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UPOV

NEWSLETTER

INTERNATIONALER VERBAND ZUM SCHUTZ VON PFLANZENZÜCHTUNGEN | UNION INTERNATIONALE POUR LA PROTECTION DES OBTENTIONS VÉGÉTALES | INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

No. 25 February 1981 Geneva

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Information from UPOV

This issue contains the Records of a Symposium on

THE USE OF GENETIC RESOURCES IN THE PLANT KINGDOM

held on October 15, 1981,
on the occasion of the fourteenth ordinary session
of the Council of UPOV*

* The Records have also been printed in English, French and German in UPOV publications No. 336(E), (F) and (G) respectively and may be obtained free of charge from the Office of the Union. A Spanish edition is in preparation.

INFORMATION FROM UPOV

FOREWORD

by

Dr. A. Bogsch*

On October 15, 1980, during the fourteenth ordinary session of the Council of the International Union for the Protection of New Varieties of Plants, a Symposium was held on "The Use of Genetic Resources in the Plant Kingdom."

The lectures given and the ensuing discussions touched on a number of questions which are of vital importance both within and far beyond the field of competence of the Union and which will play a major role in its future considerations.

The Symposium, which was the first to be held within the framework of a UPOV Council session, was attended by representatives of all twelve member States of UPOV and of eleven non-member States and five intergovernmental and non-governmental organizations, and gave an opportunity for a broad exchange of very positive views on the use of genetic resources.

Our aim in publishing the Records of the Symposium in this issue of the UPOV Newsletter is to ensure that the lectures and the discussions achieve the permanence they deserve and that they reach the broadest possible circle of persons interested in plant variety protection and plant breeding matters.

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* Secretary-General of the International Union for the Protection of New Varieties of Plants (UPOV).

GENE BANKS AND CLONAL REPOSITORIES

by

Dr. J.T. Williams

I would state at the beginning that although I am here basically as the result of an invitation to FAO, I am here in several capacities. Firstly, as the Senior Genetic Resources Officer in FAO, I have charge of all the UN programmes in genetic resources. One specific one is for Europe, which we will be hearing about later today from Dr. de Bakker. Secondly, the FAO in Rome provides the headquarters and the secretariat for the International Board for Plant Genetic Resources. I am the Executive Secretary of the Board and direct the programmes on its behalf. Perhaps I ought to point out that the International Board is not an FAO organization but a centre of the Consultative Group on International Agricultural Research. I mention this because I have also been asked to be present today to report the discussion to the Technical Advisory Committee of the Consultative Group which is also interested in genetic resources as they relate to the International Agricultural Research Centres. You may know that the Consultative Group is an informal group of donors. Many countries represented here are donors to the Consultative Group and they provide funds for the research of the International Agricultural Research Centres. The IBPGR is one of these International Centres. The Consultative Group is co-sponsored by FAO, UNDP, and the World Bank.

I think it is pertinent, before discussing current activities relating to gene banks and clonal repositories, to recall the origins of the activities on crop genetic resources. Until the time in the mid-nineteenth century when it was realized that important progress could be made through selection, our ancestors had developed over many thousands of years primitive cultivars of crops. These primitive cultivars were adapted to their environments and to the cultural and economic conditions. When cross-breeding started earlier in this century this led to a vast increase in the genetic diversity available for use by breeders. At this time when plant breeding was in its infancy not many breeders used the potential of crosses between parents adapted to different environments and not until the time of the Russian, Nicolai Vavilov, did breeders begin to realize the value of this material and to use material from the vast reservoirs, or gene pools, which were available in the so-called centres of diversity. Even though Vavilov's concept of centres of diversity has been progressively modified,

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the overall concept still holds: there are large areas of the world where a great deal of genetic diversity is to be found in particular crops.

The problem facing us today is that ever since the time of Vavilov warnings have been given that these reservoirs, or gene pools, were being depleted as developing countries began economic development. The vast majority of the centres of diversity are in developing countries. It is only right that these countries should begin agricultural development and therefore use the new cultivars produced by the breeders, cultivars with higher and more uniform yields and even with better quality and certain nutritional attributes. Nonetheless, the introduction of this type of material into these areas began the phasing out of most of the land races and populations.

It was not until 1967 that a Technical Conference at FAO really succeeded in suggesting some possible solutions to this problem and so the need for genetic conservation became fairly widely recognized. A long period of gestation was needed to bring about action at the international level and the final action was the creation of the International Board for Plant Genetic Resources in 1974. The IBPGR, with the assistance of FAO, is actively establishing a global network of activities for the preservation of crop genetic resources in the centres of diversity. Since 1974 this network has become a reality.

The range of germ-plasm has an important bearing on the activities in which we are engaged. The types of germ-plasm with which we are principally concerned are the following. Firstly, there are the wild species which may or may not be the progenitors of cultivated plants; they may be closely related to them, or indeed they may be of known breeding potential value. There is usually a range of wild species except for those crop species which are cultigens, in which case we do not really know the actual origin of the cultivated form. Secondly, there are the primitive cultivars or land races. These are in effect populations which are in balance with their environment and which have remained relatively stable over very long periods. Although relatively stable they have continued to evolve through natural selection, gene exchange, introgression and the normal evolutionary processes. May I say here that the principles of the methodology of plant breeding are really an extension of the normal evolutionary processes which have gone on in the field for many thousands of years, except that the selection that is imposed is largely artificial. In addition to these types of germ-plasm there are the current or recently used cultivars which have been released. Fourthly, there are obsolete cultivars, the old varieties which are no longer in vogue, and lastly the special genetic stocks or breeding lines.

There has been, I think, in the past few years some confusion between the use of the terms genetic resources and germ-plasm. Germ-plasm of course relates to all the reproductive material; "genetic resources" was a term coined specifically for the wild material and primitive land races, even though all the different types of germ-plasm are resources for breeding. This distinction has become a little blurred, particularly in the thinking of non-breeders and others.

Faced with these different types of germ-plasm our responsibility must ultimately be to conserve for future use the whole spectrum of germ-plasm whether it is a wild species or the special genetic stocks. The special stocks may of course include mutants which have been produced by mutation breeding. There are certain mutant lines which are extremely useful and may well be useful in the future. So I include them as a type of germ-plasm which should be preserved for the future.

