer and safe storage of germplasm essential to the new agricultural revolution offered by genetic engineering. The new thin green line may be composed of the International Agricultural Research Centres of the CGIAR system. This new line stretches from the International Food Policy Research Instititute in Washington to the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico to the International Rice Research Instititute (IRRI) in the Philippines; from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India and the International Centre for Agricultural Research in Dry Areas (ICARDA) in Syria to the International Centre of Tropical Agriculture (CIAT) in Colombia and the International Potato Centre (CIP) in Peru. Although their crop mandates



Map 6 The IARCs and the gene transfer system

are often narrow, most are strategically placed in the Vavilov Centres of diversity.

Much has been said about the Green Revolution. There is little dispute now that its initial phases were counter-productive but its advocates today claim that the scientific community has learned from its mistakes and is now contributing to Third World development with much more sympathetic tools. True as this might be, it is a fact applauded by some and dreaded by others that the IARCs are continuing to draw peasant farmers into the mould required by the Western food system.

Studies of the IARCs have tended to focus on their impact in the Third World. Very little has been said of their impact on the First World. Like the botanical gardens of the last century, the IARCs of today are making a substantial contribution to the transfer of genetic material to the North.

CIMMYT, for example, supplies the North with improved breeding material through its large nursery trial programme. One hundred and twenty-seven states participated in the trials in 1978 involving a total of 2,226 trials. Test stations are obliged to report back the results of the 'grow out' to CIMMYT but they are welcome to keep the germplasm either for direct use as a variety or for use as a parent line in other varieties. Over a quarter of all the wheat nursery trials take place in the North. There were 17 trials for wheat in countries as far north as Finland, Norway, and Sweden, and another 37 in Canada.

The scientific need for a breeding programme, devoted to the development of the South, to test its improved germplasm in the North is limited. Certain climatic conditions found in the South are replicated in the North it is true, but CIMMYT already has nursery trials in these areas in the South. CIMMYT does gain from the higher level of scientific experience and equipment quality available in the North. This alone might be sufficient to justify the time and expense required in growing and shipping samples for testing. But it is equally true that the nursery stations in the North gain substantially from their access, on an annual basis, to the best germplasm that CIMMYT has been able to produce.

It should be seen that the North contributes barely 1 per cent of all the nursery trials for maize. Given the importance of this crop to such states as America and France, their lack of interest in maize might seem surprising. Yet, at another level, the North's interest is very high. CIMMYT has a problem growing out maize germplasm in its Mexican gene bank. It lacks both the personnel, the time, and the land on which to rejuvenate accessions whose germination rates are declining in the bank. One American company has stepped into the breach and has volunteered to multiply this exotic material at its own Florida research station. That company is Pioneer Hi-Bred—the world's largest maize breeding corporation.

At least at one level, there is no reason why the North should not also benefit from the research they have financed for the South. To refuse to make advanced germplasm available to the North, would be for CIMMYT to violate the widely-shared principle of full and free exchange.

The concern arises because 282 of CIMMYT's wheat nursery trials are conducted in member states of UPOV: states in which CIMMYT material might be directly patented or indirectly incorporated into a patentable variety. The stations involved are under no obligation to share their discoveries with CIMMYT as freely as CIMMYT has shared its research with them. This concern increases in the context of genetic engineering where the access to germplasm can be extremely important. Again, it is unlikely that the economic benefits derived from use of this germplasm in the new technologies will flow as easily back to the Third World as CIMMYT has allowed it to flow North.

The International Agricultural Research Centres also fulfill an important role in training scientists. In the dozen years from 1966 to 1978, for example, CIMMYT trained 886 future agronomists—virtually all of them from the Third World. Another 840 scientists visited CIMMYT during the same period in programmes that ranged from a week to several months.

Table 21 CIMMYT international nursery trial locations in 1980[3]

State	Wheat	Durum	Triticale	Barley	Maize
North America	51	28	51	32	2
U.S.A	38	22	35	19	–
Canada	13	6	16	13	–
Puerto Rico	–	–	–	–	2
Oceania	10	7	9	2	–
Australia	7	4	7	–	–
New Zealand	3	3	2	2	–
Europe	90	94	92	61	6
Albania	3	4	3	3	–
Austria	–	3	2	1	–
Belgium	1	–	–	–	–
Bulgaria	1	1	1	3	–
Czechoslovakia	2	–	–	–	–
England	2	–	1	1	–
Finland	–	–	–	1	–
France	2	5	8	7	–
Germany F.R.	4	4	3	4	–
Greece	7	7	6	7	2
Hungary	4	4	4	4	–
Ireland	2	–	–	–	–
Italy	5	19	8	2	–
Malta	–	6	–	5	–
Netherlands	1	–	–	1	–
Norway	3	–	2	3	–
Poland	8	1	12	4	–
Portugal	7	5	5	4	–
Rumania	6	3	9	3	–
Spain	20	23	16	8	2
Sweden	3	1	3	–	–
Switzerland	1	–	3	–	–
USSR	2	2	1	1	–
Yugoslavia	6	6	3	6	2
Others	27	12	9	11	–
Japan	2	–	–	–	–
South Africa	16	6	7	7	–
Israel	9	6	2	4	–
Grand Total	178 (28%)	141 (33%)	161 (36%)	106 (26%)	8 (1%)

No breakdown of the nationality of these researchers is readily available but from our own discussions with agronomists from Finland to Australia, it is common to encounter women and men with practical CIMMYT experience.

In the case of IBPGR, financial support has long been given to the University of Birmingham (UK), for a genetic resources training programme. The Board has both funded Third World trainees and subsidized the overall cost of the course. Fully 39 per cent of all trainees have come from industrialized countries. Thus, trainees from the North have also been directly subsidized by the Board.

Plant breeding and genetic engineering needs genes—and it needs scientists to work up the exotic material into catalogued characteristics. The International Agricultural Research Centres—often unwittingly or unwillingly—find themselves becoming the servants of private interests.

A study for Canada's International Development Research Centre (IDRC) noted in mid-1983 that there have been 'several instances' where IARC-developed material was acquired by a private concern and patented in a UPOV-member state. [4] In informal discussions, IARC scientists tell stories of visits from corporate breeders who—short months after a stroll through IARC test plots—would announce the introduction of a new variety wholly or heavily dependent upon the IARC's material. The late Dr Glenn Anderson of CIMMYT was particularly outspoken in his criticism of the use private companies were making of CIMMYT. He told one almost unbelievable story of having displayed new varieties at an exhibition in Chicago. A short while later, an American company (Anderson never revealed its name) wrote to him asking for a sample of the variety. Anderson complied. Not long after, the company wrote back asking the CIMMYT scientist for help in completing some attached forms. The forms were an application for PBR in the USA for CIMMYT's variety.

The first phase of the Green Revolution taught CIMMYT scientists that it is better to release improved germplasm than finished varieties. Increasingly, they see their role as supporting national breeding programmes. To that end, they identify and circulate material which may have value to any interested party. This is as it should be. But the danger—now being recognized by the IARCs—is that they will be relegated to the role of doing basic research for the benefit of private companies. The companies can take IARC material and exploit it for their own commercial purposes—and on a global scale. Many IARC scientists find this possibility deeply disturbing.

As valuable as the gift of a new IARC variety may be for exploitation in the North, genetic engineering is shifting the interest from whole plants to specific genes. We have already referred to Pioneer Hi-Bred's role in testing CIMMYT's exotic maize material. This is not a unique situation. Indeed, the US Government now regularly turns over its exotic germplasm for 'grow out' help from American companies. US officials describe the support provided by the companies as a 'generous offer' and even (with some confusion) have said, 'If the US Treasury had notified citizens of a gold shortage, how many would have answered the call with a direct donation?'[5] In fact, the reverse is true. The National Seeds Storage Laboratory at Fort Collins—a genetic Fort Knox—is offering to give its 'gold' to private companies for sampling. The companies have responded with enthusiasm.

Table 22 US private sector involvement in government exotic germplasm 'grow outs'[6]

Company	Crops
Agrigenetics	Maize, Sorghum, Soybean, Sunflower
Atlantic Ritchfield	Cotton
Cargill	Barley, Cotton, Maize, Sorghum, Sunflower, Wheat
Chocolate Vayou	Rice
Ciba-Geigy	Maize, Sorghum
Dekalb-Pfizer	Cotton, Maize, Sorghum, Soybean, Sunflower
Del Monte	Beets, Peppers, Spinach, Beans, Peas, Tomatoes
FFR Cooperative	Beans, Maize, Millets, Forage Legumes & Grasses
Gold Kist	Groundnut, Soybean
Heinz	Tomato
Illinois Foundation	Maize, Soybean
ITT	Grasses
Kay	Safflower, Sunflower
Land O'Lakes	Sorghum
NC+Hybrids	Maize, Sorghum
Pioneer Hi-Bred	Maize, Soybean, Wheat
Pure Seed Testing	Grasses
Sandoz	Maize, Pea, Bean
Shell/Olin	Barley, Lucerne, Soybean, Wheat
Stoneville Pedigreed	Cotton
Sturdy Grow	Maize
Southwide	Soybean, Sorghum
Soybean Research	Soybean
Tejon Ranch	Lucerne
Upjohn	Maize, Soybean, Sorghum
George Warner Seeds	Barley, Oats, Rye, Sorghum, Wheat

As was the thin green line of yesteryear, the thin green line of today continues to be a conduit of Third World information and resources.

Notes

1. For an excellent review of the history and for further details on the examples cited here, read Brockway, Lucile H., *Science and Colonial Expansion: The Role of the British Royal Botanic Gardens,* Academic Press, London, 1979.
2. For a general discussion and data, see Lemmon, Kenneth, *Golden Age of Plant Hunters,* Phoenix House, London, 1968.
3. CIMMYT Review, 1981.

4. Dias, Clarence J., and Ghai, Yash P., 'Plant Breeding and Plant Breeders' Rights in the Third World: Perspectives and Policy Options', IDRC Draft Report, April, 1983, p. 19. We recommend the whole report for reading, however.
5. From *Diversity*, Vol. 1, No. 3, November/December 1982, p. 9.
6. We have grouped individual companies by their actual owners.

The Global Seedsmen

The Birth of the Genetic Supply Industry

As the Green Revolution erodes genetic resources and as the Gene Revolution exposes the importance of control over these resources, the traditional family-dominated seed companies are being taken over by a group of transnational enterprises. Most of these companies have one foot in pesticides and another foot in genetic engineering. Now they are taking command over two major agricultural inputs: seeds and chemicals. Seeds are the first link in the food chain. If a company controls seeds, it is well on its way to controlling its end product: food.

> *The economic importance of plant breeding is being increasingly recognized for a number of reasons—not least the advent of the Green Revolution and of plant breeders' rights.*
> J T Walker, Royal Dutch/Shell, in *Span* (a Shell publication), 15 March, 1972, p. 123.

The seed trade has been with us almost as long as agriculture itself. Early in history, farmers would barter and exchange seeds either because of disease problems with their own saved seed or to change crops. It was not long before successful landraces were accorded magical powers and were exchanged among farmers at premium prices. As civilizations encountered one another in the forests of southeast Asia, during the Middle East Crusades, or in the Andean mountains, enterprising adventurers returned with wondrous new seeds. Often these seeds were marketed to unsuspecting farmers, who as often as not found themselves paying dearly for bags of weed seed and pebbles.

The modern seed trade springs only in part from these exotic origins. R and G Cuthberts of England can trace its ancestry to the final quarter of the seventeenth century and the import business in camellias and azaleas. When it was bought by Sweden's KemaNobel in the mid-seventies, it was the oldest surviving seed house in the world. Paris' Vilmorin-Andrieux is almost as old and at least as exotic. Since 1727, it has combed the world for exotic ornamentals. It was bought a few years ago by Limagrain.

Another branch of the seed trade traces its roots through the grain trade and their original business as flour-millers and shippers. Companies such as Brooks Hasler in the United Kingdom are almost as old as the venerable plant explorers but their base was in farming—which led to milling —which led to seed-cleaning and trading. Now Brooks Hasler is a part of the Ranks Hovis McDougall empire. Austria's Probstdorfer Saatzucht and Germany's KWS (Kleinwanzelbener Saatzucht) share a similar history and may yet live to share the fate of many of their contemporaries.

Table 23 The global seedsmen [1]

Rank	Private enterprise	Home state	Parent industry	Total sales (US $ millions)	Seed sales (US $ millions)	Seed firms* Direct	Seed firms* Indirect	Number of crops	Number of var.	Number of states
A	Royal Dutch/Shell	Anglo/Dutch	Petrol	82,291	650	68	3	55	83	76
	Pioneer Hi-Bred	USA	Seed	557	557	27	2	6	55	16
	Sandoz	Switzerland	Chemical	2,946	319	34	—	12	172	13
	Cardo	Sweden	Agro-Ind.	440	285	25	5	18	108	7
	Dekalb-Pfizer	USA	Seed/Chem.	—	187	29	1	8	142	20
	Ciba-Geigy	Switzerland	Chemical	7,061	107	19	7	9	76	14
B	Upjohn	USA	Chemical	1,828	139	10	1	13	52	7
	Cargill	USA	Agro-Ind.	15,000	—	11	—	6	47	5
	Suiker Unie	Netherlands	Agro-Ind.	353	100	15	1	12	72	7
	Svalöf	Sweden	Seed	—	—	7	3	16	62	3
	Clays-Luck**	France	Seed	155	155	5	—	—	—	6
	Kleinwanzelbener Saat.	F.R.Germany	Seed	80	80	26	1	14	125	11
	Cebeco-Handelsraad	Netherlands	Agro-Ind.	—	—	7	—	13	85	7
	Florimond-Desprez	France	Seed	—	—	1	4	10	44	3
	Limagrain	France	Seed	130	130	22	—	8	41	8
	UNCAC	France	Agro-Ind.	—	—	6	—	12	32	2
	De Danske Sukkerfabrikker	Denmark	Agro-Ind.	400	—	10	—	6	46	8

* Direct=a subsidiary.
Indirect=a company of which the senior enterprise has a contractual relationship which may or may not include equity interest.
** There are some indications that a significant share of the Clays Luck equity is now in the hands of public and private French corporations.

At the close of the 1970's, FAO identified 1,782 public and private entities engaged in plant breeding or seed trading. The OECD lists 652 enterprises engaged in the international trade of agricultural seed (as distinct from horticulture or silviculture) in 37 leading countries. Like the grocery store cornucopia, the image is one of vast diversity. Like the groceries, the reality is somewhat different. Since the early seventies, about the time that the opening quote appeared in Shell's in-house publication, well over 500 seed houses have been taken over by large—almost always trans-national—companies. Another 300 seed houses appear contractually linked to these larger firms or, in a few cases, are the result of internal expansion by the parent firm. The effect, in the course of a dozen years, has been to utterly transform the seed industry. Where once it was small and family-based, it is now large and highly corporate.

The size of the prize

The commercial value of the seed trade is not easily assessed. Early in this decade, its global worth appears to be around US $50 billion—including retail level sales in every sector as well as the nursery trade. Because cereal seed can easily be saved by farmers and used for sowing the next year's crop, only a fraction of this market yields to annual sales. Also, public sector seed sales in some industrialized and most Third World countries continue to restrict the market available to the companies. In sum, the commercial seed market may be closer to an annual sales volume of US $13 billion.

A 13 billion dollar market is not large in the scheme of things—certainly not large for Shell Oil or Ciba-Geigy. Yet the profitability of the trade is substantial. Even in the 1960's, its returns were ranked second only to the pharmaceutical industry. A recent conservative estimate offered in a report for the International Development Research Centre concluded that the trade has an annual profit rate of 19 per cent. [2] Some EEC officials in Brussels have placed the return on investment (within Europe) as high as 45 per cent—an astronomical calculation.

As impressive as these returns may be, they would not of themselves warrant the all-out take-over of the trade now nearing completion. In Brussels, the same EEC lawyers argue that Shell, Mobil and British Petroleum approached the Massachusetts Institute of Technology (better known as MIT) early in the seventies to conduct a study advising them of new areas of high-technology in which to invest. The answer that came back was the 'genetics supply' industry—livestock and plants. Not only could the seed industry expand its commercial potential enormously to take a much bigger bite out of the US $50 billion market but the agricultural applications of new genetic engineering technologies could open up a new market area capable of reaping another US $100 billion by the end of the century. Then, too, there were other under-explored areas such as the half-billion dollar medicinal plant market that could itself erupt with increased plant exploration and the new genetics. On the basis of this understanding, the major petroleum companies began to buy into seed companies and to develop their own biotechnology capacities.

While the above factors were undoubtedly contributory, the reasons for immediate action in the seed industry are better summarized by Shell's article in *Span* (1972), on the Green Revolution and PBR. Norman Borlaug—who had just won the Nobel Peace Prize—demonstrated two crucial truths for the seed industry: that it is possible to breed a basic cereal strain that can be adapted over a vast market area and that governments and foreign aid programmes are prepared to finance the introduction of new varieties and even handle the costs of distribution to peasant farmers. Until Mexi-Pak wheat, the major companies had regarded the seed market as too geospecific to allow them to exercise their special skills in transnational marketing. Suddenly, it seemed possible to invest a modest sum in R and D and still sell an adaptable variety on several continents. At the same time, the previously insurmountable obstacle of successfully selling a new variety to millions of smallholders—a hugely expensive marketing proposition among customers who could not afford to pay—now seemed solved as the World Bank, UNDP, FAO and a host of bilateral aid programmes began to accord a high priority to the distribution of HYV seed. The companies could sell to their own governments or to a Third World government agency and let them bear the burden of distribution. Third World governments were prepared to heavily subsidize prices and also to force peasant farmers to buy new seed by attaching the use of 'improved' varieties to access to agricultural credit and other inputs including irrigation. From being a needful but uneconomic market, the Third World loomed as a vast and highly profitable one.

The potential for PBR became significant again, at the same time as the Green Revolution was being canonized with the Nobel Peace Prize. Until 1971, the concept of granting exclusive monopoly patents for new plant varieties had been confined either to fruits and ornamentals (as in the United States) or to agricultural crops in a handful of western European countries. Then, at the outset of the seventies, the valuable market area for PBR quadrupled with the inclusion of France, Sweden and the United States into the exclusive-monopoly fold. With similar moves afoot from South Africa to New Zealand, Shell and other transnationals could predict that a worldwide regime of PBR would not be long in coming. Plant patents would give them royalties and, far more importantly, allow them to set the conditions of sale for their varieties and thereby to manipulate the global marketplace.

Petro-chemical companies could see yet another advantage in the seed industry. Many of them are directly engaged in the production of agro-chemicals: fertilizers and pesticides. Many others have an interest in pharmaceuticals. For those interested in pesticides, there was an obvious advantage to adding seeds to their repertoire, since the same advertising and distribution channels were employed. Then, too, the governments that subsidized seeds might also subsidize agro-chemicals for those seeds. Companies linked to pharmaceuticals also tend to market pesticides and their primary interest was with this business opportunity. There was a second opportunity, however, in medicinal plants.

All three areas—seeds, pesticides and pharmaceuticals—have a common ground in intensive research related to genetics and chemicals. With great

Table 24 The chemical seedsmen [3]

Company	World rank in pesticides	World rank in pharmaceuticals	Activity in the seed industry
Bayer (D)	1	2	Breeding Prog. at Helena Chem. in USA
Ciba-Geigy (CH)	2	4	Maize, Soya, Sorghum, Cotton with pest.
Shell (NL/GB)	3	—	Barley, Wheat, Maize, Soya, Cotton with pest.
Monsanto (US)	4	—	Hybrid Wheat prog. with growth regulators
Rhone-Poulenc (F)	5	16	Rumoured link to Clays-Luck in France
BASF (D)	7	—	Has sold or is selling seed interests
Eli Lilly (US)	8	11	Active in agricultural genetic engineering
Du Pont (US)	9	—	Active in agricultural genetic engineering
Stauffer (US)	10	—	Maize seed and pesticides in USA
Hoechst (D)	11	1	Has one known British seed company
Dow (US)	12	33	Active in agricultural genetic engineering
Union Carbide (US)	14	—	Has sold seed interests
Rohm & Haas (US)	18	—	Hybrid wheat with sterilizing chemicals
Sandoz (CH)	19	7	Maize, Wheat, Cotton with pesticides
Diamond Shamrock (US)	20	—	Sorghum in Mexico; pesticides
Sumitomo (J)	21	x	Vegetable seed interests; pesticides
Takeda (J)	24	10	Rumoured vegetable/oilseeds seed firms
Pfizer (US)	x	8	Maize, small grains breeding with Dekalb
Upjohn (US)	x	18	Soybean seeds and chemicals; vegetables
Reichold (CDN/USA)	x	—	Turf and garden seeds and chemicals (Florida)
Tenneco (US)	x	—	Albright and Wilson (GB) seeds and pest.
KemaNobel (S)	x	x	Fruit and vegetable seeds & fungicides
Olin (US)	x	—	Maize, Soya, Barley, Wheat, Cotton with pest.
ITT (US)	x	—	Turf, garden seed with pest. & fertilizers
W.R. Grace (US)	x	—	West Indies seeds; fertilizers and pest.
Celanese (US)	x	—	Vegetable seeds and seed coatings
Elf Aquitaine (F)	—	x	Genetic engineering in pharm. and seeds; four French seed houses
Occidental Pet. (US)	x	—	Vegetable seed co.; fertilizers and pest.
Cardo (S)	x	—	Seeds; retail pest.; also sugarbeet coats and genetic engineering
British Petroleum	x	—	Has two Dutch vegetable seed houses—rumours of others
Mitsubishi (J)	x	—	Rumoured vegetable seed interests
Mitsui (J)	x	—	Rumoured vegetable seed interests
Atlantic-Richfield (US)	—	—	Vegetable seed co. in USA
Terra Chem. (US)	x	—	Has one US seed co.

x=active in the field; — = not notably active.

new markets and patent security on the horizon, it was only natural for chemical concerns to become the world's new seedsmen.