Nonetheless, from an operational point of view, the emphasis of the international programme has to be clearly on the wild species and primitive cultivars, for the following reasons. Firstly, for nearly all crops or species of economic interest these types of germ-plasm are barely represented in the germ-plasm collections. To give you an example, there is a very large collection of rice held now by the International Rice Research Institute, but this is relatively deficient in wild material. We have recently conducted a survey of the wheat collections of the world and even though this was a very difficult task, and in some cases some countries were unwilling to release their information, we were able to make relatively educated guesses and we found the taxonomic range to be completely inadequate. We find that the samples from geographical regions that are represented in these collections, are also completely inadequate and this poses the question now whether we proceed from the base we have already got for an important crop like wheat or whether we really start again and go about it in a much more scientific manner. At the same time, the collections have been relatively deficient in primitive cultivars, largely because breeders in the past have not used them to any great extent. I think breeding is moving towards the use of this material particularly in such areas as resistance breeding and breeding for adaptation. The primitive cultivars do contain many adaptive complexes which cannot really be resynthesized quickly in the laboratory or the experimental fields, and I think that is an important point in relation to the operation of an international programme. It is this type of material which is being eroded in many parts of the world; in fact for many crops we are facing a crisis situation.

I think you are all aware of the loss of material, particularly in the Mediterranean and the Near East. One has tended to think that certain centres of diversity are undergoing erosion much more than others. 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. We were recently collecting with a group of rather fit, vigorous young men, on foot in the mountains of Nepal, and we thought, of course, that the results of modern breeding would not have intruded very far into the remote valleys and that we would be able to gather a lot of primitive material. It is surprising how quickly the new technology advances even into the remote areas. This is one of the big success stories of plant breeding. The material is, in fact, adopted particularly in the developing countries and the remote areas.

The material we are talking about represents a heritage of mankind, not of a particular nation or a particular country. This is so because the material is needed in many parts of the world. Most of the material that breeders, for instance in Europe or in North America, require comes from other parts of the world. Throughout history man has moved his crops from continent to continent. There are some fascinating stories of the movement of crops from Africa to South-East Asia, from China back to Africa, and so on.

The organizational problems in salvaging primitive material are such that they include all activities from surveying the situation, collection, conservation, evaluation, and documentation through to utilization by the breeders. Hence, it requires the mobilization of nationals in the countries in the centres of diversity, and technical assistance and transfer of technology where there is not the expertise to do the work. These activities pose a host of practical and scientific problems. At the moment we are attempting to deal with upwards of fifty crops of global importance. If we add the related species this takes the total to over one hundred. These one hundred species are scattered throughout the world, in about fourteen regions of diversity. The magnitude of the job is rarely appreciated. Nor are the costs really appreciated. I think it is interesting to note that some five or six years ago in one country in Africa a particular scientist was able to collect population samples of African rice for approximately one U.S. dollar per sample. When we are dealing with countries where communication is difficult, where there are high energy costs and so on, some of the samples we have been collecting recently are costing in the order of four hundred dollars each, and these costs are escalating at an ever-increasing rate. Hence, people are beginning to realize that germ-plasm is valuable, probably for the wrong reasons, I think, by recognizing monetary value rather than value in plant breeding.

Less attention is placed by us in this international programme on the recent cultivars and stocks, although we recognize that these too must be conserved. We place less emphasis on them because they are frequently the responsibility of the developed world, and, apart from clonally reproduced stocks such as fruits, they pose few scientific or technical problems. It is simply a question of mobilizing interest and getting the material into conservation centres. When we are involved with programmes such as the FAO/UNDP Cooperative Programme for Europe that I mentioned earlier, then more attention has to be given to gathering together the obsolete cultivars and the recently issued but about to be superseded cultivars because the aim, in such a programme, is to have a direct impact on breeding and this material may be of more direct interest in breeding than much of the primitive or wild material. The impact on breeding in many other parts of the world of the gathering together of the primitive material will be well into the future, except for certain notable exceptions and the excellent ongoing work of the International Centres.

When the International Board came into existence it readily accepted a series of principles which had previously been defined by FAO. These principles continue to guide the activities that we carry out, to guide the granting of funds and so on. There are two major principles. One is that when material is collected in a country a subsample is left in that country for national use. Secondly, there is the principle that there shall be guaranteed the free and full availability of the material to all bona fide workers. Now I have to clarify this because these principles refer to the collection and conservation of wild and primitive material. Although some scientists would argue that they should apply to all germ-plasm, in practice, breeding lines, élite material and so on are excluded. In one or two cases, where for intance aspects of national economies are involved, we have to accept some restrictions even on wild and primitive material. One important example relates to the ban by the Government of Ethiopia on the export of coffee germ-plasm. Another example would be the wish of the beet breeders of Europe to place a moratorium on the ready exchange of material for a period of say five, ten or fifteen years. In the case of breeders' material, sometimes a time restriction is placed before the material can be freely available. Both FAO and IBPGR recognize that their member Governments and/or donors include State, public and private breeding enterprises. Hence, neither organization can or is likely to have any official policy concerning breeders' rights, except to work in a pragmatic way with all systems. Probably this is the first official statement that has come from FAO.

Recently there has been confusion concerning genetic resources, germ-plasm and plant breeders' rights, both in the press and other mass-media. There has been a statement that breeders' rights detrimentally limit the movement of germ-plasm, but there is no objective assessment of this. I am pleased to inform you that the International Board has commissioned a special study of this matter so that it can be discussed at its next Plenary Meeting in February 1981, and we hope that some of the myths can be killed fairly quickly.

Much of the confusion has been caused by the publication of a book by the International Coalition for Development Action. Not only was the book written by a non-technical person and thus some mistakes could be forgiven, but--and I now refer specifically to the chapters on genetic resources--so many official reports have been directly misquoted that the book cannot be taken seriously. Nonetheless, this book has been widely issued and is creating a large amount of discussion, not least in the developing countries.

These comments lead me to the title of this paper--a discussion of gene banks and repositories--because on this subject the book by the International Coalition for Development Action had such misconceptions of what the responsibilities of gene banks are that I need to put the record straight in public.

FAO and the IBPGR have defined two types of conservation centres. The first are base centres, that is conservation centres for long-term conservation and not for general seed exchange. In other words, the seeds are put away for posterity, they are stored according to suitable standards and their viability is monitored so that there is little or no genetic change in the stocks. The second type are active centres which hold samples from the base centres and which are involved with evaluation, documentation and exchange. In addition to these there are breeders' collections. All breeders maintain germ-plasm collections specifically related to programmes they are carrying out. The IBPGR has for a series of years now been defining a world network of base collections for the major crops. I stress that it is a world network of base collections, preserving the material against loss, for future use by plant breeders. This network is growing year by year and, in the first instance, it was necessary to designate those centres which were already in existence, which already had the facilities and the manpower. As a result many are in developed countries or in International Centres. I think it is important to point this out because the book that was issued accused the developed world of taking the genetic resources from the developing world. The IBPGR has also funded a number of base collections which act in a regional capacity, as well as several medium-term seed stores for national collections in developing countries. The biggest task we are now facing is to develop the active centres, thus helping to maintain the national collections. But it seems to me that in the foreseeable future much of the conservation has to be done in the developed world when the facilities are available.

A similar network has not yet been built up for clonally propagated species, such as fruit trees, partly because there are difficulties to be overcome. There are, for example, quarantine difficulties. We have given some attention on a world scale to banana and coconut and the IBPGR is at present engaged in discussing other important clonal material such as cassava, sweet potato and several other root crops, and already supports activities on the tropical fruits of South-East Asia. We have commissioned a global survey of tropical fruits and we hope to be able to expand our activities as from next year.

Before conserving the material it has to be collected. In 1979 the IBPGR agreed to an indicative global plan for collection to be supported over the succeeding five years. This plan will remain flexible and it will be revised annually depending on the results that have been achieved and the potentiality to move ahead. This plan represents collection requirements both by crop species and also by geographic regions of diversity. In addition, there are several groups of crops which we have not really studied. These include the tropical fruit and nut species which I have already mentioned, many of which are of global importance, and groups of other crops such as medicinal plants, spices, and tree species of interest for fuel wood, for timber and for environmental stabilization, particularly in the arid zones. With reference to the tree species the Board has commissioned the Forestry Department of FAO to undertake a preliminary survey of the arid zones of the world and to report on action which could be taken. It looks as though we will be taking action, in 1981, on this group of plants. So the activities of the International Board are very diversified, encompassing a wide range of material.

I go back to collecting because since 1977 the IBPGR has been extremely active in collecting and about 70% of its grants have been given to national institutions in areas where the projects are sited. This stimulation of local interest and participation in an international endeavour is a remarkably significant part of the work which we have initiated. Plants do not recognize national borders and so, wherever possible, the IBPGR tries to stimulate regional cooperative activities, although we are faced with a host of political problems in this respect.

In all this work the International Board provides pump-priming funds. It supports emergency collecting or priority work aimed at salvaging material and ensuring that it is adequately conserved. This, of course, involves many other activities which are outlined in the reports that we issue such as Annual Reports. But there are two items of interest to breeders which deserve mention here because I think again these are policy matters.

Since the use made of samples or accessions in the collections of germ-plasm depends upon the information which is available about them, the Board has from its inception supported a range of activities designed to facilitate the acquisition, storage, management, retrieval and exchange of information about the samples. This has met with varying degrees of success and we have had various policy changes in the way we have supported this type of work, largely because we have been overtaken by events in computer technology. It now seems that the original idea of developing an internationally acceptable system is no longer acceptable and there are now many other ways of doing this.

The International Board has discussed evaluation for the past two years and the decisions reached are rather far-reaching. We now make an arbitrary distinction beween what we call "characterization and preliminary evaluation" and "full evaluation." Characterization includes the collection data, the taxomomic identity and the scoring of a series of characters of high heritability. These are the kind of things that taxonomists really play with. But there are quite a number of characters of high heritability which are of direct interest to the breeders. This is in effect the

the preliminary evaluation. The full evaluation involves the screening for agronomic and physiological performances, the pest and disease resistances and the other traits on which breeders require information. We regard the characterization and preliminary evaluation as a task for the genetic resources centres, and the full evaluation as a task mainly for the breeders. Full evaluation, of course, is open-ended. It can go on for ever, depending on the interests of the breeding programme, and we should not lose sight of the fact that breeders will be breeding for novel requirements in the future. In this, I think, on the international scale we have a big role to play in seeing that the work gets done, but it is fraught with a large number of organizational problems. We have to do something, otherwise the collections will become museums, but it seems difficult to convince breeders to carry out the full evaluation other than for the traits in which they are particularly interested. I leave this as a thought with you. With international funding for genetic resources we simply do not have the funds to pay for the full evaluation of the material.

The term characterization for a variety, of course, has a different connotation. Here I have a plea to make in regard to documentation systems. We have been involved for some years in trying to issue a series of internationally agreed descriptor lists for the major crops. UPOV is doing the same for varietal classification. It was only recently, after our experiences with grapes and beet, that we came to realize that the UPOV lists had been finalized but that the coding for the states of descriptors does not leave sufficient "space" for the whole spectrum of germ-plasm. They have been used for varieties, modern varieties, old varieties and so on, and there is no room in the system to include the primitive material or the wild species. We are trying to resolve this amicably so as to avoid unnecessary duplication. But I would point out that the documentation systems really should be the same for all material.

In conclusion, Mr. Chairman, may I say that the main aim of the FAO and the International Board is to safeguard for mankind, through this global network of activities, the genetic variation of cultivated plants of major economic importance, and to ensure their better and speedier availability to breeders. Success in this task seemed far from reality a few years ago. I think the recent progress we have made indicates that, whilst there is still a great deal to be done, the goal is not unattainable. The more cooperation we have with breeders the sooner the goal will be reached. Finally, may I say that we are always ready to collaborate and cooperate whenever necessary.