Because the seed industry has been historically made up of small family-based enterprises generally operating in specific regions, there is no 'track record' or detailed data available allowing us to easily compare the current situation with what has gone before. It is, for example, extremely hard to identify the actual market shares held by specific companies. One crude indicator, however, is the list of cultivars provided annually by the OECD

Table 25 OECD variety domination of 13 major crops. Public and private sector domination of the internationally-traded varieties for 13 major crops as identified by the OECD Scheme for the Varietal Certification of Seed Moving in International Trade in 1981.

Crop	No of varieties	Enterprise	Direct percentage	Total percentage
Maize	1038	Public Sector=		8.36
		French Govt.	3.22	
		Private Sector=		91.64
		Dekalb-Pfizer	10.57	
		Sandoz	9.19	
		Ciba-Geigy	6.25	
		Pioneer Hi-Bred	4.96	
		Upjohn	4.30	
		Kleinwanzelbener Saat.	3.68	
		Cargill	3.58	
		Top 7 Private Firms=		42.53
Winter Wheat	412	Public Sector=		35.43
		Italian Govt.	9.89	
		Bulgarian Govt.	5.52	
		UK Govt.	5.29	
		Private Sector=		64.57
		Royal Dutch/Shell	5.06	
		Dekalb-Pfizer	3.22	
		Cebeco-Handelsraas	3.22	
		Florimond-Desprez	2.99	
		Cardo	2.30	
		Top 5 Private Firms=		16.79
Sugar-beet	326	Public Sector=		4.90
		Romanian Govt.	2.15	
		Private Sector=		95.10
		Suiker Unie	11.96	
		Great Western	10.43	
		Cardo	9.20	
		Kleinwanzelbener Saat.	9.20	
		SES	6.75	
		Top 5 Private Firms=		47.54
Spring Barley (2 row)	217	Public Sector=		19.35
		UK Govt.	5.07	
		Canadian Govt.	3.23	
		Private Sector=		80.65
		Royal Dutch/Shell	9.68	
		Cardo	9.22	
		Cebeco-Handelsraad	5.99	
		Svalöf	5.22	
		UNCAC	3.23	
		Top 5 Private Firms=		33.34
Lucerne (Alfalfa)	173	Public Sector=		84.33
		Italian Govt.	14.37	
		US Govt.	12.07	
		Canadian Govt.	5.75	
		Australian Govt.	4.02	
		Private Sector=		15.67
		Sandoz	4.02	
		De Danske Sukkerfabrikker	4.02	
		Top 2 Private Firms=		8.04
Spring Wheat	152	Public Sector=		44.07
		Kenvan Govt.	15.13	
		Canadian Govt.	10.53	
		Australian Govt.	5.26	
		Private Sector=		55.93
		Sandoz	7.89	
		Cardo	6.58	
		Cebeco-Handelsraad	3.95	
		Royal Dutch/Shell	1.97	
		Ciba-Geigy	1.97	
		Dekalb-Pfizer	1.97	
		UNCAC	1.97	
		Top 7 Private Firms=		26.30
Spring Oats	128	Public Sector=		47.65
		Canadian Govt.	22.66	
		UK Govt.	7.81	
		Private Sector=		52.35
		Svalöf	7.03	
		Cardo	3.91	
		Kleinwanzelbener Saat.	3.13	
		UNCAC	3.13	
		Dekalb-Pfizer	2.34	
		Cebeco-Handelsraad	2.34	
		Top 6 Private Firms=		21.88
Durum Wheat	107	Public Sector=		52.33
		Italian Govt.	30.84	
		Canadian Govt.	4.67	
		Private Sector=		47.67
		Sandoz	1.87	
		Dekalb-Pfizer	1.87	
		UNCAC	1.87	
		Top 3 Private Firms=		5.61
Field Pea	99	Public Sector=		33.33
		Hungarian Govt.	7.14	
		German Dem. Rep. Govt.	5.10	
		Private Sector=		66.67
		Cebeco-Handelsraad	10.20	
		Svalöf	6.12	
		Cardo	3.06	
		Top 3 Private Firms=		19.38
Timothy (pratense L.)	97	Public Sector=		35.05
		Canadian Govt.	6.93	
		Polish Govt.	5.94	
		Private Sector=		64.95
		Suiker Unie	9.90	
		Cebeco-Handelsraad	7.92	
		Svalöf	2.97	
		Top 3 Private Firms=		20.73
Winter Barley (4-6 row)	84	Public Sector=		19.04
		Private Sector=		80.96
		Florimond-Desprez	8.33	
		Kleinwanzelbener Saat.	8.33	
		UNCAC	3.57	
		Royal Dutch/Shell	2.38	
		Top 4 Private Firms=		22.61
Sun-flower	71	Public Sector=		
		French Govt.	14.08	
		Romanian Govt.	12.68	
		Private Sector=		53.53
		Sandoz	21.13	
		Cargill	5.63	
		Top 2 Private Firms=		26.76
Soy-bean	63	Public Sector=		19.04
		Canadian Govt.	7.94	
		Private Sector=		80.96
		Sandoz	31.75	
		Kleinwanzelbener Saat.	9.52	
		Dekalb-Pfizer	4.76	
		De Danske Sukkerfabrikker	4.76	
		Top 4 Private Firms=		50.79

Scheme for the Varietal Certification of Seed Moving in International Trade. The list deals with the major cereals, forages and sugarbeets but does not provide details on vegetables or potatoes. Although 37 countries participate in the scheme, the list has a European focus and cannot take into account the significance of varieties on the important American market. No effort is made to indicate the market shares held by any variety and all that can be seen is the number of internationally-traded varieties held by specific governments and enterprises. Nevertheless, the inroads made by transnationals over the past dozen years are noteworthy; especially since it often takes from 10 to 15 years to bring a new cereal to market.

The above table also excludes 'shared' varieties where the ownership (patent—where applicable) of the variety may be divided among two or more enterprises. This shared category can run as high as 15 per cent of all the varieties of that crop. As a general rule, one of the major companies is a partner in such shared material. In fact, Shell is particularly active in leasing varieties held by other enterprises. By contrast, governments are rarely involved.

As the table below indicates, ten major companies control almost one-third of all cereal varieties listed by the OECD. In the context of privately-held varieties, the share controlled by these same firms is rising towards half of all cereals. This is a remarkable achievement, considering that four of the top ten (Shell, Sandoz, Ciba-Geigy and Upjohn) are newcomers to the business and are still largely living off the R and D programmes of the companies they purchased short years ago.

Table 26 The OECD's ten leading private seed enterprises. Percentage of cereal varieties held by the ten firms in 1981 [4]

Enterprise	Of all varieties	Of private varieties	Enterprise	Of all varieties	Of private varieties
Dekalb-Pfizer	6	8	Upjohn	2	3
Sandoz	5	7	Pioneer Hi-Bred	2	3
KWS	3	5	Cebeco	2	3
Ciba-Geigy	3	4	Cargill	2	2
Shell	3	4	*Top ten*	31 %	43 %
Cardo	3	4			

These figures still do not expose the true strength of the newcomers. It is common with any crop that a handful of varieties actually dominate production in any given country. Thus, although there were 53 companies listed as the maintainers of internationally traded agricultural seed based in Great Britain in 1981, a national seed trade publication estimated that 40 per cent of all the royalties earned on patented cereal seed in the country went to one company: Royal Dutch/Shell. In total, only three companies dominate the UK cereals market; six are dominant in horticultural crop breeding and a dozen have a significant share of non-cereal livestock feeds.

Of the old traditional seed houses, few remain their own masters today. Leading the acquisition route has been the flour-miller, Ranks Hovis McDougall, with between 90 and 100 take-overs of seed or agricultural merchant (including seed) houses. Shell has acquired 30 local firms, and Cardo, in conjunction with Agricultural Holdings, has obtained another 19. In total, the last few years have seen the demise of close to 200 British seed-related enterprises.

This is nowhere more evident than in the famous English country garden, where three firms—two Swedish and one Anglo-Dutch—now account for about 80 per cent of retail seed sales.

Table 27 Control of the British garden seed market[5]

Parent	Market share percentage	Subsidiaries
KemaNobel	27–29	Carter/Cuthbert/Dobies
Shell	25–26	Bees/Webbs
Cardo	24–26	Suttons/Hurst
Total	76–81	

No country in the world is more renowned for its seed industry than the Netherlands. FAO identifies 60 noteworthy seed merchants in its 1979 list and 36 maintainers are listed by the OECD as dealing in international agricultural seed. According to a 1983 study by Tom Groosman of the Development Research Instititute at Tilburg, [6] this seeming diversity hides the fact that three enterprises control 95 per cent of the Dutch agricultural seed market. Three others account for 75 per cent of the key Dutch seed potato export business. Four firms equal about 90 per cent of the turn-over in horticultural seeds.

The world's single largest seed market is the billion dollar US maize seed crop. The American Federal Trade Commission concluded in a recent study [7] that about 80 per cent of that market was held by ten private

Table 28 Seed control in The Netherlands [8]

Type of seed	Market share per cent	No. of firms	Parent entities
Agricultural seeds	70	3	Suiker Unie Cebeco-Handelsraad Barenburg
Horticultural seeds	90	4	Royal Dutch/Shell Sandoz British Petroleum Royal Sluis

enterprises. Eight of these ten enterprises have won their market position by buying out other companies in the years since 1968. Only one company (the maize leader: Pioneer Hi-Bred) has managed to survive and strengthen its position. Half of the market in the United States continues to be controlled by two companies: Pioneer and Dekalb-Pfizer chemicals company with an old family seed house Dekalb Genetics. Dekalb-Pfizer is a joint venture linking the genetics interests of the Pfizer chemicals company with an old family seed house, Dekalb Agresearch, which has fallen upon hard times. There are rumours, too, that Pioneer is also suffering and may have to consider a merger with another chemicals giant.

Table 29 Seed control in the US maize market [9]

Enterprise	Percentage	Enterprise	Percentage
Pioneer Hi-Bred	38	Cargill	4
Dekalb-Pfizer	12	Golden Harvest	3
Ciba-Geiby	7	Agrigenetics	2
Sandoz	7	*Top 8 enterprises*	77
Central Soya	4		

The US Government and its Land Grants colleges have always dominated the small grain cereals breeding work in the USA. Lately, this situation has begun to change. In the summer of 1982, the American Government announced that it was getting out of plant breeding and would confine its scientists to basic research in the service of the private sector. While state-funded programmes and universities can continue their involvement, many observers expect the public sector to pull back from varietal release programmes leaving the field clear for the new seedsmen. The cereals scene was already looking good for the transnationals a year earlier when Royal Dutch/Shell's North American seeds subsidiary undertook a study of R and D funds going into the major wheat and barley markets in the United States.

Table 30 Wheat and barley R and D in the USA[10]

Crop	Enterprise	Percentage	Percentage	Crop	Enterprise	Percentage	Percentage
Hard Red Winter Wheat	Public Sector=		33	Hard Red Spring Wheat	Public Sector=		29
	Private Sector=		67		Private Sector=		71
	Pioneer Hi-Bred	15			Pioneer Hi-Bred	19	
	Royal Dutch/Shell	12			Royal Dutch/Shell	16	
	Dekalb-Pfizer	12			Dekalb-Pfizer	16	
	Cargill	12			Western Plant Breeders	10	
	Rohm and Haas	9			Sandoz	6	
	Sandoz	5					
Soft Red Winter Wheat	Public Sector=		38	Spring Barley	Public Sector=		61
	Private Sector=		62		Private Sector=		39
	Royal Dutch/Shell	16			Royal Dutch/Shell	19	
	Pioneer Hi-Bred	16			Western Plant Breeders	7	
	Kleinwanzelbener Saat.	13			Sandoz	6	
	Rohm and Haas	11			Cargill	6	
	Sandoz	8					

The scene is everywhere the same. The OECD may list 88 French agricultural crop maintainer but the 'Club de Cinque' governs the marketplace aided and abetted by American transnationals. In the final analysis, Sweden has only three seed companies: Cardo and Svalöf with sweeping worldwide breeding and marketing interests; and KemaNobel—now Europe's largest retail garden seed company. Where once there were thousands of names there now remain a few hundred and a few dozen powerful corporations.

Multinational or transnational corporations are a menace by exerting their deleterious influence in a variety of ways. For example, in vegetable cultivation, one has no choice but to plant cultivars bred by Suttons of England (Cardo) or Burpee of the USA (ITT) etc. and subsequently protect them with pesticides produced by Shell Limited, ICI, Monsanto, etc .
M A Adansi, Chief Research Officer/Head, Oil Palm Research Centre, Ghana. [11]

The Southern market

In his book, *Merchant of Grain* [12], Dan Morgan has referred to the role of the transnationals in distirbuting Green Revolution seed. In 1977, he claims, Cargill and Continental Grain (two of the world's largest grain traiders and also major factors in the seed trade) 'cornered' the market on HYV wheat multiplied in Mexico for global distribution. It seems the major companies often act as middlemen between HYV seed growers in one country and the governments and agencies in other countries anxious to buy the seed for their farmers.

The new seedsmen often have the way paved for them in the Third World through a host of foreign aid and national government support programmes. In Cameroon, for example, USAID has been distributing groundnut and sorghum seed in its 'Project Semencier' since 1976. Development agencies in the Cameroon often distribute seed to farmers on credit and do not look for repayment until after the crop is sold. Germany's GTZ has launched a number of seed multiplication projects including a Sierra Leone rice multiplication scheme intended to provide improved seed to local farmers and eventually allow that country to market HYV rice to other parts of Africa. In Egypt, the government subsidizes seed prices to the tune of US $2 million while the Kenyan Government both supplies farm credit for seed purchases and subsidizes the work of local seed companies and actively promotes the use of new varieties through the media. Almost all rice seed is imported in Bangladesh as is three-quarters of the country's wheat seed. The government encourages the use of new seed through credit control, advertising, and its own extension service. The Indian Government provides credit for seed production. In China, the government subsidizes the price of new varieties to farmers. New varieties in Malaysia are popularized by state extension services and the seed is distributed at a nominal fee.

Seed information and credit programmes, government initiatives to subsidize national seed multiplication and distribution, etc. are all intended —when equitably administered—for the benefit of peasant farmers. Of themselves, such efforts are beneficial to the cause of food availability. They are also, inevitably, to the benefit of the new seedsmen.

The fate of the cereals market in the Third World is still not finalized. CIMMYT, IRRI, the other IARCs and national breeding programmes undoubtedly have the lion's share of the market. With the marginalization of the IARCs into the position of basic researchers for the private sector, however, the transnationals are expected to out-manoeuvre national programmes to take command of this vital sector. Transnationals like Pioneer Hi-Bred, Ciba-Geigy and Shell are already developing strong positions in maize, sorghum and barley.

The South's vegetable seed market is already firmly in multinational hands. Suttons (owned by Cardo), Ohlsens Enke (owned by Svalöf), Daehenfeldt of Denmark and Zaadunie of Holland (owned by Sandoz) are major suppliers of vegetable seed to Africa and western Asia. Japanese breeders like Takii and others which appear to be controlled by Sumitomo and Mitsubishi have a lead position in Southeast Asia. Yates of

Australia and its unrelated namesake in New Zealand are also fighting for a share. Vegetable seed for Latin America and the Philippines is marketed by American companies like Dessert Seeds (Atlantic-Richfield) and Ferry-Morse (once held by Purex and now controlled by Limagrain of France).

The important seed potato market in the South seems to be largely in the hands of three Dutch private and cooperative companies: Hettem, ZPC and Agrico. Seed potato exports bring the Netherlands about 300 million guilders a year, of which 100 million guilders is derived from sales in the South.

The range of seed-related activities in the South is growing daily, Hilleshög (a Cardo subsidiary) is working with Swedish Match to breed Acacia Mangium trees for the Philippines. Campbell Soup has joined forces with an American genetic engineering company and Brazilian interests to breed new tomatoes in Brazil. The International Plant Research Instititute (a very private company despite its name) has launched a joint venture with Sine Darby Berhad of Malaysia (Asian Biotechnology) to breed new crop plants for that region. Among the many vegetable varieties growing this year in both Kenya and Canada are cabbages from Ohlsens of Denmark (again, a subsidiary of Svalöf of Sweden); cauliflower and carrots from Dutch and American subsidiaries of the Swiss pharmaceutical house Sandoz; lettuce from Atlantic-Ritchfield's seed subsidiary; cucumbers from the US offspring of a French cooperative; still more carrots from the British seed house of a Swedish corporation; and a sprinkling of beans and melons from various Italian and French concerns.

At least the American, French and Dutch governments have been anxious to promote the export interests of their domestic seed companies through the inclusion of their seed in foreign aid schemes. In turn, the companies themselves have dug deep into their hearts to find ways to help the Third World develop its seed industry. The International Federation of the Seed Trades (FIS) has engineered an apprenticeship plan through which member companies receive and train Third World agriculturalists. For varying lengths of time, these foreign students learn the wondrous way of the transnationals and are then encouraged to return to their home countries where they are expected to eventually assume positions of importance––importance to their mentors in the North. The FIS scheme is based upon a much older scheme utilized by German seed houses with GTZ. State-funded GTZ finds and finances likely prospects in the South and then attaches them to a German seed-exporting company for training.

The regeneration of ICP

In the 1980's, a new sophistication by the development of export opportunities was introduced by the Industry Council for Development (ICD). In an earlier reincarnation, ICD was ICP: the Industry Cooperative Programme affiliated to FAO. Late in the seventies, an outraged FAO Director-General and the Swedish Government combined to expel the Industry Cooperative Programme from the policy tables of FAO in a much-publicized row. Since the sixties, a crowd of around 80 world agribusinesses had gathered together under the ICP umbrella in order to influence the direction of agricultural development as propogated by FAO. To his considerable credit, Edouard Saouma confronted the companies and forced their hasty exit from Rome.

Unfortunately, they did not exit very far. For a brief time, they found offices at Petit Saconney in the annex to the Palais des Nations in Geneva. Their new address proved indiscreet, however, and the old ICP disbanded long enough to rise again, pheonix-like, as ICD on UN Plaza in New York. Other than the name, virtually nothing had changed. The secretariat remained basically the same and ICD was still heir to the remnants of the old ICP war chest. Its corporate membership had been blighted, however, by the unwelcome publicity the old lobby had attracted in Rome.

The glare of publicity did not concern Kurt Waldheim—then UN Secretary-General—who is reported to have personally invited the agribusiness consortia to New York and to have instructed UNDP Administrator Bradford Morse to prepare a home for them inside UNDP. Certainly, the newly-crafted ICD brochures speak almost intimately of the lobby's relations with the Secretary-General and UNDP. The flight to New York is depicted as a timely move made in order to be closer to the heart of the UN system.

Whatever its past, ICD's future seems closely linked to the seed industry. Indeed, its first new initiative was to establish the Commercial Seeds Industry Development Programme (CSIDP)—a programme intended to lend the Third World the advice and expertise of the commercial seed trade in the North in order to develop national and regional seed capabilities. The introductory brochure speaks repeatedly of the opportunities of 'joint ventures' with international companies. Although ICD is in New York, CSIDP began its life on the banks of the Thames—in the British headquarters of Royal Dutch/Shell.

CSIDP began operations with direct funding from USAID (US $825,000) and with its diplomatic path made straight by a somewhat reluctant UNDP. The lobby's first initiative is with the Caribbean Food Corporation and plans for a regional seeds project covering much of the Caribbean. In sum, ICD's people seem to envisage a regional seeds industry which undertakes its own seed multiplication and distribution (including certification etc.) while receiving the foundation seed (the varieties themselves) from international companies such as, for example, Shell or Ciba-Geigy (both ICD members). ICD's team offered to advise regional governments on all aspects of the trade including the appropriate legislation intended to attract the best varieties.

In other words, USAID money (Canadian CIDA funds have also been sought) would be used to establish a government-controlled regional service system through which the new seedsmen might channel their proprietary products.

Not all has gone well for CSIDP, however. Neither Shell nor Ciba-Geiby welcomed the attention this initiative earned in the early eighties and both have since withdrawn. The fate of the Caribbean enterprise is uncertain.

Statistical strategies

Aside from the substantial government support available, the new seedsmen found the growth potential in the Third World market almost irresistible. At present, no more than a third of the cultivated hectares devoted to small grains in the South can be regarded as 'viable' in the commercial sense. Even these commercially-accessible lands tend to save

Table 31 Estimates of the potential market for selected cereals for the Third World in US $ millions [13]

Crop	30% commercial returning every 4 years	50% commercial returning every 3 years	80% commerical returning every year
Rye	2.4	5.2	24.9
Oats	2.9	6.4	30.9
Barley	28.7	63.7	305.9
Wheat	98.1	247.8	1,046.3
Maize	114.1	253.3	1,216.9

their own seed and seek certified seed, on average, perhaps once in every four years. With a little help from the aid bureaucracy, however, the new seedsmen can hope to increase their market by linking farm credit to the use of certified seed. This could greatly increase the share of the crop brought into the commercial fold and improve the rate at which farmers return to the market for seed. Increasingly, Third World governments are being persuaded to sow hybrid maize and grain sorghum. Not only is the price and profit ratio much higher for hybrid seed but farmers are then obliged to return to the company every growing season to buy new seed. This kind of push has already worked wonders for the seed industry in industrialized countries and the companies have every reason to assume that the same is possible—at much less cost—in the South.

The other side of the coin

Executives of Ciba-Geigy and Sandoz like to boast that the 'Seed Capital of the World' has been shifted from King's Lynn or Enkhuizen to their mutual hometown of Basel. If not Basel, the alternate choice might be Arusha, Tanzania—known for Nyerere's famous Declaration calling for self-reliance and, now, as a base for twelve foreign seed companies, including Shell Oil and Royal Sluis.

Harvesting lettuce seed or rogueing maize plants is backbreaking work involving virtually thousands of labourers in seasonal jobs. Along with labour costs, land costs are also important. The South offers Northern seed companies a number of advantages: cheap labour; cheap land; and a 'second season' (allowing them to multiply their seed in the warm South while their northern test plots endure winter cold). Cheap land can be particularly significant since many companies like the modern equivalent of 'slash and burn' agriculture by exhausting the soil through intensive cultivation and then moving onto the next land. Africa has become a particularly popular region for seed multiplication for these reasons. Tanzania is a centre for vegetable seed, especially beans and lettuce, while Morocco and Tunisia have become important for forage grasses and legumes. Chile and Mexico are also important for American companies.

Regulated carefully, the South's value as a germplasm storehouse as well as a 'second season' growing region for Northern companies could be combined to the financial benefit of the Third World. There need be no distortion to the intent of the Arusha Declaration if the global seeds industry finally recognizes that its logical home lies in the South.

Commerciogenic Erosion

Bolivia ... is already feeling the effects of reduced 'source of seed' competition because the multinationals have already purchased a number of smaller suppliers and then only provide one 'most profitable' line from among those purchased.
James H Thomas, Chief of Party, Consortium for International Development (of six US Universities) [14]

Reducing competition in the South

The new seedsmen hotly deny that their activities in the South in any way contribute to genetic erosion. They concede that newly introduced varieties may replace landraces but they maintain, in the face of overwhelming evidence to the contrary, that the old material is already safely stored in gene banks. In addition, they insist that the varieties moving into the Third World largely originate in the International Agricultural Research Centres.

This last point is, in general, certainly true. Private companies, however, already show considerable insensitivity to the need for genetic conservation. Since they are now taking over the next phase of the Green Revolution from the IARCs, there is reason to fear that the danger of commerciogenic erosion will spread.

The IARCs in the CGIAR system have proven themselves to be genuinely concerned about genetic erosion. They recognize their own role in erosion and many of them have established their own gene banks to help reduce the long-term negative impact of their HYVs on diversity. Even business consultants in the private sector, however, have stated that the Genetics Supply industry has shown little interest in genetic conservation. In contrast to the IARCs, private companies have good business reasons to extend their proprietary varieties over the widest possible area. Taking a leaf from the industrial sector's book on extending the product life cycle, the new seedsmen are inclined to take a variety whose popularity has begun to wane in its primary market area and, with few or no adaptions, sell the 'new' variety in the Third World wherever and however they can. Such tactics lead to two forms of genetic erosion: first, the new cultivar may supplant superior (better adapted) landraces causing them to disappear from cultivation entirely; second, the new seed may encroach upon an entirely different crop causing totally unanticipated erosion in that other crop. In this way, geneticists have watched the replacement of high-protein legumes and other so-called 'poor people's crops' by less nutritious and often export-oriented cash crops. Peasant farmers may not only have to buy the new seed and accept the loss of their old seed but

Table 32 The vegetable green revolution [15]

Crop	Commercially-related cause of some erosion
Broccoli	Popularity of cauliflower is leading to erosion of broccoli in Italy
Brussels sprout	IBPGR says F1 Hybrids have caused 'massive genetic erosion' Early-maturing Asian types have been developed
Cabbage	F1 Hybrids represent a world-wide 'threat' to their genetic base, according to an IBPGR report
Cauliflower	New commercial varieties replacing old types in Italy
Chinese cabbage	In Korea and Japan, new F1 Hybrids have led to erosion
Leek	Commercial breeding for uniformity is narrowing genetic base
Okra	Commercial cultivars are replacing traditional varieties everywhere in the Third World
Onion	F1 Hybrids offering a narrow genetic base, from Japan, Europe and the USA, are rapidly replacing older cultivars
Pak choi	New F1 Hybrids are threatening Chinese resources
Sugarbeet	German varieties have almost destroyed the genetic diversity of beets in Turkey, according to IBPGR
Tomato	New Hybrids are causing erosion of old varieties, says IBPGR; US varieties have replaced old cultivars in several Latin American countries
Vegetables (all)	An IBPGR newsletter reported that the take-over of small seed houses in Italy by transnationals was leading to the reduction of old varieties in favour of newer types that can be grown over a larger area
Watermelon	Commercial cultivars are replacing valuable local landraces in India and other parts of Asia
Welsh onion	Japanese seed companies are marketing F1 Hybrids that may endanger this Asian food crop's breeding base

they may find themselves harvesting a poor crop because the variety pushed by the seedman simply does not match the climate or the terrain.

Such commerciogenic erosion has been seen clearly in the profitable vegetable seed industry. In recent decades breeders from industrialized countries have been enthusiastically exporting their hybrid seed to Third World countries. In one blow, an F1 hybrid can not only erode the old cultivars it replaces but also compel the farmer to return to the company for seed each year. (F1 hybrids are either sterile or they do not breed 'true'—meaning that the next generation will not have the agronomic characteristics sought by the farmer.) From Recife to Singapore, the Third World is being encouraged to grow temperate zone vegetables instead of their better-adapted and sometimes much more nutritious tropical types.

A 1977 Dutch review entitled 'Tropical Vegetables and Their Genetic Resources' concluded that, 'Many cultivars offered by international seed companies are not usually adapted to local tropical conditions and are often inadequately protected from the effects of high atmospheric humidity'.

The impact of commerciogenic erosion has also been felt in the beet industry. In a short report on 'Beet in Turkey', [16] co-authored by the Executive Secretary of IBPGR, the almost total extinction of very valuable native beets was attributed directly to the introduction of the commercial 'Detroit Globe' type. In fact, the study specifically laid the cause of the erosion at the feet of German seed houses. (Kleinwanzelbener Saatzucht—the Federal Republic's largest seed company and one of the world's largest beet breeders—is the only seedsman known to operate in Turkey.)

Another IBPGR report on the genetic erosion of forages in Kenya by Dr K M Ibrahim shows the influence—direct and indirect—of the seed trade on erosion. In 1979, Ibrahim warned of the imminent risk of losing essential forage legumes in Kenya. He said that collection work had favoured the gathering of forage grasses leading to the neglect of Kenya's forage legumes. 'This emphasis,' he wrote, 'was compounded by the establishment of a seed industry in Kenya which found grasses much easier to handle than legumes, and the export market at the time was higher for African grasses than legumes. The seed industry concentrated on only a few species, which were largely adapted to the better watered, more fertile regions of the tropics.' [17] Thus, the industry biased the conservation drive for its own interests and also bred grasses that replaced the uncollected legumes—all for the benefit of an export market.

One of the greatest causes of commerciogenic erosion in Latin America and in other middle-income Third World countries, has been the takeover of national seed companies by transnational seedsmen. Dr James Thomas—formerly with Agriculture Canada and now with a consortia of American universities—identified the problem in Bolivia. Big companies acquire a handful of little companies and then streamline their variety offering so that only the most profitable varieties remain on the market. The de-listed varieties are relegated to extinction.

Reducing competition in the North

This, too, has been the experience in the industrialized countries. In a parallel example to that of Bolivia, Dr Brian Ford-Lloyd (who co-authored the 'Beet in Turkey' report with Trevor Williams of IBPGR) and Peter Crisp described the commerciogenic erosion of vegetables in Italy. The two scientists argue that considerable genetic diversity can still be found in the stocks of small European seed companies but that this situation is changing because 'small companies are rapidly being taken over by larger, often international companies which are more interested in supplying varieties acceptable over a wide area, with the result that local types are superseded'.[18] To prove their point, Ford-Lloyd and Crisp searched through 30 family-owned seed houses in Rome and Naples and came up with a hundred samples of cauliflower, broccoli and red beet 'almost all of which', they added, in response to the companies that claim everything is collected already, 'were unobtainable in gene banks'.

The EEC provides a horrific example of how corporate 'rationalization' of their seed catalogues can destroy genetic diversity. Early in the 1970's Common Market agriculture ministries agreed that a 'Common Catalogue' of all the marketable seed varieties of regulated agricultural and horticultural crops should be produced for the greater edification of Common Agricultural Policy (CAP) farmers. Most governments maintain their own National List of acceptable varieties (usually a 'merit' list guaranteeing the quality of the varieties, so that they amount to a licensing system for these varieties and, in most cases, only those varieties on the National List may legally be sold in that country). Thus the task of creating a Common Catalogue was originally envisaged as a matter of simple collation. The advantage of the final catalogue was seen to be that, normally, all varieties would be available to all member countries. Only listed varieties, however, could be sold to farmers.

Problems were not long in appearing. Companies complained and bureaucrats agreed that a single variety often bore different names in different countries and even in the same country. To produce a usable Common Catalogue, it would be necessary to reduce the number of synonyms leaving each variety with a single name. In the case of vegetable seed, officials realized that the task of deleting synonyms was enormous. The only way to ascertain that two different 'brands' were actually the same seed would be to put all the varieties through a two or three-year grow-out trial. The costs would be staggering. The alternative solution would be to invite the seed companies to 'confess' that all the different brand names were actually the same variety. This route was adopted with enthusiasm and EEC officials were delighted to find that the companies responded to the Brussels appeal with whole-hearted generosity. The lists of synonyms began to pour in.

After a number of technical delays, Brussels declared that 1,547 'synonyms' covering 23 vegetable crops would be banished from commerce forever on the 30th of June, 1980. The initiative was seen as a move in favour of 'consumer protection' since CAP farmers would now be saved from a bewildering array of brand names signifying nothing and since they would now have access to the same varieties from Scotland to Sicily.

Table 33 Commerciogenic erosion and the EEC Common Catalogue: Vegetable varieties deleted from the Common Catalogue on 30 June 1980, noting both the number of varieties to be deleted and the percentage share described by EEC officials as 'synonyms'. [19]

Crop	Total deleted	Synonyms	Synonyms as percentage of total
All 23 species	1547	591	38
Onion	137	41	30
Leek	67	19	30
Celery	41	28	68
Celeriac	5	1	20
Spinach Beet/Chard	11	7	64
Beetroot	57	31	54
Curly Kale	18	8	44
Cauliflower	275	149	54
Brussels Sprout	112	23	21
Savoy Cabbage	36	27	75
White Cabbage	185	88	48
Red Cabbage	30	21	70
Kohlrabi	15	8	53
Turnip	57	24	42
Endive	19	9	47
Melon	36	5	14
Cucumber	70	10	14
Gherkin	21	1	5
Lettuce	1	0	0
Parsley	41	23	56
Radish	66	29	44
Tomato	171	18	11
Spinach	76	21	28

Europe's gardeners and farmers began to show some signs of doubt that Brussels and the seedsmen were cooperating wholly to the benefit of those who have to buy seed. In particular, the Henry Doubleday Research Association in England began to look into the list of 'synonyms' about to be dropped. What they read in the computer print-outs caused genuine alarm. Only 38 per cent of the proposed deletions were actually identified as synonyms. The remainder were slated for removal because companies claimed they were no longer economic. The Henry Doubleday people were not convinced that this was sufficient reason for extinction.

Even among the so-called synonyms, there were a huge number of unanswered questions. There was, for example, the Bedfordshire Champion onion which was presented as being the synonym of Up-to-Date—even though a British Government publication had long before described one as resistant to a disease while saying the other was susceptible to the same disease. Among the Savoy Cabbages, 11 synonyms of the variety Ormskirk are identified, as well as seven synonyms of Alexander No. 1. Yet another synonym known as Late Market is granted the remarkable status of being a synonym to both Ormskirk and Alexander No. 1. This is not easily accomplished. Two white cabbages, one named Exter and the other Gemeni, are both listed as synonyms of Primata. Since Exter is a hybrid, this seems particularly difficult. The confusions are almost endless.

The creation of the Common Catalogue took place at a time when European seed houses were literally being gobbled up by transnational corporations. As we have already seen in the case of Bolivia and Italy, these take-overs are accompanied by reductions in the catalogue offerings of the acquired companies. Brussels offered the new seedsmen a golden collective opportunity to not only 'rationalize' their own offerings but to get rid of the low-profit competition offered by non-hybrid or nonproprietary varieties: Europe's traditional cultivars that belonged to no one. With the stroke of a pen, over 1,500 genetically-diverse vegetable varieties were turned into 'synonyms' and thrown out of the market.

This point needs strong emphasis: companies have no choice but to regard traditional cultivars as 'competition' to their hybrid or otherwise proprietary (via PBR) varieties. With 'consumer protection' legislation like the Common Catalogue (and/or by many other means), the major companies will always strive to eliminate this competition. The result: commerciogenic erosion.

The debate at international level

The IBPGR position

The link between PBR and genetic erosion has inspired an intense international debate. Very surprisingly, the Secretariat (but not the Board) of IBPGR has been in the forefront of those anxious to disclaim any connection between the two issues. In 1980, IBPGR hired Dr K S Dodds (the same Dodds who was later hired by FAO as a consultant to draft background documents on Resolution 6/81) to prepare a paper on the issue for the Board. Dodds' conclusion: 'When emotive issues are put aside, there appear to be no hard facts to support the contention that Plant Breeders' Rights do or will hinder the conservation of plant genetic resources.' [20] Since the Dodds paper was unsubstantiated by interviews or data, IBPGR's Lennart Kåhre urged that a more thorough paper be prepared in time for discussion at the Board's next session in February 1981. Ewert Åberg, Kåhre's colleague at the Swedish University of Agricultural Sciences, submitted his study a few weeks before the Board meeting. Åberg, perhaps due to the shortness of time, relied almost entirely for his information on a single UPOV newsletter which, in turn, reported on a UPOV-sponsored symposium on the issue held a short while before. Undaunted by his data problems, Åberg summarily dismissed all of what he described as the 'commercially-influenced negative view' in a single paragraph. [21]

Despite the two papers, the Board discussion did not go well for the Secretariat. The hope had been to push through a statement that would enable IBPGR to publicly condemn the PBR/erosion link. Dr Bommer (FAO's Assistant Director-General overseeing this area and a staunch supporter of PBR as he knows it in Germany) was brought in especially for the discussion and led the push for a statement. Among those in strong opposition was the Director of the Indian Agricultural Research Institute, Dr H K Jain. In the final analysis, no consensus was achieved and the Secretariat was left unable to officially attack the connection between PBR and erosion. This has not prevented Dr Williams, the Executive Secretary, from doing all in his power to support PBR at every opportunity.

FAO—looking for a place to hide

As an intergovernmental organization, FAO has no formal position on the PBR/erosion link. However, when the issue was first publicized by the Saskatchewan Council for International Cooperation in a 1978 paper, irate seedsmen demanded that FAO's Director-General publicly disassociate the organization from the views expressed in the paper. [22] In March 1979, the British Association of Plant Breeders put their demand in writing. Within a month, Dr Oscar Brauer of FAO replied on behalf on the Director-General, noting that 'the views of the Saskatchewan Council for International Cooperation on Genetic Conservation do not differ significantly from those of the Organization'. [23] At the end of 1979, following the publication of *Seeds of the Earth,* FAO indicated its general support by contracting with ICDA to do follow-up work on the responses to the book from the South.

Then, in February 1980, FAO went a step further and produced a policy guideline memo, circulated to all department heads, dealing with the relationship between UPOV and FAO. Not a response to outside pressures, the memo was occasioned by a row between FAO's forestry section and UPOV over their different botanical and legal descriptions of the poplar tree. After a frustrating encounter in Lisbon, Dr L E Huguet of the forestry section insisted that FAO formulate a policy guideline on PBR and UPOV. The memo was hashed out over several months of interde-

FAO OFFICE MEMORANDUM

TO: Mr. L.E Huguet
Director, FOR

DATE: 28 February 1980

FROM: Declan J. Walton
Director, IAA

IL 3/3

SUBJECT: Cooperation with the International Union for the Protection of New Varieties of Plants (UPOV)

Please refer to your office-memoranda of 26 October 1979 and 9 January 1980 on the above matter.

Problems related to the determination of policy guidelines for FAO's co-operation with UPOV were discussed with representatives of AGP, FOR and LEG at a meeting organized by IAA on 16 January and the following position was agreed in principle:

1) It is a well-known fact that plant breeding in the last decade is being increasingly carried out by commercial enterprises, with the growing participation of multinational companies. Considerable financial and technical potential is nowadays a characteristic of the private sector in the plant breeding business, paralleling a situation that already exists in the industrial and other sectors of the economy. It is obvious that the tendency of growing participation of the private sector in plant breeding will continue in the future and it is imperative for FAO to study this process and its consequences on the world's agriculture and to develop an appropriate modus vivendi with it.

2) UPOV is a union of countries (having a sophisticated plant breeding structure and legislation) one of whose aims is to promote progress in plant breeding by allowing plant breeders (or, in practice, commercial plant breeding enterprises) a monopoly under which the latter's authorization is normally required to the production (in the country concerned), for purposes of commercial marketing, of the propagating material, as such, of new varieties created in the enterprises, and to the commercialization of such material. The monopoly is limited to the country which granted it, is for a limited period (around 20 years) and does not extend to the production of plants from a protected new variety or to the sale of those plants. The membership of UPOV consists mainly of developed countries.

3) Results of plant breeding activities in the commercial sector can certainly contribute to speeding up the process of creating new promising plant varieties and are, as such, an undeniable factor of scientific and technical progress in agriculture. Therefore, they deserve our attention to the extent that their application may contribute greatly in solving the problems of hunger in the world.

4) While UPOV may promote progress in plant breeding in certain cases, and has no direct effect on plant breeding in developing countries other than its already recognized tendency to encourage private sector activities at the cost of a corresponding reduction in the public sector, there is a possibility that it can indirectly exert a negative influence on the development of plant breeding in the world as a whole, and be detrimental for developing countries in particular.

In fact, the growing concentration of plant breeding in the private sector has already demonstrated some negative effects. Among those are to be noted, for example, the increased cost of development

Document 2 Cooperation with the international Union for the Protection of New Varieties of Plants (UPOV) (Text re-typed from copy of original) programmes linked to increased cost of seed and related inputs, the use of marketing techniques inappropriate in developing countries, which have led to grossly unbalanced agricultural inputs, and the not infrequent cultivation of high-return plantation crops on top-grade food-producing agricultural land owned by multi-national companies and intended for foreign markets.

Furthermore, since the germplasm of most of the world's important crops originates in developing countries, while most plant breeding, particularly sophisticated private sector production of new varieties, is conducted in developed countries, in an increasing number of cases developing countries have been required to pay royalties for varieties, the germplasm of which originated within their own borders.

Finally, it may be noted that the commercialisation and the subsequent commercial competitiveness resulting from the system of plant breeding encouraged by UPOV has led to intensive breeding of new varieties on a limited genetic base, resulting on several occasions in widespread disease epidemics.

There is also the recent experience of difficulties encountered between UPOV and the International Popular Commission in reaching agreement in procedures for the registration of popular names.

5) UPOV administers an "International Convention for the Protection of New Varieties of Plants" providing for the granting, in its member countries, of the rights referred to in paragraph 2 above, concerning the commercial marketing of new varieties. While the Convention may have been established to protect the rights of plant breeders, it has in fact contributed to an excessively monopolistic atmosphere in plant breeding in developed countries which has had negative effects on the complex structure of international plant breeding. An important example of such negative effects recently encountered by FAO and the UN System has been the restriction of the free exchange of some categories of germplasm.

6) The possibility that UPOV may be promoting the negative effects referred to above is of serious concern to FAO. Developing countries are (and will remain such for a long time) net importers of technology and this includes plant breeding techniques, seeds, etc. which are among the most important components of modern technologies, aiming at breaking the vicious circle of food, feed, fibres, wood, etc. production. FAO has to defend their rights and an adequate policy should be followed in this respect.

7) It would not seem advisable at this stage to develop elaborate general policy guidelines regarding FAO/UPOV cooperation and a more flexible, ad hoc position should be preferably taken by units (AGP, FOR and others) in cases of cooperation with UPOV, i.e.:

a. FAO's participation, in observer capacity, at various UPOV's meetings should be encouraged in order to follow developments closely. Our participation in technical matters is important, but our contribution should avoid any impression that we support or sponsor UPOV's activities in toto. FAO's staff participating at these meetings should be thoroughly briefed by the respective units in FAO.

b. At these meetings, when there is a need, our representatives should explain that FAO is defending the interests of developing countries and point out any aspects of items under discussion which might damage the interest of developing countries.

c. The details of cooperation of FAO with UPOV in concrete cases should be decided in respective departments and divisions.

partmental discussion and was finally distributed by the Director of the Inter-Agency Affairs branch.

The memo could hardly have been more critical. FAO warns that PBR can lead to a decline in public breeding and that it can have a negative effect on plant breeding world-wide. Attacking transnationals for increasing costs and for 'grossly unbalanced' agricultural inputs, the memo adds, 'in an increasing number of cases developing countries have been required to pay royalties for varieties, the germplasm of which originated within their own borders'. Finally FAO adds that PBR, under UPOV, 'has led to intensive breeding of new varieties on a limited genetic base, resulting on several occasions in widespread disease epidemics'.

One year later, Dr Bommer was supporting PBR at the IBPGR Board meeting and Trevor Williams—as an FAO representative—had already told a UPOV symposium that FAO had no official position but that the Organization could see how UPOV might be of help to agricultural development. FAO's confusion and ambiguity continue to this day.

The IARCs—taking a stand

Even as IBPGR, the CGIAR institute for gene conservation, was pushing for a policy in support of PBR, CGIAR's Green Revolution institutes were moving towards a policy of opposition to PBR. To be sure, the move was painfully slow; but it was also more thorough and more open.

PBR had been a 'hot' topic among the IARCs since at least the mid-seventies, when Norman Borlaug and Glenn Anderson of CIMMYT began to comment publicly on the barriers PBR was creating for the exchange of germplasm. When the wider debate arose at the end of the seventies, Centre Directors called for a CGIAR study of the implications of PBR for their work. This study was finally produced—after several drafts—at the time of FAO's 21st Conference session in November 1981. Co-authored by three well-regarded Dutch specialists—a lawyer, the head of the Government's PBR office in Holland and a Deputy Director of Agricultural Research—the report concluded: '*As a rule the infrastructure and requirements in developing countries are still such that PBR in the sense of the UPOV convention can at present serve no useful purpose** ...' [24] Despite this criticism of PBR, the thrust of the paper does not give support to the PBR/erosion link.