[Original: English]

THE USEFULNESS OF GENE BANKS - PERSPECTIVES FOR THE BREEDING OF PLANTS

by

Professor G. Fischbeck*

It is now generally accepted that there is an urgent need for international cooperation in the development of a worldwide network of plant genetic resources. This development is in progress, but there are still a great many gaps to fill. The essential focus of these efforts is on the need to make such resources useful to future breeding developments in our cultivated plants. The gene banks we already have and those that will be set up in the future, and also the large collections of cultivated plants that have so far been accumulated in various places, are a guarantee of the diversity of forms that our cultivated plants have taken on by a process of natural evolution. We are aware that existing collections by no means completely cover the full range of natural forms, but if an inventory were to be made, it would be found that a great deal is in fact available, and the actual exploitation of what is already in store or otherwise accessible falls far short of existing possibilities.

At this point I should put in a word on the way in which developments in plant breeding take place. All plant breeding work has to be based on a minimum level of genetic variability. Only seldom is such variability found to an extent sufficient for immediate access. In the majority of cases breeding must first produce new genetic combinations, in order to be able to make selective use of them, i.e. by screening out those genotypes that are best suited to specific production situations. In this connection we must bear in mind--and this is quite important--that the existing or newly produced genotypic diversity available for breeding represents only a first step towards the necessary genic diversity. In other words it is not so much the sheer number of different genotypes as the different genes that are needed for novel recombinations to be produced. The difficulties that arise at this stage, to which we shall have to address ourselves more and more in the future in connection with guaranteeing and taking full advantage of plant genetic resources, are clearly apparent even from the few figures in the table below (Table 1).

The product of a cross between two parents whose genes differ in only one locus can only produce 2^1 different types of gametes, from whose random recombination into

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new zygotes a maximum of 3^l different genotypes can result, including 2^l genotypes in a homozygous state. The smallest "perfect" population that would be necessary for every genotype to be represented at least once would be 4^l F_2 progeny. If we assume an independent segregation (unaffected by linkage) of ten heterozygous loci, this already produces 2^{10} = 1,024 different gametes and the same number of homozygous genetic combinations, and 3^{10} = approximately 59,000 different genotypes. There would have to be more than a million progeny in order that each of these genotypes be represented at least once in the F_2 generation. A cross with 20 different loci, which in relation to the total number of genes in a plant species is absolutely minute, already produces more than a million homozygous but genetically different progeny and also more than three thousand million distinct genotypes, including heterozygous combinations, and we reach inconceivable numerical dimensions, which we can no longer handle, if we calculate the smallest "perfect" population in which all these genotypes would be represented at the same time. What interests the breeder, however, is not the actual presence of all these genotypes, but rather the use of the different alleles in optimum combination. In this way we are faced with an unavoidable dilemma. The gene banks will fill up with more and more material and we do not know how many different genes they contain. We know and can predict that an incalculably large number of genotypes will be stored in the gene banks. For breeding purposes however, for which this material is ultimately to be used, it is becoming increasingly important to have certain minimum data on the genetic make-up of this diversity of forms.

We shall now proceed to a second chapter, which is particularly significant in connection with the importance that should be attached to the protection of genetic resources. This is the question of genetic erosion.

The international debate has quite rightly assumed that the progress of plant breeding itself is, in any case, linked with a reduction of the former diversity of forms. It then of course seems equally fair to deduce that at the same time many genes will simply die out and be lost. However, if we are to be scientifically accurate, the question is at the outset one of the erosion of genotypes, and once again we do not know for certain whether we have already actually lost the last example of a particular allele or whether such rare alleles are still included in the infinite number of possible recombinations of different hereditary components. The question is therefore an extremely difficult one, and it must not be disregarded whenever the problems of genetic erosion are spoken of. There is undoubtedly a risk that we cannot rule out fully, in spite of all the efforts made, even if one considers the extent of interest in, and approval of, measures for the safeguarding of genetic resources.

We now have to concern ourselves with the question of the way in which the safeguarding of genetic resources can be used to the best advantage in future plant breeding work. This overlaps the question of the use of gene banks now being set up and those already in existence. On this subject too I should like to start with an example which, while not at all of universal validity, nevertheless affords a good introduction to the problem area concerned. Even though it originated in what today are already the more developed countries, it could well have even greater importance for present developing countries. Figure 1 shows the parentage of certain varieties of winter wheat, which admittedly, with the exception of Cappelle, are no longer grown, but are of special significance in relation to the thoughts we shall develop later. The figure makes a distinction in each case between those progenitors of the end products shown that were grown in the latter's own home country and could often be traced to land races from those countries, and other progenitors from foreign countries, which show that foreign genetic material has always been a factor in the development of the wheat varieties selected for the illustration. The figure thus makes it very clear that the breeding development of winter wheat in Central Europe has relied from the very outset--there is in any case no exception among these five particularly important varieties--on combinations in which domestic material, with its adaptability to local conditions, was mixed with foreign genetic material that by no means always originated in neighboring countries. Thus, well back in the parentage of German winter wheats there are not only Swedish and French progenitors, but also Russian local wheats and spring wheats from the United States of America. I should like to make this clear in connection with what we have never known and probably never will know, namely what and how many alleles our domestic wheat population has lost in the course of this process, precisely because the old land races have completely disappeared from the fields, and because we certainly have not preserved all of them in the old collections of cultivated plants. What is certain, however, is that from the very outset the breeding development of such highly sophisticated species of cultivated plants as wheat was determined by an input of genes intended to enrich the domestic diversity of forms with genes with particularly good combining ability from quite different ranges of diversity. This reflects a principle which is basically always present, albeit in different forms. The breeding development of important cultivated plants is never a purely national matter, indeed such a situation has never existed. Even though attempts have sometimes been made to raise administrative barriers, healthy personal relations between individual breeders on all sides have always ensured that there is some gene exchange involving interesting breeding material, to the mutual advantage of the parties concerned.

At this stage it would seem appropriate to make some comments on the problem of genetic vulnerability, which is one that is brought up in any discussion on genetic erosion. There are a series of examples of the situation where concentration, in the growing of individual species of cultivated plants, on a few closely related genotypes or even just one variety has been responsible for painfully decreased yields, and these are then attributed to the "genetic vulnerability" which in fact is the result. One of the most significant examples from recent times is the use of "Texas" cytoplasm in American maize breeding. It served the sole purpose of cheapening the production of hybrid seed. By incorporating Texas cytoplasm, male-sterile forms of inbred lines could be produced, thereby avoiding the costly work of "detasselling" (removing male flowers) one of the crossing partners in the production of seed of hybrid maize varieties. Unfortunately all American maize breeders used the same initial material (Texas cytoplasm) for this development, even though other sources of cytoplasmic male sterility were already known, albeit less easy to handle. A few years after this development had been extensively implemented, a particular race of a leaf disease occurred in epidemic proportions in 1970, to which all Texas cytoplasm hybrids were very susceptible, and in that year there was a loss of about 15% of the overall grain maize harvest of the United States of America. A drastic decision to return to detasselling had to be taken, leaving the problem of vulnerability that was caused genetically, by the concentrated cultivation of genetically closely related types. Another case occurred somewhat later, in 1972, in the Soviet Union, during a particularly severe winter, causing losses of some millions of tons of winter wheat. At that time the famous Soviet Union variety Besostaja had reached an area of cultivation of about 40 million hectares. It had gone far beyond its original cultivation area in the region of Kuban and had spread far into the Ukraine, forcing out the more cold-resistant varieties that were suited to the area, because even in the Ukraine, after milder winters, it had produced higher grain yields. This too is an example of genetic vulnerability in conjunction with the exclusive use of a high yielding variety.

There is no doubt that the losses referred to above were caused primarily by the progress of breeding. However it is not correct to look on the genetic vulnerability reflected in them merely as the reciprocal of genetic erosion. The lessons to be learned from these circumstances have to take at least two facts into consideration. In breeding care has to be taken not to fall below a minimum level of genetic diversity, and in cultivation one should not forget to make use of the remaining genotypic diversity.

We can now address ourselves to the central issue which above all others will benefit from the use of gene banks. It consists in the conservation and availability of genetic reserves for the purposes of future plant breeding. Here too I should like to start by considering a suitable example, which shows what genetic reserves plant breeding draws on at present in the advanced stages of development (Figure 2). In doing this we can continue the previous presentation of the parentage of certain varieties of winter wheat (Figure 1). Figure 2 uses the same variety names, for instance Derenburger Silber, Heine VII, Cappelle and Carsten VIII. The Merlin variety resulted from the cross Derenburger Silber x Heine VII and the Caribo variety resulted from the cross Cappelle x Carsten VIII. This produces without any difficulty two groups of relationships, which are specifically identified in Figure 2. The same figure also shows that, with only a few exceptions, the whole range of winter wheats available on the German market, representing about 40 bred varieties, is in some way attributable to recombinations of these two groups of forms. Clearly advances in breeding have led to a concentration of valuable genetic combinations, which can also be regarded as adaptive gene complexes. The example moreover leads one to believe that between the adaptive gene complexes in the two groups of forms identified here there is a specific combining ability, which might explain the high degree of success of these crosses in particular. Something similar may have occurred in the previous stages, where the degree of concentration of the available gene complexes was less. Therefore the genetic reserves for the continued development of breeding for high performance have to be sought above all in comparably highly adaptive gene complexes with different genetic origins. However, our example already points to the fact that the genetic concentration process associated with it cannot continue indefinitely, but requires the input of new genetic reserves at a high adaptive level. New genetic material is therefore required even for the further breeding of high-yielding wheats in Europe. We must not however expect it to be available in the form of individual gene bank numbers, just waiting for discovery and subsequent use; it will far more probably require systematic development work, for which of course the gene banks do have the raw materials.

At a lower level of breeding the solution to this set of problems may be easier, but the principle will look no different. And yet it would be fundamentally wrong to look at the use of genetic resources by breeders only from the point of view of the individual losses or gains of the country of origin or breeding firm. It is far more important when considering the problem of the use of plant genetic resources to understand that, between collecting and using genetic reserves for plant breeding, there is an enormously difficult task to be carried out, namely that of establishing, by systematic and patient cooperation, where the genetic resources that are really important for the future are actually to be found.

Finally an attempt should be made to devise systematic guidelines for the use of gene banks (Table 2). Four problem areas can be distinguished in that connection.

The simplest case refers to the introduction of rare alleles into existing breeding material that is suited to a particular region. Significant examples of this are the efforts to improve the protein content of maize and barley, or the modification of the fatty-acid composition of rape oil. The prerequisite for this is the tracing of such rare alleles in available collections, which as a general rule succeeds only with the aid of suitable testing methods which make it possible to conduct some 10,000 tests in the course of a few months. It may be expected that it will be necessary again and again to apply such newly developed testing methods to the material stored in the gene banks in order to identify hitherto unknown hereditary characteristics. Thereafter the use of the results in the breeding process becomes quite simple. It consists in the relatively simple use of back-crossing methods, in which admittedly there is no guarantee of eventual success in any case, as shown by the so far fruitless efforts to breed high-lysine barleys with a normal yield.

The demands increase when one seeks to achieve systematic diversification of the range of varieties, for instance in order to lessen the genetic vulnerability of an important species of cultivated plant. Here appropriate test procedures must be used first to identify suitable resistance factors, but then, in a further stage, to establish their genetic identity or differentiation, as the case may be, in order to permit systematic use for the adequate differentiation of the resistance spectrum of the cultivated bred varieties. This set of tasks can also become more difficult in terms of method, when consideration has to be given not only to qualitative but also to quantitative differences in states of expression of the characteristic concerned. These at the same time represent the transition to the subsequent, third stage.

The third stage involves the systematic use of adaptive gene complexes and their improvement by genetic transfers. Here too it is first necessary to use appropriate test procedures to identify the characteristics sought, for which in many cases, however, pure laboratory methods may no longer be sufficient. The characteristics concerned are as a rule quantitatively inherited characteristics, including for instance increased cold or drought resistance or heat or salt tolerance, which can be of considerable importance to many developing countries. But even increased yield potential within the adaptive material can be included. In this area we must expect not only great difficulties with respect to the identification of hereditary differences in reaction: there is also the fact that specific combining ability between individual characteristic vectors has to be identified with a view to achieving the aim of their improvement by transfer, which at present only seems possible by means of fairly costly analysis of crosses.