The connection was made in a report commissioned by the International Development Research Centre (the Canadian Government's institute that relates to CGIAR). The study's two authors identify much more closely

* Their underlining

with the Third World perspective than do their Dutch counterparts. In a paper that is extremely critical of PBR, the authors conclude that 'PBR will increase the possibility of *genetic wipe-outs.** PBR, while not the sole cause, will contribute to the degree to which genetic diversity will be eroded'. [25]

It remained for the IARC Directors themselves to make the most significant statement on the issue. Dependent as they are on funds from a handful of donor countries in the North—most of whom have PBR laws and many of whom are embroiled in some local debates about these laws—the IARCs were obviously reluctant to make any statement that would place them at odds with their bankers. That they did so, is enormously to their credit. Meeting at CIMMYT in June of 1982 they offered one crucial sentence in a much longer discussion critical of PBR: 'The Centre Directors recognized that the introduction of PBR may entail some danger of genetic erosion'. [26] It is noteworthy that IBPGR's Executive Secretary was not included in the statement.

Searching for solutions

The seed industry has responded to public criticism with a glossy multi-language publication entitled *Feeding the 5000 Million.* [27] Trading heavily upon scientific developments engineered by the IARCs, the propaganda piece attempts to present the industry and PBR as the front-line defense against global starvation. It implies that critics of PBR would prefer to force the Third World to stick with their traditional cultivars and crops as a protection against genetic erosion without showing any concern for the human erosion that would result: conservationists are willing to let the poor starve for the sake of plants. The threat of the 'population explosion' is again used as a justification for draconian measures that may in the end advance the plant breeders much more than the peasants or the plants.

This is hardly a reasonable analysis of the issues at stake. Every farmer should be able to grow the seed she or he wished (even if somebody has an exclusive patent on the variety). Every government has to make its own development decisions. But it is to the benefit of both North and South that the decision to introduce a new variety be made on the basis of two careful observations: (1) the effect it will have on other botanical resources and whether or not these other resources are conserved; and (2) the comparative quality of the new variety to the ones it will supplant.

* Their underlining.

The notion of environmental impact studies is well accepted in many countries in the mining and heavy industry sector. Yet agriculture has done more—by far—to restructure our environment than any other sector. Third World governments should work with UN agencies, bilateral aid programmes and, where appropriate, private companies to ensure that such studies are part of the 'package' offered with the new seed. Conservation agencies such as IBPGR should be informed when planning is underway to introduce a new variety. They may wish to launch an emergency collecting expedition. Wherever possible, individual farmers or local villages should be offered an honorarium to conserve small plots of the retiring cultivars. This is not a solution to genetic erosion of itself, but it make a very real difference in the future.

The actual merits of the landrace about to be replaced may well be unrecorded. It would not be surprising if the old cultivar had superior qualities to the new variety. This should be known before planting. It is by no means always true that the well-promoted superseed from the North will out-perform the well-adapted landrace already freely available. Quality test trials must be an important part of any plant introduction strategy.

A note on the role of NGO's

Much more remains to be said in this area. At this point, however, it is essential to emphasize the often important role played by Non-Governmental Organizations (NGOs) in the voluntary sector. Church and secular NGOs in the North often have an influential place in introducing both new varieties and new crops at village level. Because they are non-profit-making and essentially 'grassroots', they can wield considerable power in farmer decision-making. By and large, these NGOs do not pay close attention to their seed-introduction responsibilities. Environmental-impact studies are virtually unheard-of. They are often unaware of the nutritional value of local vegetables and unhesitatingly import the seed of other species. Since they sometimes canvass seed houses in the North for free or cheap seed, cost may play too important a role in their decision-making and they may sometimes be acting more in the interests of certain companies than of their cooperants in the Third World. For all of these reasons, NGOs could and should take a lead role in turning seed introductions around for the long-term benefit of the farmers.

The Connection between Chemicals and Seeds

Plant Breeders are looking for three main qualities in new varieties: increased yield; greater suitablility for mechanized farming and processing; and better resistance to pests and diseases. It is very difficult to achieve all three and the one most readily sacrificed those days is resistance to disease. This is partly because the other two qualities, once bred into the variety, tend to stay there, whereas resistance can be overcome by a new strain of a disease or pest; and partly because plant breeders know that if they cannot achieve improved resistance, they can rely on the availability of pesticides ...'
The Influence of Environmental Protection Measures on the Development of Pesticide Production and Consumption, UN Economic and Social Council (Economic Commission for Europe), 1982, p. 83.

The connection in the laboratory

If a chemical compound won't cure cancer, it might wax a car, de-lice a cat, froth up a beer or rid a sorghum field of Johnsonsgrass. Sometimes, a company can strike it lucky with a combination that can do a whole range of chemical chores. So it has been with Ethylene Dibromide (EDB). While its first use is as a 'scavenger' in leaded petrol, EDB also serves as an intermediate in the pharmaceutical industry, acts as a solvent for gums and waxes and does increasing duty as a fumigant for grain and fruit. Sad to relate, this ambidextrous little blob of molecules may also be carcinogenic.

EDB is just one example of why chemical companies branch out into a host of related fields. Many of today's leaders first began in the dyestuffs industry of the last century. They were part of the colonial pursuit of the indigo plant and they branched out from there to mulberries and other plants and coal products in search of new and better dyes. From plants for dyes, it was a short step to plants for gums and waxes. The dyestuff enterprises began to harvest guar in Bangladesh and African copal from Zaire. In 1935, it was the experimentations of a Bayer chemist with red dyes that led to the modern pharmaceuticals industry.

Plants—often exotic plants—continue to be an essential part of the industry. Nine years ago, claims a study by the US National Research Council, the retail value of plant-derived drugs in the United States was US $3 billion. According to Bayer officials, of the 8,742 entries in Germany's pharmaceutical 'Rote Liste' for 1982, 1,251 drugs were derived totally from plants. While this may be less than 15 per cent of all medicines, Bayer hastens to add that 40 per cent of the global turnover in the industry is based on plant material and in such areas as antibiotics and laxatives,

Table 34 Branching out: drug companies in agriculture

Pharm. co.:	Pharm. rank	Pest* rank	OTAF** rank	Pat. no.	Seed cos.	OECD*** var.	US PVPA**** no.
Bayer	2	1	3	281	1	—	1
Ciba-Geigy	4	2	2	309	26	76	4
Hoechst	1	11	18	52	1	—	—
Sandoz	7	19	45	25	34	172	74
Upjohn	18	—	15	72	11	52	101
Pfizer	8	—	90†	11	30	142	6

This table does not include intermediates in the drug industry.
* 'Pest Rank' indicates sales volume as determined by OECD.
** 'OTAF' is the US Patent Office study of all herbicide and fertilizer patents in force in USA at end of 1981.
*** 'OECD Varieties' indicates number of cereal or sugarbeet varieties listed for firms by OECD in 1980.
**** 'US PVPA No.' indicates number of patents held by firms under the US Plant Variety Protection Act in 1982.
† In 1982 Pfizer and Dekalb combined their genetics operations.

the plant connection rises to 90 per cent. Officials at Sandoz report that the company runs collection expeditions in Africa, South America and Papua New Guinea in search of medicinal plants.

Some companies have already run into the politics of germplasm control and have opted to grow their own rather than depend on overseas collections. Eli Lilly avoided a periwinkle embargo a few years ago by developing their own crop. The periwinkle is useful in the treatment of some cancers.

From their work with plants, it was not difficult for chemical/drug companies to grasp the logic of their involvement in pesticides. The development of any new product involves painstaking searches through virtually thousands of chemical combinations. To include pesticides in the corporate repertoire was partly a matter of adding some new questions to the compounds checklist. However, since an increasing share of the raw materials load in pharmaceuticals and other chemicals was being taken up by 'synthetics' drawn from the petroleum industry, major petrol—now petrochemical—companies became involved as well. Within a short period, the world's top pharmaceutical houses had also become the world's leading suppliers of agricultural chemicals.

At the beginning of the seventies, a number of factors propelled chemical firms into seeds. First, the houses had money to spend on acquisitions and the economic environment around 1970 was conducive to mergers.

Second, the costs of bringing new drugs and pesticides onto the market were sky-rocketing due to increased public health and environmental protection concerns. The easy victories of the fifties and sixties were ebbing and the struggle to find new compounds was growing harder. Third, many of the major patents won in the fifties were dying out and some top companies were buying other firms in fear of losing their profitability. Finally, agriculture and land have always been seen to be a relatively safe investment since people always need more food and since land prices tend to remain fairly secure even in poor economic times. With these concerns in mind, chemical firms bought out large areas of farm land in North America and moved aggressively into produce marketing. In November 1970, *Businessweek* asked, 'What has household bleach to do with lettuce patches? What have man-made fibers to do with raising hogs, or chlorinated solvents with catfish farming? Not much. But a growing list of US companies based in chemicals and allied products are venturing back to the good earth ...'[28]

American business journals failed to note, however, that many of the companies were actually buying out seed houses. In 1970, Purex bought Ferry-Morse, ITT bought O M Scott and General Foods bought W Atlee Burpee (Purex later sold to Limagrain and General Foods later sold to ITT.) In Europe, KemaNobel of Sweden was beginning to eye the seed industry—as was Sandoz of Switzerland. BASF was already into breeding in Germany.

Seeds offer the petro-chemical complex a number of opportunities. Both plant breeding and chemicals involve the same kind of intensive research and sifting through thousands of possible combinations. As of 1970, a global patent-market for plant varieties appeared in the offing. Chemical firms have always placed great store on patent protection. And then, if governments became so hard on pesticides as to harm profits, the future would swing to improved seed varieties. The less farmers use chemicals the more they will have to buy seed. Finally, the companies could see no way in which the environmental movement could harass them in the seeds business.

The decision to move from pesticides to seeds was entirely practical. After all, both products could travel the same distribution route and there might even be economies in advertising.

The assumption behind the trend [of take-overs by chemical houses] is that the new owners can improve the plants' resistance to the herbicides and pesticides that the parent company sells.
Thomas N Urban of Pioneer Hi-Bred in an interview, *New York Times*, 5 May, 1981, p. D2.

The connection in the field

It stood to reason, too, that chemical companies would move their most experienced personnel in to take charge of their new seeds subsidiaries. Often the agro-chemicals and seeds ventures were grouped within the same corporate division—or seeds were actually placed inside the agro-chemicals programme. Union Carbide moved its top man in pesticides over to take charge of seeds. Shell Oil made its agro-chemicals boss the head of its Nickersons Seeds subsidiary. It made sense: but it also meant that the people 'calling the shots' over plant breeding R and D were people more experienced with and oriented to pesticides R and D.

Relying upon their past knowledge, KemaNobel—one of Europe's leading suppliers of fumigants for fruits and vegetables—naturally bought out Europe's leading garden seed companies to become the continent's number one retail seedsman. In the same logical way, Reichold Chemicals—a supplier of pesticides for lawns and gardens—acquired lawn and garden seed companies in the United States. When Stauffer Chemicals looked into the seeds business, it made perfect sense for a company with a strong position in maize pesticides to merge with maize seed companies: it bought three. Likewise, when Ciba-Geigy cast about for companies to buy in 1974, it hit upon Funks Seeds. Ciba-Geigy was the dominant maize pesticides firm in the United States and Funks ranks among the top maize breeders in the same market. There was hardly any surprise when Celenese bought out Harris Seeds and other garden seed houses. After all, Celenese is a major provider of seed coatings for the same breeders.

It was not long before all this business logic led management to some other conclusions. Corporate directors were becoming aware that there were ways they could make money in the seeds business beyond the reach of traditional breeders. To be more specific, chemical firms can profit by:
1. *Coating seeds* with chemical protectants (fungicides etc.) so that farmers and gardeners buy the seed as a package deal thereby increasing the use of company chemicals;
2. *Designing advertising packages* promoting specific varieties and the company chemicals that can be used with those varieties so that more product is used at less marketing cost to the company;
3. *Dove-tailing pesticides* and seeds research and producing compatible seeds/biocides that might even 'need' each other.

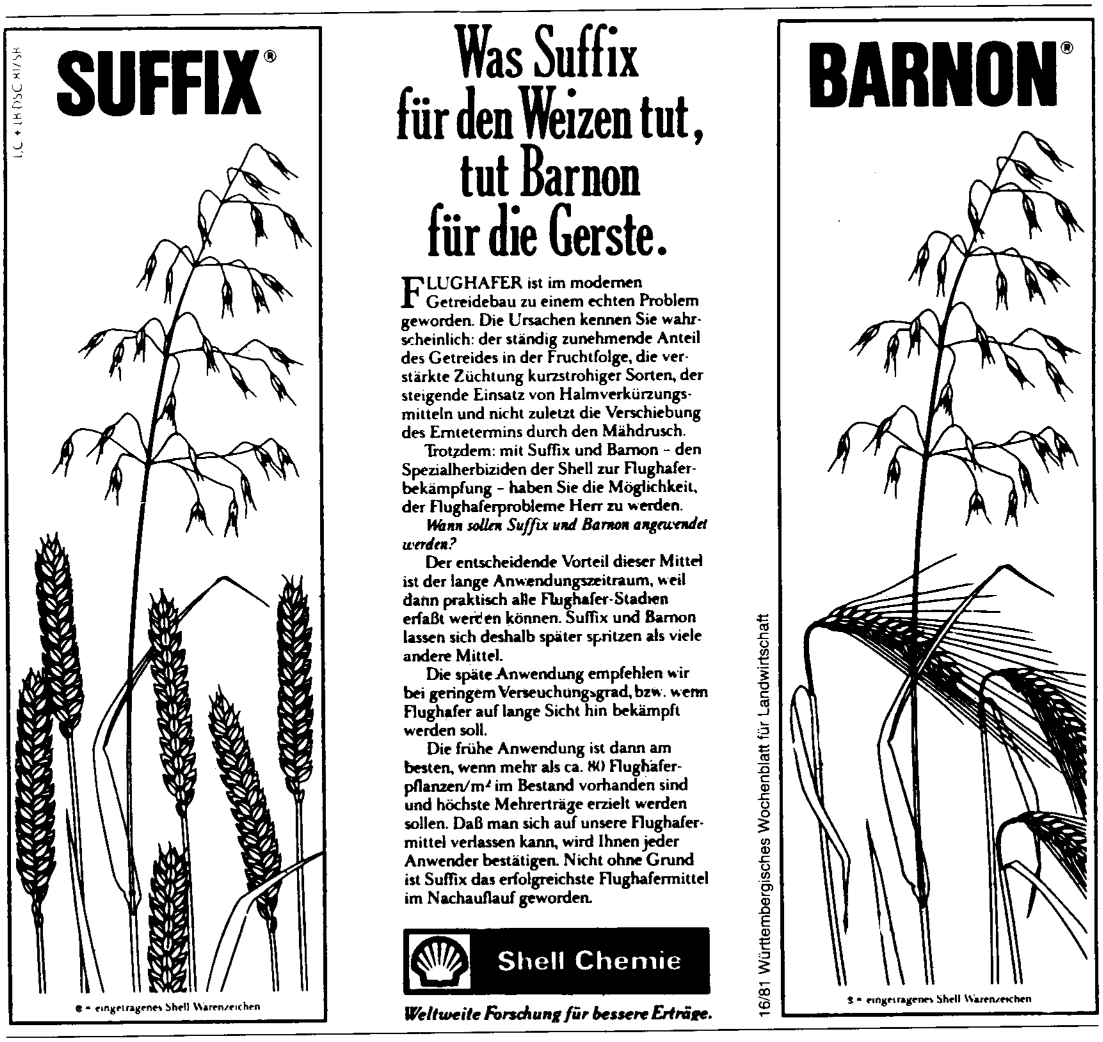
Seed coating and seed pelleting are becoming a standard practice in many major crops. In the case of seed pelleting, the primary objective is to make seed a uniform size for seed drilling. Increasingly, fungicides and plant growth regulators are added to the passive clay-base of the pellet in order to give the seed a 'head start' in the field. On the heels of seed pellets have come seed 'coats' or 'dressed' seed. The purpose is strictly to 'safen' the new plant against unwelcome intruders in the soil. In 1983, for example, it is even possible to buy fluorescent maize seed (allowing farmers to plant at night under the glow of their own seed) wrapped in a swarm of special chemicals protecting it from everything from rot to weeds.

For farmers, the advantages can be considerable—if they want the chemicals in the first place. Theoretically, farmers can reduce chemical costs and be more efficient with what they do use. At least 'obvious' environmental and health risks are reduced since there is no spraying. Those with less confidence in the transnationals, however, might suspect them of using this method to increase the use of their chemicals and to force farmers into a system where they must have chemically-wrapped seeds.

The opportunity for advertising packages has also proven irresistible. In the United Kingdom, Shell is not only the largest private breeder of cereal varieties but it is also a major marketer of proprietary pesticides for cereals. Beginning in the 1980's, Shell has developed information booklets accompanying the purchase of its proprietary seed advising the buyer of the various chemicals that may be used with the seed. Exact details on rates of use and timing are provided. It should be pointed out that Shell does refer to the products of other companies—but it must be also added that its competitors are not thrilled with Shell's strategy.

In Germany, Shell has gone the direct route. Where once it advertised its maize varieties separately from its maize herbicides, it now combines the two products in the same advertisement.

The chemical companies once claimed that they kept their pesticides and seeds branches at arms length. That is no longer the case. If you want Nickersons' patented seeds in South Africa, talk to Shell Chemicals in Johannesburg. For Nickersons' vegetable seeds in the West Indies, contact Shell Petroleum in Jamaica. Nickersons' 702 maize hybrid can be obtained in Greece through Shell Chemicals (Hellas) Ltd., or in Italy via Shell Italia. But for news on its hybrid wheat programme, contact Shell Development Corporation in the United States.



Document 3 The Shell game

Perhaps the most exotic profit centre for the chemical seedsmen lies in the 'dove-tailing' of pesticide and seed R and D programmes. The trend in this regard was publicly conceded by Thomas Urban of Pioneer Hi-Bred in a *New York Times* interview two years ago. Urban's example of this orientation was Ciba-Geigy's 'Herbishield'. The company has wrapped its proprietary grain sorghums in three chemicals: two are to protect the seed from the encroachment of grasses while the third is present to protect Ciba-Geigy's seed from Ciba-Geigy's leading herbicide—Dual. Dual is normally toxic to grain sorghum. The entire package allows Ciba-Geigy to sell more Dual.

In the North, such 'dove-tailing' is alarming. In the South, it can be disastrous to peasant economies. According to Silvio Bertalomi of Zurich Television, Ciba-Geigy has already attempted to market this package in the Sudan. Sudanese officials tell us that they have now refused the deal.

The easiest route to profits

The disadvantage to all the strategies cited above is that they all require time and money. However, if a company is both the supplier of patented

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7/83 Württembergisches Wochenblatt für Landwirtschaft

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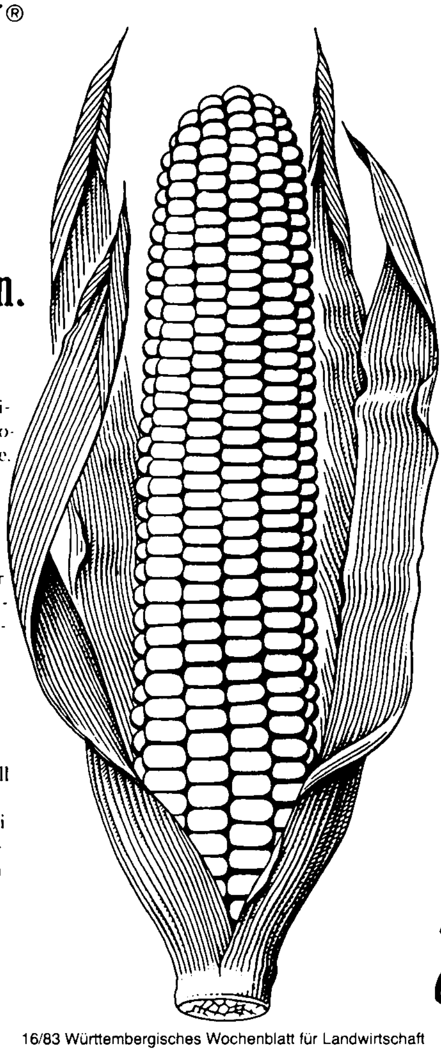

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16/83 Württembergisches Wochenblatt für Landwirtschaft pesticides and patented seed for a crop in a given market area, it may be faced with an interesting choice: when disease attacks the crop (as it inevitably will) the company can either opt for a plant breeders' solution and breed around the new disease—or it can opt for a pesticides solution and refer farmers to the chemicals on the shelf. In short, it can make money by doing nothing at all.

This likelihood was inadvertently identified by the Economic Commission for Europe in its 1982 study of the chemicals industry. The ECE noted that breeders had three objectives: yield; machine harvesting and processing; and disease resistance. It added that breeders were happy to 'sacrifice' disease control where pesticides were available. If the breeder is also the pesticides manufacturer, that 'sacrifice' hardly hurts at all.

The chemical breeders have been with us for less than a decade and it is still far too early to assess the implications of their involvement. It takes at least eight years to bring a new pesticide to market and as long or longer to develop a new variety. The real impact of the linking of these two major agricultural inputs will not be clear until the 1990's—when it will be too late.