There is nevertheless a further, fourth stage that causes even greater difficulties in the systematic exploitation of genetic resources. This stage involves the "reassembly", so to speak, of adaptive gene complexes from simpler recombinations of the genes responsible, with the specific aim of ensuring at the same time a high specific combining ability with available performance vectors. Here then exploitation is preceded not only by the recognition stage, but also by what can be a long drawn-out development stage. In this connection Professor Schnell has invented a very apt expression, namely the constitution of "Evolutionsramschen", or random collections of evolutionary material. There is every likelihood, judging by the state of genetic relationships between German winter wheat varieties, that this may soon become necessary at the high level of breeding that in some cases has already been reached.

Only in a few exceptional cases can specific demands on existing gene banks be met in relation to the two simpler problem areas, at least with respect to part of the material stored in those banks.

Thus we can see what enormous challenges have to be met in the practical evaluation of the material at present stored in gene banks and not yet completely described, even before its systematic use in plant breeding can begin. The time has definitely come to devote far more attention to those challenges.

I should now like to sum up this survey in the form of three conclusions:

1. The value of existing gene banks and of the international gene bank network currently in preparation is evident in the possibilities they afford for further breeding development of our spectrum of cultivated plants in the form of rapid and perhaps even systematic access to the material necessary for the production of novel genetic combinations.

2. The use of gene banks in breeding calls for considerable preliminary work in the evaluation of the material available. The initiation and carrying out of this evaluation work must be given more priority and concentration than hitherto.

3. The evaluation work for the identification and release of plant genetic resources has to change in line with progress in breeding research and practical breeding objectives. This will be achieved only through international cooperation combining the efforts of breeding research and development.

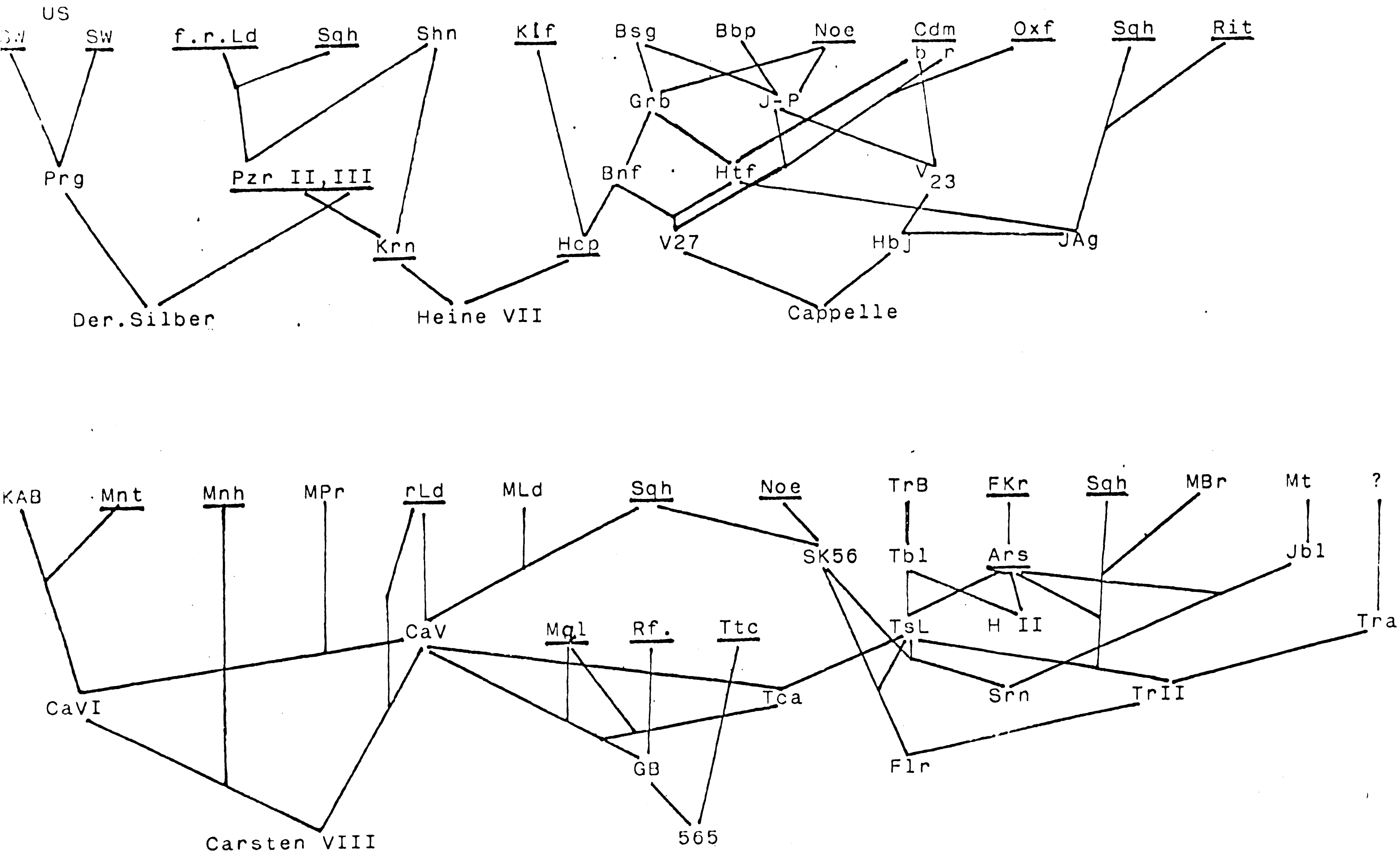
[Translated from the German]

Table 1

NUMERICAL RELATIONSHIPS FOR GENETIC SEGREGATIONS
ACCORDING TO NUMBER OF PAIRS OF ALLELES INVOLVED

NUMBER OF SEGREGATING PAIRS OF ALLELES (N)	1	5	10	20	N
NUMBER OF GENETICALLY DIFFERENT F_1 GAMETES	2	32	1 024	1 048 576	2^N
NUMBER OF GENETICALLY DIFFERENT F_2 GENOTYPES	3	243	59 049	3 486 784 401	3^N
SIZE OF THE SMALLEST "PERFECT" F_2 POPULATION	4	1 024	1 084 567	1 099 511 627 776	4^N

Origins and relationships of important parent material for crossing in winter wheat breeding in the Federal Republic of Germany



non-indigenous parent material underlined

Figure 1

Figure 2

Groups within the range of winter wheat varieties

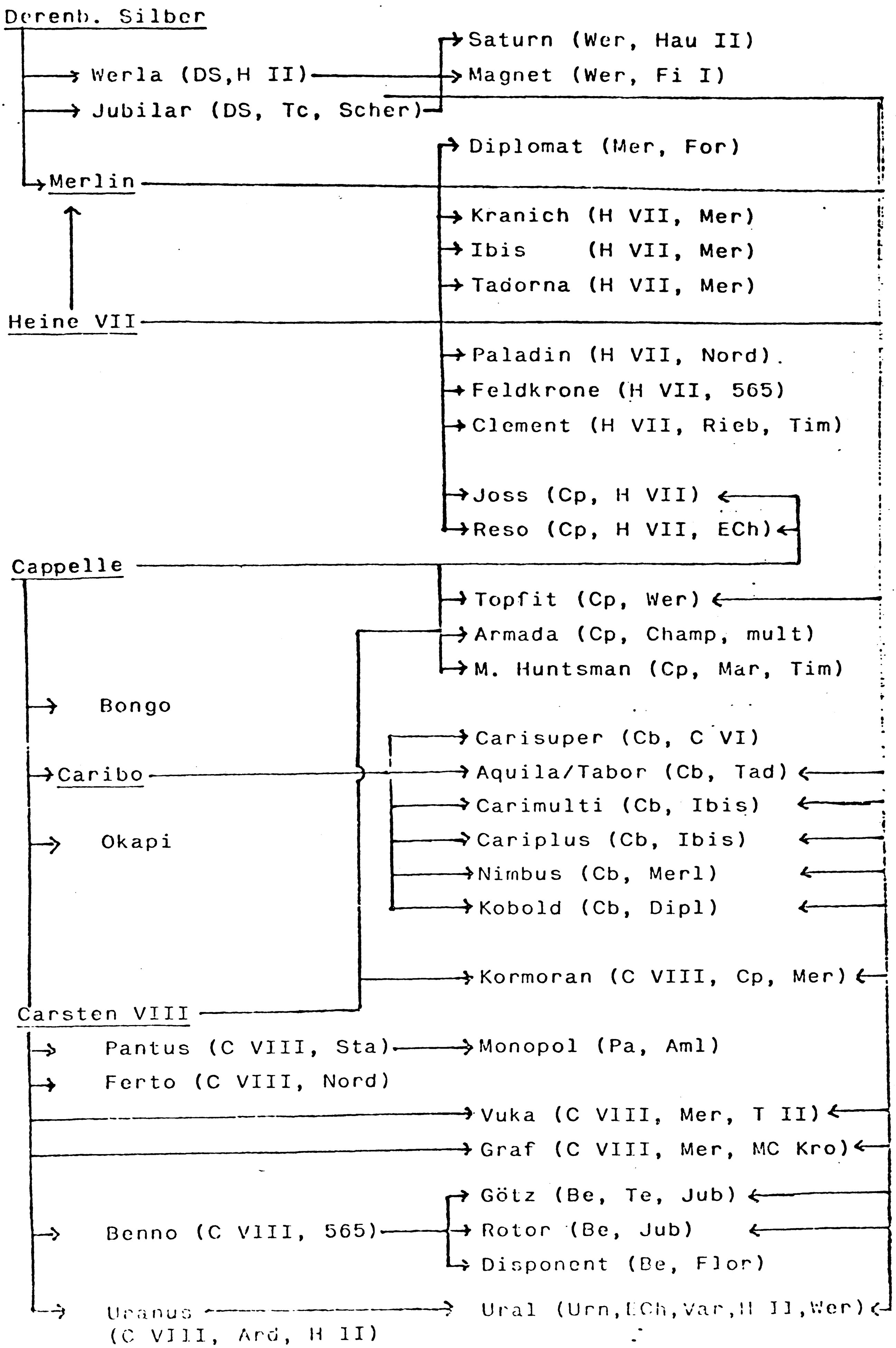


Table 2

PROSPECTS FOR THE USE OF GENE BANKS IN PLANT BREEDING

	OBJECTIVE	METHODOLOGY REQUIRED	BREEDING ACTION	EXAMPLES OF USE
1)	INTRODUCTION OF RARE ALLELES	SUITABLE TESTING PROCEDURES	BACK-CROSSES	ALTERATION OF QUALITY CHARACTERISTICS
2)	PLANNED DIVERSIFICATION OF AVAILABLE VARIETIES	GENETIC ANALYSIS OF RESISTANCE CHARACTERISTICS	BACK-CROSSES AND RECOMBINATION INSIDE GROUPS	CONTROL OF DISEASE EPIDEMICS
3)	INCREASED USE OF ADAPTIVE GENE COMPLEXES	SUITABLE TESTING PROCEDURES	IMPROVEMENTS BY TRANSFER AND RECOMBINATION OF UNRELATED BASE MATERIAL	ADAPTATION TO EXTREME ENVIRONMENTS
4)	CONSTITUTION OF RANDOM COLLECTIONS OF EVOLUTIONARY MATERIAL (EVOLUTIONSRAMSCHEN)	DATA BASE FOR SELECTION OF (UNRELATED) BASE MATERIAL	RECURRENT SELECTION IN SEVERAL PARTIAL POPULATIONS	ENHANCEMENT OF PERFORMANCE POTENTIAL

PLANT BREEDERS' RIGHTS AND THE IMPROVEMENT OF PLANT VARIETIES

by

Mr. P.W. Murphy

I have been asked to speak on the subject of plant breeders' rights and the improvement of plant varieties. I should like right at the start to add a qualification in that I am going to talk only about the improvement of plant varieties in the United Kingdom because that is really all I know a great deal about in the context of plant breeders' rights. What I propose to do therefore is to try to make an assessment of the contribution to agricultural productivity arising from the introduction in 1964 in the UK of the plant breeders' rights system.