Nevertheless, there are some marginal indications of the kinds of problems that can arise. In the United Kingdom, for example, officials at the National Institute for Agricultural Botany (NIAB—a semi-governmental regulatory agency) have been concerned that barley yields have tended to lag behind gains made in wheat yields. One 1978 study[29] notes that the two crops increased apace until about 1967 when barley fell behind. The study goes on to say that the crop has suffered from severe disease problems. The impact of those problems—according to the NIAB—is a rapid turnover of new varieties in the market and an increase in the use of fungicides and other chemicals. The NIAB attributes some of the problem to a simplistic orientation in plant breeding that almost guaranteed that varieties would be overturned by disease within three or so years. Until quite recently, wheat varieties remained largely in the public breeding domain in Great Britain while barley breeding has been controlled by the private sector. The leader in barley seed has been Shell Oil—also a major supplier of barley chemicals.

Shell cannot be blamed for the whole problem, however, since the trend was well-established among private breeders before the chemical company became involved. Nevertheless, a rapid turnover in varieties and increased chemical sales are obviously the stuff of profits.

A year after the NIAB study, the Office of Technology Assessment (OTA) of the US Congress produced a report on pest management strategies that was far from complimentary to the seed trade. It noted an increase in disease and/or pest problems in the American wheat and maize crops on the Great Plains. The report lays some of the blame at the doorstep of state research institutes that have pulled out of some breeding work, as the OTA says, 'on the assumption that commercial seed companies could do the necessary work to maintain and increase pest resistance. Experience indicates that this was not a correct assumption'. The same report adds, 'commercial seed companies have also de-emphasized efforts to incorporate insect and even some disease and nematode resistance into new cultivars'.[30]

The move to greater chemical dependence is clearly underway. Of the 762 mergers or expansions we have found in the seeds industry since about 1970, at least 246 have been brought about by chemical companies. Ciba-Geigy markets at least seven maize herbicides in North America along with its numerous maize varieties. Along with its cotton breeding work, the company markets at least three cotton insecticides and herbicides. Along with its new wheats, Monsanto can offer Avadox, Round-up, and Barran chemicals. Sandoz has a number of vegetable herbicides to go with its vegetable seed and Shell—in conjunction with its North American partner, Olin—seems to have chemicals for virtually every crop in which it does breeding work. Even Upjohn is now developing new pesticides and biological control agents through its own agrochemical subsidiaries for one of its major breeding crops: soyabeans.

Scientists at Ciba-Geigy and Sandoz personally resent any suggestion that they would be a party to a deliberate decline in disease-resistance work in plant breeding. Some have bluntly said that they would quit before accepting such a situation. There is no reason to doubt that this is the case. At the same time and in the same discussion, however, the same people could see situations arising where adverse economic environments would force cut-backs in breeding programmes. They could also visualize pressures to bring new varieties to market quickly and R and D leaders being forced into situations where they would have to allow a variety to go ahead 'early' knowing—as the ECE says happens already—that there is a chemical on the shelf to protect the seed.

The implications for society

OXFAM's David Bull has estimated that 375,000 Third World peasants become ill every year from pesticides—and that 10,000 die. When pesticides and seeds start living together farmers and consumers—South and

North—had better be concerned. Seed coatings are becoming commonplace in the North and not so rare in the South. Sometimes 'old' seed with dubious germination capabilities winds up, all dressed, in Asia or Africa where the chances are even as to whether the little pellets will go into the soil or directly into someone's stomach. With cereal seed, the means of production is also the end product for consumption. People have been known to die.

There are other reasons to worry. The seeds/chemicals connection poses significant nutritional concerns. A 1977 report by Canada's agricultural department claims that human nutritional requirements—our demand for higher quality foods—increase with the use of pesticides since the body must strive to detoxify the alien substances.[31] Researchers at the International Seed Pathology Institute in Copenhagen add to this news, reports that the level of microtoxins in HYVs may be increasing at an alarming rate. In fact, the chemical breeders have pushed nutrition into the realm of a non-factor in their breeding strategies as they work to meet the legal requirements for plant patenting. In the early seventies, one industry survey in the United States argued that only one or two breeders actually had facilities for determining the nutritional merits of their new varieties. Maybe now it takes two apples a day to keep the doctor away.

The immediate problem, however, is that the world can simply not afford to have two major agricultural inputs in the hands of one industry. The risks for the food system and for food security are too great. The economic cost is too high. The environmental and health cost is also too high. Steps must be taken to separate the two industries.

In downtown Kalamazoo, Michigan, there stands a seven-story building erected in 1977 by Upjohn to house its diverse R and D activities. There and in the fields outside town, Upjohn is developing hybrid vegetables as well as hybrid maize, sorghum and soybeans for the animal feed market. Upjohn is also investigating plant growth regulators and, through its TUCO and Asgrow Florida subsidiaries, it develops and markets crop pesticides. In the same building, Upjohn also researches animal growth regulators and a whole range of veterinary medicines and food supplements. Still in Kalamazoo and at the company's Cobb subsidiary, scientists are heavily into hybrid poultry breeding. From egg to Easter dinner, it is conceivable that your bird may never move outside of the range of Upjohn products. And, of course, if all this leaves you feeling a little ill, maybe Upjohn—the drug company—can help out!

As Third World diplomats in Geneva and Rome have been saying, 'Give us this Day our Daily Bread' must not become a prayer to Shell Oil.

Notes

1. Data derived by ICDA from a wide range of corporate information sources.
2. Unpublished draft of May 1983 prepared by the International Council for Law and Development for IDRC.
3. Data derived by ICDA from a wide range of industry sources.
4. Data derived from the OECD Varietal Certification of Seed Moving in International Trade, 1981.
5. Rowe, Frances, 'The colourful world of the packet seed trade', *Agricultural News,* April 1981, p. 35.
6. Groosman, A.J.A., and van den Meerendonk, J.C.M., 'De Nederlandse Zaaizaad sector', Iris-Rapport No. 22, Development Research Institute, Tilburg, Netherlands, June 1983.
7. US Federal Trade Commission, *Competition on Farm Inputs: An Examination of Four Industries,* Policy Planning Issue Paper, February 1981.
8. Groosman, A.J.A., and van den Meerendonk, J.C.M., 'De Nederlandse Zaaizaad sector', Iris-Rapport No. 22, Development Research Institute, Tilburg, Netherlands, June 1983.
9. Derived by ICDA from a variety of industry sources.
10. Data derived from tables provided by North American Plant Breeders' Inc. (A Shell/Olin seed subsidiary) on June 5th, 1981.
11. Letter to Vic Althouse, M.P. Canadian House of Commons, dated 11 May 1981.
12. Morgan, Dan, *Merchants of Grain,* Viking Press, New York, 1979.
13. Data based upon current North American seed prices and FAO data on agricultural production.
14. Letter to Vic Althouse, M.P. Canadian House of Commons, dated 13 January 1981.
15. Data derived from IBPGR Crop Advisory Committee reports and a number of other scientific studies.
16. Williams, J.T., and Ford-Lloyd, B.V., 'Beet in Turkey', *IBPGR Newsletter,* No. 31, September 1975, p. 3.
17. Grubben, G.J.H., *Tropical Vegetables and their Genetic Resources,* 1977, p. 126.
18. IBPGR Newsletter No. 48 'A Different Approach to Vegetable Germplasm Collection' by Peter Crisp and Brian Ford-Lloyd p. 11.
19. Data derived from computerized deletion list provided by the Henry Doubleday Research Association, UK.
20. Unpublished report to the IBPGR Board, 1981.
21. Unpublished paper to the IBPGR Board, 1981.
22. A letter was sent to the Director-General on the 12th of March 1979 by H.W.S. Norvill on behalf of the British Association of Plant Breeders.
23. Letter dated 17 April 1979.

24. Henver, M., Hardon, J.J., Fikkert, K.A., 'Plant Breeders' Rights and International Agricultural Research Centres', A discussion paper, AJD/TAC: IAR/81/25; Rev. 1, November 1981.
25. Dias, Clarence J., and Ghai, Yash P., 'Plant Breeding and Plant Breeders' Rights in the Third World: Perspectives and Policy Options', IDRC Draft Report, April 1983.
26. The Report of the 28th Meeting of the Technical Advisory Committee to the CGIAR, CIMMYT Headquarters, Mexico, 22–29 June, 1982, p. 5.
27. ASSINSEL, 'Feeding the 5000 Million' undated circular which first appeared in 1981.
28. *Businessweek,* 21 November, 1970, p. 30.
29. Silvey, Valerie, *The Contribution of New Varieties to Increasing Cereal Yield in England and Wales,* National Institute of Agricultural Botany, UK, 1978.
30. *Pest Management Strategies in Crop Protection Volume One,* Office of Technology Assessment, Congress of the United States, 1979, p. 72.
31. *Energy in the Food System,* Agriculture Canada, Food Systems Branch, 1977, p. 45.

Patenting the First Link in the Food Chain

From the Papal Garden to the Deacon's Masterpiece

Not the only tool nor indeed the most powerful, PBR is nevertheless the easiest and most immediate tool available to the new seedsmen to allow them to control the marketplace and set the conditions of sale for their exclusive varieties. To understand PBR, it is necessary to understand patents. New legal initiatives may have a profound effect on the ultimate control of the food system.

One must hope that governments of developing countries will, by introducing plant breeders' rights legislation, enable their agriculture to benefit as is happening in the industrialized world.
Editorial, *Span*, Royal Dutch/Shell, 18 February, 1975, p. 45.

Have you heard of the wonderful one-hoss shay,
That was built in such a logical way
It ran a hundred years to a day ...
The Deacon's Masterpiece by Oliver Wendell Holmes [1]

The origin and nature of 'intellectual property'

The notion of 'intellectual property' over inventions is hardly new. The English-speaking world tends to trace the roots of patents to the Statute of Monopolies of 1623 but the Italians can quite properly claim a much earlier history (for inventions in general and agricultural inventions in particular) dating back at least to Galilee and his design for an irrigation device. In the Middle Ages, the concept of intellectual property 'rights' amounted to an injunction by Master craftsmen on journeymen not to use techniques they had observed during their apprenticeship at least until they had settled into their own positions.

What was a practical business arrangement only became a Human Right when the Americans embodied the theory into their constitution and passed the first modern Patent Act in 1790. One year later, the French passed a similar law. From the end of the 1700's to the middle of the 1800's, intellectual property was almost a cause célèbre and European governments raced to introduce legislation. Every major industrializing power except Switzerland put laws on the books.

But opposition to private monopolies runs deep in human tradition as well. As far back as 480 AD, the Roman Emperor Zeno ruled against any effort to monopolize garments or fish or any other material object. Many historians look upon the Statute of Monopolies in seventeenth century England as being an indication of anti-patent opinion rather than support for intellectual property. By 1850, the headlong rush to safeguard the 'rights' of inventors began to be questioned by both economists and politicians. A feeling emerged that the 'rights' of society were being abused and voices were raised claiming that state-granted exclusive monopolies distorted economic choices and actually hindered industrial growth. Others noted that the 'Human Rights' of inventors were, in reality, the restrictive monopolies of private interests. Since every invention is based upon the evolution of wider knowledge within the society, why should one person or company have exclusive control over the utilization of the invention?

In the third quarter of the nineteenth century, an all-out attack on the patent idea led to quite amazing changes throughout Europe. Beginning in 1851, three different British Parliamentary enquiries and Royal Commissions reviewed the patent system and found it wanting. The House of Lords eventually passed a tough bill reducing the life of a patent to seven years and abolishing the 'exclusive' use of any patented invention.

In Germany, Bismarck openly opposed the patent system and led the North German Federation in halting the introduction of a law in that region. In 1863, supported by German trade associations and Chambers of Commerce, the Kongress Deutscher Volkswirte called for the abolition of patents. The Swiss took even stronger exception to patents, having repeatedly rejected appeals for a system among the cantons. In 1863, the government described the idea of patents as 'pernicious and indefensible'.[2] Six years later, the Dutch repealed their patent law, admitting that 'a good law of patents is an impossibility'.[3]

Opposition to industrial patents collapsed utterly, however, at a Patent Congress held in Vienna at the time of the 1873 World's Fair. The turning point came when the industrial powers that favoured patents proposed a type of consumer protection clause in patent laws known now as 'compulsory licensing'. By the inclusion of this clause, the state has the right to intervene where a patent is not being worked or where the royalties charged for the use of an invention are clearly userous. In such cases, the state could force the patent-holder to surrender the invention to those requesting it at a royalty rate determined by the state. This so-called compromise was widely accepted and an international patent convention was prepared and signed in Paris a decade later—exactly 100 years ago.

Since the Paris Union of 1883, the convention has been revised six times. Each revision has extended the exclusive monopoly powers of the patent-holder and had the effect of weakening the impact of compulsory licenses. In fact, most European countries have never—in one century—granted a compulsory license to anyone. A seventh revision of the convention is now underway. This is the first revision undertaken with the active participation of the Third World and the South is far from pleased with the way in which the patent system is used to withhold technology from them. Beginning in the mid-seventies and much supported by the Technology Division of UNCTAD, the Third World has harshly attacked patents in a manner very reminiscent of the battle that took place in Europe in the 1800's. The major difference is that the Third World has a chance to look at a century of experience with compulsory licenses to support their contention that the system should either be abolished or drastically overhauled.

Interestingly, the position of the Group of 77 on the Paris Union for industrial patents was warmly supported by a so-called 'Gang of Six' industrialized countries at their Nairobi meeting in 1981. Canada, Australia, New Zealand, Spain, Portugal and Turkey actually adopted the Third World's position, arguing that they too, as technology-importers, were being harmed by the patent system. In Canada, a 1976 working paper prepared by the Government actually called for a radical revision to the system accompanied by a ten-year review of the impact of the changes. If the review could not show that a patent regime was beneficial to Canada, the government's study proposed that the system be abolished outright.[4]

This tough view of the patent regime is based upon the almost total lack of empirical data substantiating the merits of exclusive monopoly. In the English language alone, a host of university studies, Senate reports, and Royal Commission reviews have all reached the common conclusion that there is no proof that the patent idea benefits society. Despite this, the same studies generally also conclude that the evidence against the patent system is similarly unsubstantiated and, therefore, the system should be allowed to carry on since it already exists.

If the ultimate value of the patent system is questionable, there is no longer any real debate about inventors' patents as a contribution to Human Rights. Modern studies have discounted this notion in the face of the overwhelming control of patents by corporations. The patent is most clearly understood as a form of government subsidy, a state-created monopoly permitting a company to obtain royalties and set the conditions for the use of its invention for a defined period of years.

The debate over patents is nowhere more intense than the point at which it relates to pharmaceuticals and other speciality chemicals. Many governments argue that drug houses use patents as a means of identifying their market territory and as an entrance barrier to new or smaller companies. It was on this assumption that the Canadian Government, for example, drastically revised its compulsory license laws for drugs in 1968 in order to ease the entrance of other companies and to lower prices.

Much more than royalty rates, it has always been the ability of patent-holding companies to use property rights and the threat of litigation (with the huge expenses involved) as a means of defining their 'turf', and the opportunity to determine how and who will have access to a patent, that has made the system valuable to corporations.

The push for PBR

The ink on the agreement forming the Paris Union was hardly dry when Gregor Mendel died. In the 1860's, the Austrian monk pioneered the first scientific work on the laws of heredity that made modern plant breeding possible. Yet even before breeders knew what they were doing, another Gregor, also a priest and also with a garden, had tried to patent the plants in his keeping. In the 1830's, Pope Gregor IV declared property rights over all the plants in the Papal Gardens and in other gardens in the Vatican's dispersed, Italian lands. The attempt was not successful. In the 1860's, even as Gregor Mendel was writing down the results of his fantastic experiments, an American actually did obtain a patent on a process related to his fruit tree. And, in 1877, the German Federation opened up the possibility of plant patents within industrial property legislation. Again, without Mendel, there was no logic to their actions and these lone calls for PBR found no echo.

The rediscovery of Mendel's work in 1900 gave a massive impetus to plant breeding. With it came renewed enthusiasm for PBR. The early interest in PBR arose among ornamental breeders, especially those devoted to roses. French breeders urged their government to adopt legislation. Though willing, Paris found the technical difficulties to be considerable and feared that the patenting of living things would prove incompatible to the patenting of industrial objects. Ultimately, trademarks and other regulatory procedures gave France's ornamentalists some of the patent protection they sought.

In the 1920's, patent lawyers and government departments set to work to bend existing industrial property laws to allow the inclusion of plants. Spain opened a window to floral patents in 1929 but the decisive move took place in 1930, when the American Congress adopted the Plant Patent Act. Only asexually-propogated plants were included (plants not normally sown from seed), thereby excluding vegetables and cereals. The legislative targets were fruits, flowers, ornamental shrubs and trees.

Across the Atlantic, Adolph Hitler almost single-handedly established PBR: in Germany in 1933, in Austria in 1938, and in the Netherlands in 1941. There is little doubt, however, that the Nazi initiative was welcomed by the breeders of these countries (for practical but not political reasons).

Following the War, two concerns converged to stimulate the push for a separated system of plant patents from the industrial system: one concern was that the existing arrangements were proving awkward to manage—a climate of legal opinion was developing against the patentability of plants; the second that the breeders of feed crops were arguing that if patents were a Human Right available to some breeders then they should be available to all. Once again, the push came from breeders in Northern France.

As French seedsmen launched their campaign for an international system of PBR, FAO launched its World Seeds Campaign. Both efforts culminated in 1961: FAO had its World Seeds Year and plant breeders witnessed the signing of the International Union for the Protection of New Varieties of Plants (UPOV). Following this inter-governmental agreement, the United Kingdom, Denmark, the Netherlands, and the Federal Republic of Germany enacted national laws during the 1960's, while Belgium, Italy, France, and Switzerland (all original signatories to UPOV) committed themselves to legislation.

Until December 24, 1970, PBR for food crops was seen as a Common Market, or at best, west European phenomenon. Then, on that day, the US Congress passed the Plant Variety Protection Act over the opposition of the US Department of Agriculture. Overnight, PBR took on global proportions. By the mid-seventies, all the original signatories had legislation as well as New Zealand, South Africa, Israel, Spain, Japan, and Sweden. Although not all of these countries initially joined UPOV, corporate breeders were given the opportunity for exclusive monopoly patents in each of them.

Signing up the South

Toward the end of the 1970's, PBR—in the UPOV mould—was rolling like a 'bandwagon' through national ministries of agriculture. The Austrians and the Finns—each with their own laws—were expressing willingness to join. In countries without any form of plant patenting such as Norway, Canada, Ireland and Australia, ministries promised legislation. In the South, Kenya had adopted a Plant Varieties and Seeds Act virtually identical to British legislation and this Act included PBR. Despite this, the Kenyan Government was reluctant to enact the PBR part of

Table 35 Status of plant patenting around the world[5]

State	Type*	Legislation** Early	Legislation** Modern	Species*** No.	Species*** Year	Active titles No.	Active titles Year	Comments
Argentina	IC	—	1973	—	—	—	—	Inactive?
Australia	PBR	—	1981	—	—	—	—	Bill being debated
Austria	Pat/PBR	1938	1981	—	—	165	1976	UPOV membership debated
Belgium	Pat/PBR	—	1976	75	1982	292	1982	UPOV member
Bulgaria	IC	—	—	54	1977	—	—	PBR under consideration
Canada	PBR	—	1980	—	—	—	—	Bill tabled—not debated
Chile	IC	1969	1979	36	1979	54	1977	Inactive?
Denmark	PBR	1962	1982	113	1975	361	1979	UPOV Member
Finland	Patent	—	—	—	—	—	—	UPOV rejected
France	PBR	—	1971	75	1983	1461	1982	UPOV member
FR Germany	Pat/PBR	1877	1953	138	1977	2008	1979	UPOV member
DR Germany	IC	—	—	—	—	—	—	—
Hungary	PBR	1970	1982	—	—	27	1979	UPOV member
Ireland	PBR	—	1980	6	1982	16	1982	UPOV member
Israel	PBR	—	1973	77	1982	150	1982	UPOV member
Italy	PBR	1833	1977	67	1980	83†	1982	UPOV member
Japan	Pat/PBR	—	1978	386†	1981	286	1982	UPOV member
Kenya	PBR	—	1975	—	—	—	—	Inactive
Mexico	PBR	—	1978	—	—	—	—	UPOV member
Netherlands	PBR	1941	1966	113†	1977	1722	1979	UPOV member
New Zealand	PBR	1973	1979	All	1982	137	1982	UPOV member
Romania	IC	—	—	—	—	—	—	—
South Africa	PBR	1952	1977	83	1980	85†	1982	UPOV member
Soviet Union	IC	—	—	—	—	—	—	—
Spain	Pat/PBR	1929	1975	18	1982	2	1980	UPOV member
Sweden	IC/PBR	—	1971	88	1978	180	1982	UPOV member
Switzerland	PBR	—	1977	44	1983	69	1982	UPOV member
United Kingdom	PBR	—	1964	—	—	2147††	1982	UPOV member
United States	Pat/PBR	1930	1970	All	—	4000†	1982	UPOV member
Yugoslavia	IC	—	1975	—	—	—	—	Exact status unclear

* PBR is Plant Breeders' Rights or exclusive monopoly type; Pat is Patent law-based legislation; IC is Inventor's Certificate-type legislation.
** Australia and Canada have introduced bills which have yet to be debated.
*** Species should be interpreted as kinds or genera as established by each state through national legislation.
† = plus
†† = estimated

the Act. In Latin America, Argentina and Chile offered a form of plant patent but these states, too, seemed distrustful of UPOV.

In the 1970's, in fact, UPOV enthusiastically pursued the Third World by both bringing delegations to its annual Council session and by sending expeditions abroad in search of members and advising on legislation. Senior UPOV representatives have gone at least twice in the last few years to Latin America, for example, to address regional seeds symposia and to proselytize PBR. Specific country visits have also been made by experts to African states. Heribert Mast, UPOV's Vice-Secretary-General and most

Table 36 Plant patent pressure on the Third World[6]

State	Type of 'protection'	Remarks
Algeria	—	Attended UPOV Council
Argentina	IC	Legislation is inactive
Bangladesh	—	Attended UPOV Council
Bolivia	—	Legislation under consideration
Brazil	—	Non-UPOV PBR Bill expected
Chile	IC	Legislation is inactive
Colombia	—	Legislation under consideration
Ecuador	—	Legislation under consideration
Egypt	—	Attended UPOV Council
Gabon	—	Attended UPOV Council
India	—	Legislation under consideration
Iran	—	Attended UPOV Council
Iraq	—	Attended UPOV Council
Ivory Coast	—	Attended UPOV Council
Kenya	PBR	Legislation is inactive
Libya	—	Attended UPOV Council
Mexico	PBR	Legislation undeclared
Morocco	—	Legislation under consideration
Panama	—	PBR Bill expected in 1983
Peru	—	Legislation under consideration
Saudi Arabia	—	Attended UPOV Council
Senegal	—	Legislation under consideration
Thailand	—	Attended UPOV Council
Turkey	—	Legislation under consideration
Venezuela	—	PBR Legislation deferred

senior officer, even attended FAO's 1981 Seeds Symposium in Nairobi simply to pass out brochures and make interventions lauding the benefits of PBR. In 1980, UPOV produced its 'Model Laws' for PBR aimed directly at Third World countries.

UPOV was strengthened in its drive for Third World membership by the new seedsmen. Officials of the Industry Council for Development talked to UNDP officials about the difficulties of supporting seed programmes in countries that do not have PBR, for example, and Shell Oil even wrote an editorial in its own publication calling upon the Third World to accept PBR for the sake of agricultural development.

Despite all the enthusiasm, the tide against UPOV and PBR began to turn. Even by 1980, early drafts of the Dutch position paper on PBR for the CGIAR System were circulating for comment within the seed trade and all but the most evangelical companies recognized that the body of scientific opinion would come out against PBR. Logic dictated that countries that did not have adequate seed multiplication or certification procedures should not be pushed into PBR. Leaders in the industry counselled for a low profile. Hastily, changes were made in the *Model Laws for Developing Countries* booklet already en route to the printers (such '*Model Laws*' are a standard series under World Intellectual Properties Organization [WIPO] auspices and include advice on design, industrial patents and trademarks). The cover was replaced to read *Model Law on Plant Variety Protection*. At the same time, UPOV's member governments began to disclaim any interest in inviting Third World participants and, in conversation with some of them, they openly disassociated themselves from Heribert Mast and his efforts to attract the South. Indeed, at FAO's Nairobi symposium in mid-1981, Mast was prevented from making a public statement about UPOV by the secretariat and many of his own members kept the UPOV official at arm's length.

Since 1979, Brazil, Colombia, India, Mexico and Venezuela—all of whom had been contemplating PBR—have moved away from UPOV and are either flatly rejecting plant patents or are considering nationally-oriented legislation. In addition, Kenya, Chile, and Argentina have clearly no plans to alter their legislation to join UPOV.

Since 1980, UPOV has also experienced set-backs among the industrialized countries. Although Ireland completed legislative action that began in the 1970's and brought Irish farmers into UPOV in 1980, only Hungary (in 1983) is truly a 'new' addition to PBR and to UPOV. Austria continues to question the wisdom of subordinating its own national scheme to a UPOV model that would force open its borders to the transnationals. Finland has rejected UPOV membership outright. The Norwegian Government—after announcing its intention to join UPOV and establish PBR—has now reversed this decision. Three years after a PBR Bill was presented in the Canadian House of Commons it remains on the table: the government has not dared bring it forward for debate. It will die with the close of the current Parliamentary session. A Bill introduced for debate in Australia in 1981 has been stalled at every stage by intense farmer and consumer oppostion. Its future now hangs in the balance before a special Senate Committee. It is not expected to survive.

Until the present decade, plant patents had largely been isolated from public view. Farmers and consumers were not consulted regarding the nature or value of PBR legislation. In fact, in most countries, the PBR system was even isolated from the other sister areas of intellectual property such as inventions, copyright, design, and trademarks. Normally, all these areas are administered by a national bureau of intellectual property and the history and experience concerning one bears upon the practices in another. PBR was such an aberration from the normal patent approach that it avoided contact with these areas and was dealt with almost exclusively by agricultural ministries. Often there was hostility between the national bureau and the plant patent office.

For whatever reason, it is only in the last few years that the harsh international debate concerning the value of the industrial property system for the Third World has spilled over to force a rethinking of PBR as well. Indeed, the most outstanding aspect of the history of PBR over the past half-century is the almost complete absence of any kind of survey or review of its impact and effectiveness. Governments appeared to be adopting legislation simply 'because', without the ability to make more than dubious generalities about the anticipated beneficial effects. Once critics and governments began a serious evaluation, the UPOV 'bandwagon' began to look a great deal like Oliver Wendell Holmes' 'wonderful one-hoss shay'. Like Holmes' shay, the intellectual property system has been constructed so craftily that it may never 'break down'. But the signs can now be seen that the old shay, after a hundred years, may simply 'wear out'. If it does, it may—unlike the carriage—be partly due to its latest and weakest appendage: PBR.

The 'Neanderthal' of Intellectual Property

It will be recalled that in the early part of this report, we expressed sympathy with the view that if we did not have a patent system in Canada at the present time, it would be irresponsible on the basis of our present knowledge of the economic consequences of the patent system to recommend instituting one. It appears to us that the economic consequences to the country as a whole of a plant patent system are still more dubious than that of the traditional patent system.

The Ilsley Royal Commission Report, Canada, 1960.

Internal criticism of PBR is longstanding. A Canadian Royal Commission came out against it in 1960 and a counterpart US Commission called for the abolition of the 1930 Plant Patent Act later in the sixties. In 1978, EEC lawyers attacked PBR successfully in the courts. Yet the EEC decision was confined to a specific anti-combines case and the American and Canadian commissions were ignored. Only when farmers and consumers are aroused, do politicians become concerned. The emotive cry that PBR amounted to Human Rights was answered by the gut feeling that the first link in the food chain—the world's seeds—should not be subjected to exclusive monopoly control. Then, too, Third World governments gradually became aware that they were being asked—through their ministries of agriculture—to support an international convention (UPOV) whose restrictions were far more severe than the convention for the Paris Union which their ministries of foreign affairs were so adamantly rejecting at WIPO. Not only was it an affront to the intelligence of the Third World but also severely damaging to their bargaining position on the Paris Union to be accepting this 'neanderthal' of intellectual property.

PBR: technical problems

1. Legal Definitions. UPOV's intellectual problems begin with its inability to establish the legal identity of a 'plant' or a 'variety' even within its own membership. Such a problem, as we have elsewhere noted, should be enough to thwart any patenting initiative. The British Government recently went so far as to propose the removal of any definitions in its own revised legislation. It would seem that corporate interests have prevailed.

2. The missing link. There are other problems. When the Human Rights argument was disposed of in the 1950's for industrial patents (although PBR advocates ignore current legal opinion), patent systems were forced to justify their continuation on the basis of their contribution to knowledge. In effect, it was argued that patents are the result of a bargain negotiated between society and an inventor. In return for monopoly protection, the inventor gives society something new—a so-called 'inventive step'—from which others may build to achieve still other inventions. There is no such negotiation with PBR. This is by no means the fault of the breeder. The nature of the science makes such a step impossible. Nevertheless, the link is missing and the bargain struck with society is one-sided in favour of the breeder.

3. The special concern for discoveries. '2. Plants: A patent may be granted today on any new and distinct variety of any specified type of asexually reproduced plants. The statute imposes the requirement of unobviousness for patentability. In practise, however, patents are granted if the Department of Agriculture notifies the Patent Office that, as far as it can determine, the plant variety is new, and the examiner finds no art indicating the contrary.' (Report of the President's Commission on the Patent System, USA, 1966.)

The absence of the inventive step gives rise to the inevitable patenting of 'discoveries'. Under industrial regimes, discoveries cannot be patented since the inventor (in theory) cannot show how he/she accomplished the work—no intellectual 'trail' is left for others to follow.

New machines, however, are rarely found in tropical forests and even the renowned Japanese robots have thus far failed to mutate spontaneously. Plants are found in remote forests and many plant species are famous for the frequency of their mutation. Because PBR cannot require 'proof' of inventive activity, the legislation encourages the exclusive monopolizaton of purely accidental mutations which may, nevertheless, have great value. Still worse, the law encourages the theft of exotic flora in the Third World and the 'rip-off' of traditional cultivars and IARC breeding lines.

In industrial patents, the onus of proof that the invention is an original creation effectively rests with the applicant, based upon comparatively easy searches conducted by patent bureaus. In the case of PBR, the onus of proof of inventiveness rests with God. In theory and in justice, patenting authorities should only grant 'rights' for those species for which they have a complete list of all variations existing in nature everywhere on earth. This is an impossibility. Countries such as the USA, New Zealand, and Japan compound the absurdity by granting 'rights' for virtually every botanical species in creation.

In the United States, for example, the 1930 Plant Patent Act did not permit the patenting of discoveries. Yet, in his review of this Act in 1944—*Thirteen Years of Plant Patents* [7], Robert Starr Allyn notes that many patents which were openly admitted to be discoveries were patented. In a 1948 review of the impact of the US Act, [8] Orville H Kneen notes that a majority of fruits and many of the most significant flowers patented were the result of chance discoveries. Bowing to fate, the law was finally amended in 1954 to permit the patenting of discoveries found in cultivation. There is no indication that this has prevented abuses. In 1966, the President's Commission on the Patent System stated flatly that plants should not be patented since they could not meet the criteria.

Yet, the political influence of the companies has been such as to continue the practice of allowing the patenting of chance discoveries in the United States and elsewhere. How certain is the US Department of Agriculture that patented varieties are not ripped-off from other parts of the world? The following statement is still today part of the standard reply made by the USDA to the US Patent Office.

We do not have access to all the many introduced and named varieties within this species with which to compare this variety to determine whether it is new and distinct. The applicant's variety as described and illustrated appears to be distinct from other varieties with which we are familiar, but it can only be said that we do not know whether it differs from all varieties now named and in commerce. (Standard USDA form for Patent Office).

In other words, the granting of rights for discoveries is tantamount to granting a license to 'rip-off' traditional varieties and exotic plants around the world. It is technically impossible to monitor this Act with accuracy.

The patenting of exotic flora is not unusual. Some American companies actually operate out of Costa Rica and Guatemala for the purpose of selecting wild material and growing them for markets in their home country. Regular flights depart from South Africa to the Netherlands filled with exotic plants saved from forest clearing projects. Neither are the patent-holders reluctant to discuss their good fortune. US Plant Patent No. 559 is to Quincy McKeen for his 'discovery' of a heliotrope plant he named 'Black Prince'. According to his own account of the discovery. Mr McKeen found the plant by accident in Guatemala and brought back several hundred seeds to the United States. There, he grew out three sets of seeds, selected the best of the highly-variable material and then, in his own words, 'destroyed' all the plants except that which he patented. The seeds taken from Guatemala were of a kind that were of common knowledge to the people of Guatemala yet Mr McKeen was able to patent them in the United States so that any future imports of that heliotrope from Guatemala to the US could be blocked by Mr McKeen.

In 1982, at the same meeting that warned of the threat of PBR to genetic erosion, the Directors of the IARCs concluded that the risk of 'rip-off' was sufficient to warrant considerable additional expense in documenting their breeding lines and sending both documents and samples to any country having PBR legislation. International scientists also tell us that major global companies regularly search their test fields for improved sorghums and millets and that they believe that some of their varieties have been patented elsewhere by these companies. These are some of the problems encountered when the 'discoverer' of a variety need not prove that she or he has undertaken any breeding work for the variety. It is partly a problem associated with the patenting of discoveries and partly a problem inherent in PBR itself.

One argument given for the patenting of discoveries is that it encourages individual enterprise. In theory, farmers and gardeners can be on the lookout for chance mutations and earn royalties from their observations. In practice, this seems hardly the case. Within industry, we have been advised that it is common practice for companies contracting with seed growers to require that any mutations be turned over to the company. This is said to be particularly true in the case of roses and chrysanthemums. This requirement (sometimes in writing and sometimes not) practically guarantees the continued monopoly control of a plant kind by a handful of companies. For example, roses and chrysanthemums are by far the most patented plants in the world. They are also notorious for their high frequency of mutation. Nevertheless, from Europe to South Africa to New Zealand to America, a handful of companies have overwhelming control of all patents for roses and chrysanthemums. In the United States, where these two plants have been patented for over fifty years, we see that the same six firms have been dominant—with rare exceptions—for the whole half-century. Together, roses and chrysanthemums comprise well over 50 per cent of all plants patented under the 1930 US Act. Yet, in the United States, four enterprises control over 60 per cent of all rose patents while two enterprises have over 60 per cent of all chrysanthemum patents. With regard to the third most patented plant in the USA (in recent decades), two firms have two-thirds of all African Violet patents and the leading four firms have 96 per cent of all patents. Of the ten most patented plants under the 1930 Act, four companies or fewer have over 50 per cent of the patents in every case but one, where five enterprises have 52 per cent of the patents.

The opportunity for exclusive monopoly control has stimulated the creation of abusive contracts that lead to a kind of 'forward patenting' of nature's future mutation.

4. A handicap to scientific progress. 'The major question the Committee on Genetic Vulnerability of Major Crops asked was, 'How uniform genetically are other crops upon which the nation depends, and how vulnerable, therefore, are they to epidemics? The answer is that most major crops are impressively uniform genetically and impressively vulnerable. This uniformity derives from powerful economic and legislative forces.' (*Genetic Vulnerability of Major Crops,* National Academy of Sciences, USA, 1972, p. 1).

The struggle to make plants conform to the legalisms acceptable for machines makes the placing of square pegs in round holes seem eminently practical. Patent offices look for three qualities before a 'right' is issued:

the variety must be 'distinct' (unique, i.e. look different in one or more important characteristics); it must be 'uniform' (all seeds of the variety must look and perform the same in the field); and it must be 'stable' (the seed must breed 'true', i.e. present the same characteristics, from generation to generation). Agronomically, commercial farmers require a certain degree of uniformity and stability for the sake of machine harvesting and milling. Law court distinctness, law court uniformity and law court stability (in order to be able to defend the ownership of a patented plant) represent a draconian extreme far beyond actual farm needs.

As the US National Academy of Sciences (NAS) reported in its landmark study in 1972, the legal requirements of patents have increased the genetic uniformity—and disease vulnerability—of major American crops. At the time of the Academy's report, PBR was not a contentious issue and its concerns regarding plant patents went unnoticed, even though the study returned to them three times in the text. When the debate took shape at the end of the seventies, commercial breeders vehemently denied that legislation was increasing uniformity. Indeed, William L Brown, the Chairman of the Board of Pioneer Hi-Bred and a member of the NAS Commission, actually denied, in 1980, that the Academy report mentioned PBR. It was also in 1980, however, that another Commission member, the distinguished Head of the Plant Breeding Institute at Cambridge (UK) was asked to address the annual meeting of 'COGENE': the Committee on Gene Experimentation of the International Council of Scientific Unions. Dr Peter R Day listed four 'major causes' of genetic uniformity: 'the economic need for farmers to grow high-yielding, profitable varieties; the involvement in plant breeding in agribusiness, aggravated by plant variety rights legislation, and the private sector; the tendency to introduce clonal propogation methods in place of seeds; and technological dependence upon a particular feature of a crop'. [9]

Prior to PBR, breeders devoted no time at all to the entirely non-agronomic 'distinctiveness' requirement (its morphology), concentrating their efforts instead on disease resistance, nutritional quality, etc. With PBR, what the plant looks like becomes both a legal and an advertising necessity. The impact has been three-fold: (1) it has diverted attention from important breeding goals toward an irrelevent and superficial goal; (2) this has lengthened the time and cost of bringing new varieties to market; and (3) this has again increased the genetic uniformity of crops since it has stimulated 'me-tooism' or 'chrome and tailfin' plant breeding. Commercial breeders attempt to increase the pace of introductions by adding on 'cosmetic' morphological characteristics sufficient to identify the plant as a new variety and obtain a patent. The burden of those costs and delays fall back upon farmers and consumers. The benefits are nowhere to be found.

Then, too, a certain amount of 'instability' in a variety benefits the farmer. If a barley is patented in France and maintained in both the north and the south of that country over a few years, it will inevitably 'adapt' to the different climatic and other pressures it faces in different regions. This adaptation is very much to the benefit of the farmer. It does not, however, benefit the breeder, who may soon be unable to 'prove' that this unstable variety is actually patented property. As a result, companies prefer to maintain their variety in one central location in order to reduce variation. Society in general, and agricultural development in particular, lose out.

Possibly outweighing other concerns is the fact that PBR acts like a noose around the neck of scientific progress. The pressure to breed that which can be patented is such that the development of new breeding techniques and approaches cannot be pursued if they do not lead to patents. In effect, *rigor mortis* has settled over plant breeding, stiffening the science into the position it held in northern France in the late 1950's—when French breeders were attempting to impose their approach on the UPOV Convention of 1961.

Innovative areas such as multi-lining can only be pursued in the public sector or—occasionally and at great risk—in the private sector. In the case of a multi-line, a basic variety is adapted to have a number of genetically slightly different strains. While performing in almost the same way, each strain may confer resistances to different diseases and conditions. Thus a disease epidemic will have little likelihood of destroying the entire crop. Agronomically-speaking, the multi-line variety is uniform and stable enough to meet the farmers' needs. Legally, each strain of the variety would have to be patented separately at enormous cost to the breeder. Companies are understandably reluctant to pursue multi-lines.

PBR: the genetic WIPO

Given the central role of the South's botanical treasures in plant breeding and genetic engineering, it is incredible to imagine that the Third World should be offered a less favourable deal under UPOV than it has been offered under the WIPO industrial patent regime (the Paris Union).

Yet this is the case. Even the hard-nosed Paris Union has come to accept that the South has different development needs from the North and that it should receive some preferential treatment under the patent system. In the 1981 Nairobi negotiating round over revisions to the industrial patent regime, the North was prepared to reduce the life expectancy of their patents in the Third World to a bare five years from the present 17 years. By contrast, UPOV does not even nod in the direction of Third World needs and insists that all members observe the same long period of 'protection'. Barely six months after UPOV completed its 1978 revisions, the Paris Union was actively considering liberalized provisions recognizing non-exclusive patents (wherein the state would retain the right to exploit the patent as it chose while awarding the inventor the right to royalties only). Other revisions under debate include the right of a country to insist that the manufacture (or breeding and multiplication?) of an invention take place within that patent-granting country or the state may withdraw the patent and/or offer it to others to produce. Finally, the Paris Union also recognizes that it has a development support role in the Third World. Why should the Third World accept anything less from UPOV? There is an urgent need for national patent offices, foreign affairs departments and agricultural ministries to talk to one another.

The Impact of Exclusive Monopoly Control

PBR increases the number of companies engaged in the seed trade; heightens the level of investment in breeding research; enlarges the number of varieties available to farmers and encourages breeding work with non-hybrids and a wider range of crops ... according to the seed companies. In their view, exclusive monopoly control is a small price to pay for the giant leap forward in agricultural development awaiting countries adopting legislation. The data substantiating those claims is, unfortunately, not available.

The impact on seed companies

PBR proponents claim that one benefit resulting from legislation is an increase in the number of companies moving into the seed industry. British and American seed trade associations, for instance, claim to have increased their national membership by as much as 25 per cent since the enactment of laws. Thus, while transnationals may be moving into seeds, they reason, so are many others and the level of competition is high.

As attractive as the argument may be, it does not seem defensible on the basis of the data offered by trade groups. First of all, there is no automatic

Table 37 PBR and breeding institutes [10]

State	PBR Year	FAO List	OECD 1970	OECD 1975	OECD 1981	1970–81 Percentage
UPOV-Members						
Belgium	1976	31	8	21	25	+313
Denmark	1962	33	12	20	17	+142
France	1971	77	32	69	88	+275
FR Germany	1953	94	62	100	96	+155
Hungary	1983	1	—	7	15	+214
Ireland	1980	8	2	5	5	+250
Israel	1973	6	2	2	3	+150
Italy	1977	168	28	60	91	+325
Japan	1978	10	5	11	14	+280
Netherlands	1966	60	19	42	36	+189
New Zealand	1973	12	2	2	4	+200
South Africa	1952	—	1	2	3	+300
Spain	1975	26	4	4	4	—
Sweden	1971	9	8	9	7	− 88
Switzerland	1977	27	3	4	3	—
United Kingdom	1964	108	16	46	53	+331
United States	1970	527	38	44	79	+208
						(+186)
Some Non-UPOV Members						
Australia	—	29	—	8	11	+138*
Austria	1938**	19	4	18	18	+450
Canada	—	104	6	7	20	+333
Finland	**	4	2	2	3	+150
Greece	—	3	2	3	3	+150
Norway	—	2	7	11	11	+157
Portugal	—	6	2	2	2	—
						(+191)

* 1970 figure is unavailable. Figure is based on comparison with 1975.
** Law was of a peculiar national type and does not meet UPOV requirements.

correlation between the number of seed companies in a country and their membership in a trade association. British membership increased for two major reasons: British entry into the EEC forced open the relatively large UK seed market to continental seedsmen (many of these companies established representative offices in Great Britain); and the British Association of Plant Breeders has a direct role to play on the Plant Royalties Bureau established to set the royalty rate for patented varieties. This role, with a crucial regulatory body, undoubtedly attracted more members to the Association.

Since 1970, UPOV-member countries have experienced an 86 per cent increase in the number of variety maintaining enterprises as listed with the OECD for agricultural crops. Among these countries however, Denmark, Switzerland, the Netherlands, and the Federal Republic of Germany had fewer maintainers in 1981 than they had in 1975 and Sweden had fewer in 1981 than ten years earlier when PBR was introduced. By contrast, non-UPOV Western industrialized countries experienced a 91 per cent increase in OECD maintainers over the same period and none of them indicate a drop below the 1970 level.

It should, however, be stressed that an OECD 'maintainer' is not automatically (although normally) a breeder and that many of the maintainers listed in 1981 are actually subsidiaries of larger companies also listed. At best, the figures can only crudely indicate that the best available data shows no advantage in numbers of companies in plant breeding in states that have PBR over similar states that do not. Indeed, there is some suggestion that the opposite may be the case.

According to Hans Leenders, Secretary-General of FIS (International Federation of the Seed Trades), PBR does have the opposite effect. Since the public debate began, the trade has been unanimous in saying that PBR stimulates the involvement of more companies, but in 1976 the issue was not 'political' and Leenders felt able to tell the British seed industry of the Dutch experience with exclusive monopoly PBR: 'The number of firms engaged in the cereal seed trade decreased drastically ... 'The first to disappear were those firms for whom cereal seed was a side-line'.[11]

PBR's capacity to contribute to corporate concentration was also cited two years later in the 1978 EEC decision against a French/German PBR licensing agreement. Commission lawyers noted that patent 'rights' had increased profit margins which, in turn, had allowed companies holding a successful variety to manipulate market access so as to control downstream distribution. In the specific case of Limagrain (a French cooperative), one variety had given the company a third of the western European maize seed market and had enabled it to buy out the major French distribution company and its major production competitor. 'Profit margins,' the EEC report states, 'in recent years have enabled the largest of these private breeders to control or take over production or distribution of the varieties they exploit. On the world market, this trend is reflected in the recent acquisition by Sandoz, Ciba-Geigy, Shell and other groups of majority holdings of large American breeders and hence in their European agents and subsidiaries, a further illustration of the interest which major international groups are showing in the seed industry.'[12]

Table 38 Recent seed industry changes in industrialized states[13]

State	Mergers	Contract link	New start
Austria	1	2	2
Australia	16	5	5
Belgium	3	0	1
Canada	23	0	8
Denmark	10	0	4
FR Germany	28	0	6
Finland	2	0	2
France	46	8	18
Ireland	6	0	1
Italy	7	2	6
Japan	9	2	2
Netherlands	26	1	7
New Zealand	21	4	3
Spain	7	0	3
South Africa	2	0	5
Sweden	18	6	6
United Kingdom	122	15	30
United States	147	11	17

There can be no doubt that the net effect of legislative changes has been a drastic reduction in the number of independent companies. No complete list of take-overs exists. A complete listing, in fact, would be an impossibility since 'benchmark' studies of the traditional family-based seed industry were never made before PBR. Nevertheless, we have managed to identify 762 corporate 'changes' in the industry which have either taken place since the adoption of national PBR laws or, where no such laws exist, appear to have arisen since 1970. (One company, Ranks Hovis McDougall in the UK, admits to having acquired between 80 and 100 British agricultural merchant houses—all providing seed distribution—in roughly the period between the British Government's announced decision to adopt PBR and the time when the Bill was passed. The company is evasive, however, about the details and reasons for the take-over. We have, therefore, only listed its acknowledged seed subsidiaries in our count.) Of these 762 firms: 529 seem to have been acquired outright; 68 may either be controlled by larger entities or may only have a contractual relationship; and another 165 seedsmen may either have been acquired or may have been developed by the parent company. We believe these figures substantially underestimate the number of mergers that have taken place in the industry.

Mergers in the Federal Republic may be comparatively low for three reasons: first, German Cartel Law makes it especially difficult for outside entities to invade the seed business; second, the industry has conducted a form of internal consolidation through regional trading associations that act as a barrier against newcomers; and third, some consolidation took place in the immediate post-war years with the influx of private seedsmen from the eastern sector. The relatively large number of mergers in Canada, on the other hand, (a country without PBR although the Government has promised legislation since 1977) is partly due to the anticipation that PBR is on its way and predominantly because many of the acquired Canadian houses were subsidiaries of merged American seedsmen.

The availability of new varieties

There is no room for doubt that the past few years have seen a remarkable increase in the number of varieties available to agriculture. The trade attributes this increase, with partial accuracy, to PBR.

Certainly the focus on cosmetic differences has led to the patenting of a large number of new names, if not a real boom in varieties with substantive agronomic differences. Thus, a Polish onion called Wolska becomes seven different onions a short distance away in Holland. Even within the patent system, the interpretation of differences can turn one patented poplar in the United States into 15 different poplars in the United Kingdom. Farmers have a long familiarity with this tendency in the case of hybrid maize where the market has been inundated with thousands of names all based upon a handful of common inbred lines. It was a terrible shock to American agriculture in 1970 to wake up to southern corn leaf blight and discover that the swarm of brand names all amounted to the same genetic structure and the same approach to male sterility. They all collapsed under the new disease.

Yet, to be fair, there has also been a 'real' increase in the number of varieties. Is this due to PBR? Hardly. The main reasons may be summarized as follows:

1. *Double & triple seasons:* Until the 1960's seedsmen were confined to lone growing season a year—meaning that it could take from 12 to 15 years to bring a new cereal to market. Then jet cargo planes opened up the possibility of 'winter' growing seasons in other climates, allowing breeders to speed up the pace of introductions by several years. The result: more varieties, more quickly.
2. *Computer-controlled crosses:* Until the last few years, a major limiting factor in breeding was the capacity of any breeder to monitor a large number of plant crosses for a wide range of characteristics. Now, mini-

(and even pocket) computers have turned the art and science of breeding into a mechanical operation with the prize going to the company able to control the most crosses in a year. Shell, for example, has 350,000 test plots and keeps track of more than a million plants—each a potential candidate for PBR. The advent of computers has greatly in creased the pace of breeding.

3. *IARC-germplasm:* Since the evolution of the Rockefeller and Ford Foundation centres (CIMMYT and IRRI) into the IARC system in the early seventies, private firms in the North have had access to substantial quantities of improved germplasm from which to develop new material.
4. *OECD and EEC schemes:* Since the beginning of the seventies, both the OECD and the EEC have undertaken regulatory measures that greatly encourage the circulation of new varieties internationally. Much of the so-called 'boom' in breeding can be attributed to the easier flow of seed onto other national lists.
5. *The hybrid opportunity:* Late in the 1950's, research in the public sector pointed to the possibility of small grains hybridization (i.e. wheat and barley) which had seemed impossible. Hybrids have not only a built-in biological patent (since seed cannot be retained) but—far beyond PBR—hybrids guarantee that farmers must return to the market every year. The profitability can be enormous. Many companies moved into cereal breeding as a direct result.

Aside from these major factors, changing economic conditions influencing a specific crop have been extremely important. For example, the biggest growth area in US plant breeding has been in soyabeans. Unhesitatingly, Harold Loden of the American Seed Trade Association has described the expansion in soyabean work as the 'proof' that PBR works. It is true, chronologically, that most soyabean breeding began in 1970 at the same time the US Plant Variety Protection Act became law. The US seedsmen have failed to give credit to some other factors, however. For example, Jean-Pierre Berlan of INRA (the French national institute for agricultural research) has noted that EEC rules changed at the same time, eliminating the West African groundnut market (formerly protected by France) as a source of cheap livestock feed in Europe. As the West African market collapsed, its place was permanently taken over by American soyabeans. At the same time, another soyabean competitor—anchovies from the Humboldt current off Peru—drastically declined in availability because of earthquakes affecting the fishing villages and because of an actual shift in the current. Beginning in 1970, US soyabean exports quadrupled and then jumped to eight times their pre-1970 value. The US acreage devoted to soyabeans blossomed accordingly and American seedsmen scrambled to follow the market. In September of 1970, *Businessweek* wrote, 'For US soybean exporters 1970 will go down as the most spectacular year ever. During the crop year that ended last week, exports of the 'golden bean' skyrocketed from 287 million bu. a year ago to about 425 million bu. ..... A 10-year campaign by the American Soybean Assn. to increase use of US soybeans abroad has begun to pay off.' [14] American seed companies would have to have been especially stupid not to have adopted soyabean breeding programmes.

The world's most ardent advocate of PBR as an incentive to breeding is Shell Oil. Together with other companies and trade associations, Shell has argued that many companies would not have become involved in cereal and forage breeding were it not for for the exclusive monopoly opportunity. Nevertheless, Shell's own promotional material concedes that companies it has recently acquired began cereal breeding in the early fifties and undertook forages later in the same decade ... years before PBR came into vogue. If awards are to be given for the growth in variety release, then PBR should go to the real leaders—Boeing aircraft and Apple computers.

Breeding for new crops

A third advantage according to the seed industry, is that the private sector feels able to venture into crops other than hybrids. Because it is impractical to save hybrid seed for a second year's planting, the company holding the 'parent lines' (used to make the hybrid 'cross') is the only one biologically capable of providing seed of that variety. This gives a company a biological monopoly over the variety. Without PBR, the industry claims companies will always focus on those crops capable of hybridization. With PBR, companies can afford to invest in non-hybrid crop breeding—to the considerable benefit of agriculture.

Once again, the theory is only reasonable until it is fully explained. First of all, the profitability of breeding for non-hybrid crops has been such that many firms have been involved for decades before PBR. Secondly, PBR laws do not prevent farmers from saving their own seed for the next crop. Thus, open-pollinated cereals (non-hybrids) can never be as profitable —with or without PBR—as a hybrid cereal where the farmer must return to the breeder every year for new seed. In fact, there are indications that PBR royalties are simply converted by companies into research funds to create hybrids. Already, most vegetables, maize and sorghum are hybridized and work is progressing feverishly on small grain cereals like wheat and barley.

Table 39 The orientation of US private sector cereal breeding. Percentage of all private R and D cereal breeding in the USA devoted to crop hybridization [15]

Firms	Crop	Hybrid R and D percentage	Firms	Crops	Hybrid R and D percentage
7	Hard Red Winter Wheat	85	6	Hard Red Spring Wheat	59
5	Soft Red Winter Wheat	49	5	Spring Barley	33

The clearest evidence of this is in the American market, where most private wheat breeding and a third of all private barley breeding is devoted to hybridizing these two major crops. This is in marked contrast to public sector cereal breeding in the US, where breeders devote almost no attention at all to hybrids. Public breeders have the agronomic qualities for the farmer uppermost in their programmes while private firms are most anxious to produce the most profitable varieties for the company.

The effects of the private sector push in the United States is now becoming clear. Cargill and Monsanto now have hybrid wheat varieties in the market while Shell and Pioneer are expected to follow shortly. En route to their hybrids, those companies have inevitably identified and released a number of 'regular' varieties which have been patented and which are providing the companies with royalties.

The corporate response to this kind of criticism has been to defend the quality of their hybrids, insisting that hybrids add 'vigour' and increase yield and other aspects of a variety. Maize breeders at CIMMYT (who have turned away from hybrids) and elsewhere, however, increasingly agree that while hybrids might offer some short-term advantages, their reputation for improving yield is exaggerated. Geneticists claim that, for example, open-pollinated maize today can match the yield and other qualities of any hybrid. Government agronomists in France have also observed that sometimes the non-hybrid parent line for an American maize variety will perform better than the hybrid it helps to spawn. In such cases, the company undertakes the hybridization solely for the profit advantage of the company and against the wider interests of agriculture.

With or without PBR, companies have a powerful profit incentive to pursue hybrid crops.

The growth of private R and D

Dr Harold Loden of the American Seed Trade Association has insisted that PBR substantially increases private sector research in plant breeding.

Taking 1960=100 as a base year, Loden claims that 1965=164 while 1970=232 and 1976 soars to 712. PBR was passed in the USA in 1970. Loden also quotes figures developed by Sandoz to show that US R and D as a percentage of seed sales went from 2.9 per cent in 1960 to a noteworthy 5.3 per cent in 1976. What better proof could there be that PBR—even if it may not have yet resulted in a host of new companies, new varieties or new crops—is on its way to improving the quality of varieties on the market?

The initial set of figures indicating a rise in R and D to 712 in 1976 from 100 in 1960 must be compared with the second set of figures showing the percentage of sales dollars devoted to R and D over the same period (almost a doubling in percentages). In other words, the seed trade experienced a massive increase in sales over the entire period and especially since 1970. By and large, R and D increases—as shown in the first set of figures—reflect the increase in sales. There is no reason to credit this increase in sales to PBR legislation, especially since the first patents were not issued until 1973, and subsequent royalty payments could only represent a small part of the sales volume.

The second set of percentages is, however, more significant since it indicates a real increase in R and D commitment. In figures offered by the seed industry there is, unfortunately, no reference to the rate of increase of R and D budgets. Analysis of this rate shows that in the five years between 1960 and 1965, budgets increased at a rate of 0.14 per cent per annum, between 1965 and 1969 the per annum rate rose to 0.2 per cent; but in the seven years between 1969 and 1976, the per annum rate dropped to 0.13 per cent—the lowest of the entire period even though PBR was passed in 1970. In table form ...

Table 40 US private sector R and D in breeding[16]

Year	R and D as percentage of sales	Percentage growth over previous period
1950	2.9	—
1965	3.6	0.14
1969	4.4	0.2
1976	5.3	0.13

The reason why R and D investment in US plant breeding peaked in the late sixties may have been, inadvertently, provided by Dr Robert W Romig, Director of Research at Northrup King (Sandoz) when he spoke to a symposium on PBR held in Regina, Canada in March 1979: 'Budgets for agricultural research (USA) have increased steadily since World War II. In terms of real increase, support probably peaked in 1967–1968, when the Viet Nam war began to heat our economy. Dollar increases of the research budget since then have not matched inflation.'

Corporations benefit from government support to agricultural research both directly and indirectly. Directly, they may receive grants or contracts to undertake all or some part of research for government. Indirectly, companies benefit from the release of breeding lines by public institutions supported by government funds.

The upsurge in private R and D did not come coincidentally with that of government research. Taking advantage of basic research in government, many companies put their emphasis on the 'D' of R and D, letting the public sector do the hard 'R' work for them. Secondly, the boom period coincides with the discovery of a workable method for the hybridization of wheat in the late 1950's. Until about 1960, private plant breeding in major agricultural crops was limited in the United States. The vision of hybrid wheat fanned R and D activity which accelerated throughout the decade of the sixties. Some of the decline in the rate of increase since then is attributable to a general discouragement among breeders that commercially successful hybrid wheat may not be feasible. Dekalb and Sandoz both pulled back from this kind of work.

Rather than citing PBR as the cause of vastly increased R and D, the American seed trade should outline why it is that the legislation did not at least serve to maintain the momentum of earlier years.

Some other countries have also indicated data showing a massive increase in R and D. The British Association of Plant Breeders, for example, claims that investment leaped 500 per cent between 1974 and 1979. Credit is given to PBR.

Standing by itself, this suggestion is quite ludicrous. PBR was passed in 1964 in the UK and an explanation is required as to what went wrong with the first ten years to make the following five so praiseworthy. Then, too, British seedsmen might explain the impact of admission to the EEC in 1972. The instant creation of this much greater seeds market might be expected to have had some influence on investment. In fact, a number of factors ranging from the creation of the Home-Grown Cereals Authority (giving an incentive to domestic cereal varieties) to the increase in beer and liquor consumption (expanding the interest in some cereals) took place in the same period. Even the term 'R and D' cries out for interpretation, since many firms include their advertising budgets and others under 'investment', and include merger costs—an activity which has been rampant in the UK and which does nothing for the quality of research.

In short, there is no earthly reason for the British trade to claim—via the ineptitude of its own data—that PBR has stimulated R and D.

The control of patents

You can buy a Yellow Frost chrysanthemum in Sweden. Or you can buy a Yellow Frost chrysanthemum in the Netherlands. Or you can buy a Yellow Frost in the USA and its sister, Yellow Sophisticate, in Denmark. Wherever you buy it, its owner and patent-holder is Yoders Brothers of the United States. In fact, in Sweden, you can have any chrysanthemum you want so long as it is Yoders. Of course, Yoders is not the only chrysanthemum breeder, there is also Pan American Plant Breeders (owned by Ball) also of the United States and the Chrysanthemum Breeders Association of Cucacao, and Frampton's Nurseries in the UK. A few other breeders such as Hoek and Fides grouped around De Lier in Holland cannot be entirely forgotten. In the main, however, three or four companies overwhelmingly dominate the world's second most patented plant everywhere in the world.

Table 41 Top five holders of US plant patents in the 1970's (1930 Plant Patent Act)[17]

Firm	Percentage of total
Yoder Bros.	8
Geo. J. Ball	7
Bear Creek	6
Mikkelson	5
'Optimera' (FR Germany)	3
Total	20%

What is true for chrysanthemums is even more true for the roses—the world's most patented plant. France's Meilland-bred roses may be bought from the United States to New Zealand, and from South Africa to Sweden. Again, a handful of companies—Jackson and Perkins (owned by Bear Creek Corp. in the USA), Meilland (with its numerous linkages including Conrad-Pyle in the US), Sam McGrady of New Zealand, and Moet-Hennessey's Armstrong Nurseries of America and Delbard's of France—control the business. The lead companies cooperate closely. Jackson and Perkins, for example, is the world's largest grower and marketer of roses with over a thousand varieties. Beyond its own supply of patented roses, it licenses from the other major breeders and pays out almost as much in royalties each year as it takes in via the same means.

Half a century and more of PBR for ornamentals and fruits, rather than widening the opportunity for competition (among crops known for their chance mutations) has merely allowed the dominant firms to protect their position with patents.

Between 1930 and 1980, the US Government permitted the patenting of close to 5,000 fruits and ornamentals involving about 100 plant kinds. Despite the preponderence of 'sports' in most of those plant kinds, the level of concentration has remained high throughout the whole half century.

Over the entire 50 years, the leading ten firms have never controlled less than a third of all patents and—during the Second World War—occasionally claimed well over 40 per cent. Although there have been changes and amalgamations, five of the ten leading firms at the outset of plant patenting remain in the leadership ranks today.

Table 42 Top five US PVPA 'rights' holders[18]

Company	Crops	Patents	Percentage of total
Upjohn	11	101	10
Sandoz	12	74	7
Shell/Olin	7	66	6
Agrigenetics	6	46	4
ITT	13	35	3
Top five			30%

The corporate concentration in agricultural crops is not yet so clear. The history is by no means as long. Nevertheless, data on the first decade of the US Plant Variety Protection Act (PVPA) is already alarming. Five companies—all with less than ten year's history in plant breeding—now control almost one-third of all issued 'rights' for American agricultural varieties. Three of the lead group are major chemical companies while the fourth is a recently created genetics engineering venture and the fifth, ITT, is no stranger to chemicals and has a number of pesticide patents of its own.

The American situation is not an isolated one. The Dutch have had a

Table 43 Dutch plant patent control for major agricultural crops[19]

Firm	Percentage of total
Cebeco-Handelsraad	20
Suiker Unie	17
Shell	3
Total	40%

non-exclusive monopoly system of plant patenting since 1941 and an exclusive monopoly system since 1966. Holland is unquestionably the most aggressive plant breeding country (for its land area and population) in the world. In a survey of 11 patentable agricultural crops (including the dominant crops bred in Holland) covering over 450 patents in force at the end of 1981, two companies show overwhelming domination.

Both Cebeco and Suiker Unie are technically farmer-owned cooperatives. Like any other cooperative that becomes large, however, management dominates decision-making and the farmers are no more influential than the shareholders of a major corporation. This control is especially impressive in that it includes potatoes—an important Dutch commodity—with over 40 per cent of all patents. Historically, potato breeding has been the work of individual breeders. Were potatoes excluded from the listing, the extent of patent concentration would be staggering.

Why don't patents work?

Three years ago, *The Wall Street Journal,* reporting on the appointment of a new Chief Executive Officer to the American wing of Hoffman-La Roche, added that the company had overdosed on its own top product—Valium. Describing the low-level of R and D in La Roche, the *Journal* called it the 'Rip Van Winkle of the drug business'.[20] (Rip Van Winkle is a mythological American character who fell asleep under a tree for several decades.) The reason, as the article noted, was that the Swiss-based drug house had a patent on one of the world's best-selling drugs and it had complacently gone to sleep while the money rolled in.

Patents do not stimulate innovation—they reduce it. The skill and genius that could be invested in research is more safely invested in the lawyers needed to protect the patent. Patent disputes—whose average cost in the USA runs to a quarter of a million dollars in court costs—are the 'high art' of the legal profession. Given the time and expense, they are a relatively easy way for the biggest companies to buy control of an industry. Should a large enterprise and a small breeder come to legal blows over a patent, the larger firms can almost always win out of court simply with the threat that the dispute will tie up the little company for years and cost it much of its working capital. Thus, it is cheaper to buy out successful little companies than it is to do the research as a big company. In fact, the bigger the firm the less successful the in-house R and D programme.

Consider the recent areas of scientific progress. The semiconductor business which has given the world the 'chips' that first created pocket calculators and then micro-computers stems from US Defense Department and space administration-financed R and D that eventually led to key scientists taking up with small new companies to produce new consumer goods. The companies that first captured pocket calculators and those that brought out the original home computers were—by any standards—shoestring operations. Many of them are now the property of major transnational electronics companies. A few may survive to become major entities of themselves. It has been the same story for genetic engineering, the twenty or so lead firms are all the result of university-based research. The lead scientists left the campuses for the private sector to establish small companies. Now, again, the major chemical companies are moving in to buy them out. Interestingly, before the first test case of microbe patenting (in the US market) was decided, there were 100 or more other genetic engineering products ready for the patent office to examine. All of those products had been treated without any guarantee that there would be patent protection. All the companies had started up without any sense that their research would ever be 'protected'. For small firms, the objective of R and D is to be first in the market with a good product. Patents are a fringe benefit.

But patents are not fringe benefit to transnationals. They are their way—as we have previously noted—of staking out their territory and controlling the conditions for the sale and distribution of a product. The new genetics supply industry now taking over both genetic engineering and plant breeding is feeding off the research undertaken by others. It will contribute little itself. To quote one economist we are not normally given to quoting: 'Advances in any science or field often result from one out of a large number of crackpots and quacks and people who have no standing in the profession.' [21]

Milton Friedman takes the point a little too far. Among those historic and now disenfranchised innovators—by no means quacks—we would include farmers.

The Future of PBR

In its 100-year history, the Paris Union covering industrial patents has undergone six revisions—each one strengthening the positions of the patent-holder. The UPOV Convention—first signed in 1961—was revised twice in the 1970's and will be again in the 1980's. Future revisions are intended to again strengthen the company's position and to rationalize PBR in the light of changes in genetic engineering. A number of recommendations are already being discussed at the national and/or international level.

1. *Livestock patents:* UPOV has been intrigued by the idea of expanding its 'protection' to livestock—as is already the case for three East European states. The American Bar Association also supports the inclusion of livestock. Many of the prime animal targets are already hybridized, however, and the actual impact is uncertain;

2. *Gene Patenting:* in 1976, the French Government recommended at a UPOV meeting that the Convention study the patentability of specific genes. Their reasoning was that PBR had basically served as a means of patenting genes via the incorporation of a useful gene into a new variety. With scientific advances, however, the reward going to the discoverer of a new gene is far less than the actual value of the gene itself. Given these changes, UPOV might adjust to allow for gene patents. Since many crops tend to share one or two successful genes in virtually every variety grown in a climatic area, the patenting of specific genes is tantamount to allowing the patenting of the whole crop.

3. *Extending the time period:* many states are already considering 30-year patents for plants. This amounts to monopoly control of a variety for a whole human generation.

4. *'End-product' patents:* where once the notion of patenting living things was abhorent, patent lawyers have passed us through this phase to the patenting of ornamentals and then the patenting of food crops themselves. Now governments are accepting the idea of allowing end-product patents on fruits and ornamentals meaning that royalties may be won on the final plants and fruits under certain conditions. If ornamentals, why not also food plants? This appears to be the next step.

It is possible to chart the changes taking place to PBR at least in a general way, as Table 43 demonstrates.

Table 43 PBR's shifting ground

Period:	Situation	Seed trade views	Results
The past			
1920's to 1950's	Ornamentalists in Europe/USA argue for patents as a Human Right	Talk of 5 to 15-year 'protection' period for limited species; no staple foods to be included; 'rights' to be non-exclusive.	Laws pass in USA and several European states allowing up to 17 years, confined to fruits and ornamentals; US grants exclusive 'rights'.
1950's and 1960's	Agricultural breeders call for 'rights' similar to those granted to ornamentalists	Talk of 18 years or more 'protection' covering all food crops but 'right' would not extend to the food itself and state could sue compulsory licenses to protect society.	UPOV established; 17-year minimum period accepted; food plants 'patentable; compulsory licenses added.
1970's	Need to 'internationalize' UPOV formula	Testing amendments proposed to allow US UPOV entry; time period be extended; 'end-products' of fruit and ornamentals to be part of plant patent; more species to be included.	UPOV amended twice; US admitted as well as many others; 'end-products' now possible; easier international access. Three states accept patenting of all plant kinds; average period extended to 20–25 years.
The Future			
1980's	Need to 'modernize' UPOV to meet genetics age	Extend UPOV to higher-order plants and animals as well as to specific genes; lengthen protection to 30 years; eliminate right to sell seed at farm level; incorporate Third World; eliminate compulsory licenses.	Will governments respond differently this time?

Among the most enthusiastic proponents of more changes is the American Bar Association. At least since 1976—and in some cases a decade earlier–the Association has advocated the patenting of livestock as well as micro-organisms. It has also voted for the removal of provisions that normally allow farmers to exchange or sell seed 'across the fence' to one another. Most alarmingly, it is on record as favouring the elimination of compulsory licenses altogether. This view is passionately supported by the pharmaceutical companies in the industrial patent field and it is reasonable to assume that what the parent chemical firm wants for one field it will also want for the other.

Rip Van Winkle now wants to patent the tree he has been sleeping under. There is another legend, however—that of the four-leaf clover. When you are in need of a little luck, the story goes, go out and find yourself a four-leaf clover. Those of us who like to eat food could use a little luck right now. Where can you find a four-leaf clover? Well, that's US Plant Patent No. 3730.

A special note: patenting by regulation

Although PBR and UPOV are the preferred route for the new seedsmen, as opposition to exclusive monopoly legislation mounts, companies and governments are turning with increasing frequency to the regulations surrounding seeds to achieve the same ends without going through the embarrassment of parliamentary debate. Under the pretext of serving the interests of farmers, governments can enforce seed certification schemes in such a way as to give breeders *de facto* 'rights'. For example, if only certain generations of seed can be marketed by seedsmen and those generations must bear the name of the variety, it is possible that only the breeder who controls the foundation seed will be able to use the variety name. Since seed cannot be sold without a name, the company has a kind of patent by regulation.

In order to avoid this kind of 'end-run' patenting, farmers need not forego the benefits of certification. They need only to require that the acceptable 'generations' be made available to any and all requesting seed growers, and that these seed growers have the right to sell the seed by name.

Notes

1. Oliver Wendell Holmes (1809–94) was a professor of anatomy and physiology at Harvard University who also published essays, novels and several volumes of poetry.
2. Source was 'Working Paper on Patent Law Revision', Department of Consumer and Corporation Affairs, Canada, June 1976, Appendix A, pp. 1 and 2.
3. Ibid.
4. Source was 'Working Paper on Patent Law Revision', Department of Consumer and Corporate Affairs, Canada, June 1976.
5. Data derived from UPOV Newsletters Nos. 1–32, and FAO *Seed Review*, 1979.
6. Sources were UPOV Newsletters Nos. 1–32, and private conversations with government and seed trade officials in various states.
7. Allyn, Robert Starr, *Thirteen Years' of Plant Patents*, New York, 1944, a supplement to *The First Plant Patents, A Discussion of the New Law and Patent Office Practice*.
8. Kneen, Orville H., 'Plant Patents Enrich Our Lives', *National Geographic*, March 1948, p. 357 ff.
9. Extract of the speech by Dr. Peter R. Day as recorded in the minutes of the 1980 Annual Meeting of the Committee on Genetic Experimentation of the International Council of Scientific Unions.
10. Source is the OECD schemes for Varietal Certification of Seed Moving in International Trade for those years cited.

11. Leenders, Hans, 'The European View on the EEC Certification Rules', *Agricultural Merchant,* UK, July 1976, p. 33.
12. 'Re the Agreement between Kurt Eisele and the Institut National de Récherche Agronomique', *Common Market Law Reports,* 14 November, 1978, p. 434 ff.
13. Data collected by ICDA from various industry sources.
14. *Businessweek,* USA, September 12, 1970, p. 30.
15. Data derived from tables provided by North American Plant Breeders Inc. (A Shell/Olin seed subsidiary) on June 5th 1981.
16. Data were derived by Sandoz in March 1979. The interpretation of the data —showing a decline in the rate of growth of investment—was made by ICDA. Major factors leading to an increase in breeding research have been the discovery of the possibility of hybrid wheat in 1958 and the opening of the European Economic Community to soyabeans in 1970.
17. Data drawn from *Plant Patents with Common Names,* American Association of Nurserymen, all volumes 1931–1978.
18. Data derived from *Plant Variety Protection Office Official Journal,* USA, Volumes 1–9. Leading seed firms such as Pioneer Hi-Bred and Dekalb-Pfizer do not appear here since hybrid maize (corn) is not patentable in the United States. Hybrids have a built-in 'biological' patent since their seed is either sterile or will not breed true.
19. Groosman, A.J.A., and van den Meerendonk, J.C.M., 'De Nederlandse Zaaizaad sector', Iris-Rapport No. 22, Development Research Institute, Tilburg, Netherlands, June 1983.
20. *The Wall Street Journal,* March 28, 1980, p. 15.
21. Friedman, Milton, *Capitalism and Freedom,* University of Chicago Press, 1962, p. 157.

From Procrusteus to the God Farmers

From the Dag Hammarskjold Foundation to the old garden of Carl von Linné ('Linnaeus') is but a few steps. In the midst of Uppsala, it is not a bad place to sit and contemplate what humanity has been up to in the two hundred years since 'the little botanist' left us with his system for classifying the world's floral heritage. Linnaeus appreciated, indeed welcomed diversity. He never expected to find all the world's species or plants and he never doubted that his system could be improved upon. In fact, 'Project Linnaeus' is still underway at the Uppsala Botanical Garden. Two centuries after his death, his own country is still trying to compile a complete inventory of plants. Linnaeus would be delighted.

In the midst of genetic erosion and the machinations of the genetics supply industry, Linnaeus might also find some seeds of hope. After all, Easter Island's only tree—that used for its famous wood carvings—was thought to be extinct. The last known tree had died by 1962. Then the Director of Göteborg Botanical Garden in Sweden reported that the famous explorer, Thor Heyerdahl, had taken a few seeds from the last surviving tree and that they were alive and well in the Swedish garden. Now the tree is being restored to Easter Island. In a search for another 4,000 plants thought to be extinct in nature, botanical gardens recently uncovered almost half of them still safely growing within their walls. True, this does not preserve the gene diversity of the original material—but at least something has been left.

The message is that there is still time to act. We have a few years left to preserve considerable genetic diversity. Thanks to the genius of many scientists and farmers and the perception and commitment of many diplomats from the South, an International Convention governing germplasm is achievable and the chemical industry is not so far advanced down its own road that it cannot be halted by national and international legislation.

The Conservation of Plant Genetic Resources

> *... and this is where there is need for a vision because I always believe that where a vision is limited, action is equally circumscribed.*
> Dr. M S Swaminathan, Chairman of the FAO Council, 16 June, 1983.

The world now spends about US $55 million on plant genetic resources conservation. Of this figure, however, only 30 to 40 per cent passes through international channels and is even ostensibly for the benefit of Third World countries. IBPGR presently has a budget of about US $3.8 million. The IARCs spend close to another US $10 million on their own germplasm programmes. There is a drastic need to increase this figure of US $14 million to US $100 million through to at least the middle of the next decade. IBPGR and most scientists believe that such financial increases are impossible and have confined their thinking to the abysmal funding and token budget increases that have constrained conservation efforts over the past decade. Earlier this year, the Directors of the IARCs responded to a request from FAO's Director-General to identify shortcomings in the present conservation system. Their first point was the need to create an awareness of the issue. We believe that public awareness will lead to the kind of financial support that is needed.

The shortage of funds has confined the vision of IBPGR in many ways. Little time has been devoted to biosphere reserves or to cooperation with the international network of botanical gardens, for example. Botanical gardens offer a large body of trained personnel able to assist in plant identification, collection and even conservation. Likewise, inadequate use has been made of the NGO community—especially the International Union for the Conservation of Nature and Natural Resources and the Environmental Liaison Centre. These groups tap important networks that can promote public awareness, increase funding and assist in the technical tasks of conservation.

Most unfortunately, however, the scientific community has been unable to reach farmers and gardeners—those closest to the seeds. FAO's Chairman, Dr Swaminathan, referred to this in his address to the FAO Council in June 1982. Farmers care about their seed. They can help identify and conserve important landraces and weeds. In many villages in the Third World, it is still possible to find small plots of the old seeds growing in the woods preserved by families not wishing to entirely trust their fate to the HYVs. Very tiny plots of land and very little money would be required to work with villages and individual farmers to turn them into farmer/curators protecting local landraces. The costs could be a small fraction of the costs of transporting and preserving seed overseas and then shipping the seed back to be rejuvenated every few years.

Of course, there is no scientific logic to this proposal. Within the space of one or two growing seasons, the genetic variability of the farmer/curator plot would decline dramatically. Some farmers would not be true to their commitment. A host of problems could result in the loss of some plots.

We do not propose the farmer/curator system as an alternative to gene banks for landraces—but as an addition. Governments are not good at saving for eternity. It may just be that one or two centuries from now, what remains of our plant genetic diversity will have to be sought from these dedicated 'amateurs'.

The need for facilities

1. *Biosphere reserves:* international support for the formation and long-term financial support for natural biosphere reserves within the Vavilov Centres and in other areas is a crucially high priority to safeguard unexplored plant species and the wild relatives of our cultivated crops;
2. *Farmer/curators:* international support is needed to develop and finance a wide system of village-level landrace custodians whose purpose would be to continue to grow (on small plots) an admittedly limited sample of endangered landraces native to the region. Although this course does not preserve the variability of the landrace, it may finally prove to be the world's best protection against the extinction of landraces;
3. *International gene bank system:* as an immediately achievable priority in the context of the Mexican proposal, the international community should develop (or, in some cases, adopt existing facilities where they can be surrendered to FAO control) what must eventually become a series of international gene banks in each of the Vavilov regions. These banks would, as a first priority, collect and preserve endangered landraces and modern varieties and then safeguard threatened wild material;
4. *National conservation centres:* the international community—perhaps in the context of the proposals related to an International Convention—must support national conservation centres which may include nationally important, bio-sphere reserves, farmer-curator initiatives, living collections in botanical gardens, and gene banks. Support for personnel-training, physical facilities, equipment, and collection work are all part of such national centres.

The need for new structures

5. *International Convention:* of paramount importance is the early agreement to a strong International Convention open to all countries and under the control of FAO;
6. *Conservation and development fund:* within the framework of the Convention, a fund must be established to support national and international conservation of germplasm and the development and utilization of germplasm resources at the national level;
7. *Restructuring IBPGR:* the old IBPGR should be brought directly

under the control of FAO and the International Convention as the operational arm of genetic conservation. The various scientific committees and the Board itself could become technical advisory groups to FAO, while policy decisions would remain in the hands of governments through FAO;

8. *FAO inter-governmental committee:* following the adoption of the Convention, FAO should establish a representative inter-governmental committee to oversee the Convention and supervise all aspects of the international conservation strategy including the international fund and the operational arm (IBPGR);
9. *Wider cooperation:* despite the concentration of these initiatives in one inter-governmental body—FAO—provision should be made within the new committee for the active participation of other specialized agencies and members of the UN System such as UNEP and UNESCO and for the involvement, in advisory roles, of relevent international non-governmental organizations.

Elements of the International Convention

10. *Categories of germplasm:* all categories of material from wild relatives to advanced breeding lines should be included in the Convention;
11. *Private collections:* the Convention should require national legislation intended to ensure that privately-held germplasm collections are safely stored, publicly documented and freely available;
12. *National botanical heritage:* The Convention must recognize that plant genetic resources form a part of the national heritage of countries and that the storage of these resources must be assured within the country. Where samples are not in the country but are in other gene banks, duplicates must be repatriated.

The Related Issues

In ancient times, species were collected and utilized; there was a mythology about 'God farmers' who could test and identify a multitude of grasses to be used as food and medicine for humans.
Jiang Chaoyu, Director of Germplasm Conservation, Chinese Academy of Agricultural Sciences, 1982.

The ancient Greeks have a story about a robber named Procrusteus who kidnapped wayfarers and forced them to lie in a bed. If they were too long, he cut them to fit the size of the bed. It seems we have turned our approach to technology into a modern Procrusteus. Every idea is laid against a series of 'givens' of how agriculture is supposed to progress. If these 'givens' are not met, then the idea is cut off. Increasingly, what the world is 'cutting off' are its farmers.

Research into the seeds issue leads inevitably to the conclusion that the women and men doing our plant breeding at the IARCs and often even in private companies are dedicated, honourable and tremendously hard-working scientists. In talking with those people from CIMMYT to Uppsala it is impossible not to admire them greatly.

At the same time, there is the distinct feeling that the technical approach to plant breeding is not entirely correct. After all, the basic elements of breeding are not so complicated. A great deal has been and is being accomplished by keen observation and by crossing superior plants. In fact, as Vavilov noted more than once, we once had a world of plant breeders —very successful ones—who led us to our present crops. In many ways, the last four-score years of scientific plant breeding, with all their obvious progress, have also been years when the number of plant breeders, or keen observers of their fields, has declined from several million to a few hundred. All the genius of the hill farmers of Austria, the maize and bean planters of Mexico, and the sorghum growers of the Sudan is being lost to a scattering of highly sophisticated institutes.

We need the 'God farmers'. We do not need a return to the last century but, if people are to retain control of world food security and not lose it to a handful of corporations or even a handful of international institutes, we must banish Procrusteus and adapt our agricultural technology to train farmers to continue their own plant selection and adaption work. We will still need the scientists and the institutes and all the new machinery, but we must re-involve the world's farmers and gardeners. We can take another road that avoids Procrusteus—a road that leads to the demystification of agricultural technology and, eventually, to greater plant diversity.

International agricultural research

13. *Continuing the work:* the IARCs must be supported in their continuing efforts to develop improved germplasm for national adaptation|and equal efforts must be made to resist the pressures of international companies to turn the IARCs into basic research centres for their purposes;
14. *International control:* the time has come for the IARCs to come under inter-governmental control under the auspices of FAO. This will help to safeguard their scientific objectives against the pressures of companies from the industrialized countries.

The genetics supply industry

15. *Monitoring the industry:* a full study of the state of the genetic supply industry is urgently needed. The leadership for such an investigation might come from FAO or the World Food Council, and both UNCTAD and the UN Centre on Transnational Corporations should be invited to contribute;
16. *TCDC:* the very considerable potential for cooperation within the South on the convention and utilization of plant genetic resources for traditional plant breeding and for the genetics supply industry should be pursued with the support of the appropriate specialized agencies in the UN system;
17. *Commerciogenic erosion:* both public and private institutions should be required to provide national governments with environmental impact studies indicating the effect upon genetic resources of the introduction of new varieties. Notification of significant changes in varieties and crops should also be made to FAO in the event that an emergency collection is required;
18. *Separating seeds and pesticides:* national legislation should be introduced in every country guaranteeing that manufacturers of pesticide products do not become breeders or traders in the seeds industry. Where such situations already exist, the company should be obliged to divest either its seeds or its pesticides activities.

Plant Breeders' 'Rights'

19. *Evaluation:* an evaluation of the impact of exclusive monopoly PBR is sorely needed and should be undertaken in depth by UNCTAD. Information from the UNCTAD study should form the basis for a consultation on PBR prepared by FAO and WIPO with the support of UNCTAD;
20. *Legislation:* any governments contemplating any form of proprietary plant legislation should reconsider this step and at least delay action until international evaluations are available. Governments considering amendments to their existing legislation to bring laws into line with UPOV should also delay until a full evaluation of their own experience and the international experience is possible;
21. *Non-PBR restrictive practices:* UNCTAD and national governments should also evaluate the various regulatory measures that have been used by companies to give them *de facto* PBR. Such regulatory measures should be altered to eliminate this practice;
22. *Public breeding:* governments must substantially increase their financial commitment to public plant breeding (including both basic research and varietal release work) as the best means of maintaining control of the food system.

Note on the author

Pat Roy Mooney is a Canadian, working for the Brussels-based International Coalition for Development Action (ICDA). He has been engaged in international development work in Asia, Africa and Latin America since the mid-sixties, but now lives in Canada, where he also, in addition to his work for ICDA, teaches agricultural economics at Brandon University. ICDA has been following the 'seeds' issue since 1977 and has been a major actor in the development of the issue in a number of countries, as well as at various UN fora. In 1979, ICDA published *Seeds of the Earth* by Pat Mooney. A new book is now nearing completion and will be available in 1984. It is co-authored by Pat Mooney and Cary Fowler of the US National Sharecroppers' Fund. The book is a joint product of ICDA and the National Sharecroppers' Fund.

about understanding

—ideas and observations on cross-cultural communication

by andreas fuglesang

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Primary Health Care and Nutrition
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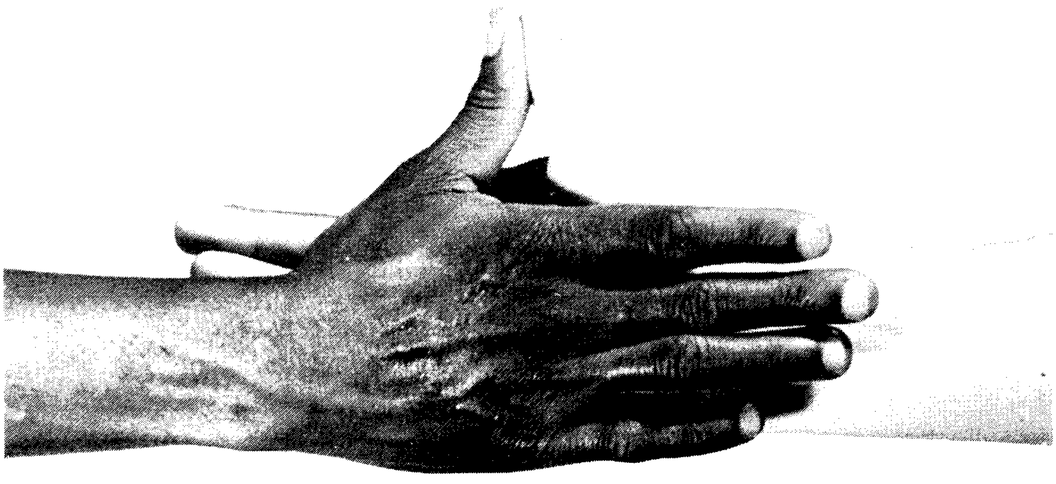
Over the last ten years there has been an ever growing importance attached to the communications *problématique.* Most efforts to transform the present international information structures have been made in a rather abstract manner and at a fairly high political level. *About Understanding* represents a major contribution to the problem of communication at the grass roots level.

In this updated and thought-provoking expansion of his earlier book *Applied Communication in Developing Countries: Ideas and Observations,* Andreas Fuglesang introduces new and bold perspectives in his analysis of the role of communications in social and economic development.

Yet the book is no abstract discourse. As a practical guide to the issue of development communication it offers workers in adult education, primary health care and nutrition in the Third World many valuable observations and ideas which they can apply to their own situations.

Andreas Fuglesang is an internationally recognized authority on information, cross-cultural communication and adult education in the Third World.



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