I should explain that I took over responsibility for the UK plant breeders' rights system only fairly recently. When I came to the job two and a half years ago I more or less took it for granted that the value of plant breeders' rights was more or less beyond dispute. Like other proprietary rights I thought it was "a good thing." Nobody seemed seriously to dispute the value of the patent system or the copyright system and similarly I thought very much the same about plant breeders' rights. It was something of a surprise to me, and probably to many others in the room today, when we were confronted with the criticism from the opponents of plant breeders' rights, from the "Seeds of the Earth" lobby. While we all perhaps realized that many of the arguments contained in Mr. Mooney's book are misinformed and misleading we had to apply ourselves to thinking about the benefits of the plant breeders' rights system and to this extent perhaps the book has served some purpose.

We have looked in the UK over the past year or so at the contribution of plant breeding generally and plant breeders' rights in particular. We are perhaps in a rather better position now to draw certain conclusions on the basis of the operation of the system over the past fifteen years. The first assessment we had to make was of plant breeding in general. We looked at the situation in the UK in 1960 when a UK system of plant breeders' rights was first discussed seriously. Our legislation was founded on a report published in 1960, entitled

* Controller of Plant Variety Rights, The Plant Variety Rights Office, Cambridge, United Kingdom

"Report of the Committee on Transactions in Seeds." This report recommended that plant breeders' rights should be introduced for two basic reasons. The first reason was as a means of providing plant breeders with a reward based on equity. All other inventors and innovators were able in some form or another through the patent and copyright protection systems to obtain a reward arising from their innovation. But this, for various reasons, was denied plant breeders. So, the first objective was to provide equity for plant breeders. But the second and probably more important reason was to encourage additional investment in plant breeding and as a subsidiary to that to encourage the introduction into the United Kingdom of good, improved plant varieties bred abroad. If we can go back to the 1960 report, it was stated there that, although it was appreciated that more effort devoted to a research programme would not necessarily mean that better results would be obtained, the Committee thought that it was reasonable to expect that an increase in the amount of breeding work, and more particularly in the number of breeders at work, would bring about an improvement in the supply of new and useful varieties. So, in other words, the Committee concluded way back in 1960 that the more resources that could be directed into plant breeding the better would the result be in terms of improved varieties. That was the conclusion of the report and so we introduced plant breeders' rights in 1964.

If we can look again at the two reasons for introducing plant breeders' rights --equity and encouragement of investment in plant breeding--we can perhaps dismiss the first objective, equity, as being one which does not really encourage governments to take action. As we have seen in other areas, plant breeders are usually a very small minority in a country and, therefore, I do not think governments would be convinced of the need to introduce a fairly elaborate system for examining and protecting new varieties if it were only a matter of fairness to plant breeders. Governments must therefore have been convinced of the need for additional investment in plant breeding, and we have to ask ourselves why. Well, of course, the reason is that plant breeding does and has been shown to make a major contribution to agricultural productivity in a number of ways: through increased yields, greater pest and disease resistance, improvement in the quality of the product and satisfaction of changing consumer and producer requirements. It is also, and this is a very fundamental point, the only means of increasing the potential yield of crops and grass. Improved husbandry methods are capable only of exploiting the in-built potential of plant varieties which plant breeders have established.

Perhaps we can have a look at some specific facts illustrating the contribution of plant breeding to agricultural productivity in the UK. A very useful study was conducted recently by Mrs. Silvey of the National Institute of Agricultural Botany in which the contribution of new varieties of wheat and barley to productivity is examined.* Wheat and barley are the two most significant agricultural crops in the United Kingdom, occupying more than 70% of the arable crop area. This is approaching four million hectares. Mrs. Silvey's study is very interesting indeed in that it shows that in the period between 1947 and 1977 the wheat yield in England and Wales--it does not include Scotland and Northern Ireland--increased by approximately 94% and the barley yield by 67%. That means an increase in the case of wheat from 2.4 tons per hectare to over 4.7 and in the case of barley from 2.3 tons per hectare to 3.8. When you look at the constituent parts of this yield increase the study shows that in the case of wheat 56 percentage points of the 94% was a result of improved varieties; in the case of barley 32 percentage points of the 67% was a result of improved varieties. What is even more interesting is that the increase in yield over the last ten years or so is almost half of the total yield increase. Furthermore, during the last ten years, by far the larger part of the increase in yield appears to be the result of improved varieties, as opposed to the contribution from improved husbandry techniques. This is based on England and Wales information, but it will be interesting to learn whether there has been a similar phenomenon in other countries, because if this trend is going to continue in the future I think it does have significant implications in that very much the greater part of the net increase in productivity that we can expect looks as if it will have to come from the improvement of plant varieties. If other countries have information similar to that which Mrs. Silvey has produced they might look at this point because I think we would be interested in the UK to have a comparison with the experience in other countries.

We know therefore from this information what plant breeding can contribute and the UK experience over the past 30 years is quite clear. The important question today, however, is to establish what role, if any, plant breeders' rights have played in this process. It is impossible to say with absolute certainty what the contribution of the plant breeders' rights system has been. But we can look first of all at the situation before we introduced a law, and then at the situation today. Going back to 1960, we can look at the Report of the Committee on Transactions in Seeds and there the position which was reported was a very disconcerting one in terms of

* Journal of the National Institute of Agricultural Botany, Vol. 14, pp. 367-384; updated and condensed in Phoenix, Bulletin of the Agriculture Development and Advisory Service (ADAS), No. 102, June 1980, pp. 1-5 (see page 31 of this issue).

the private sector effort in the UK in plant breeding. It said in fact that commercial plant breeding in the major agricultural crops was virtually non-existent. We depended either on State breeders or on improved or new varieties bred by foreign breeders. There was little possibility of the private sector breeder obtaining any return on his investment, particularly in the easily reproduced crops, and therefore it is not surprising that the State breeders were the only ones active in the agricultural crops sector. This is not of course to decry in any way the contribution of the State breeders. They have produced major varietal improvements, but it is nevertheless true that before the introduction of the plant breeders' rights system we had to depend either on the contribution of State breeders, which was really dependent upon the amount of money which the government of the day was prepared to put into plant breeding, or on the spin-off from plant breeding expenditure by commercial breeders outside the UK.

Perhaps we can compare that situation with the situation we have in the UK today. We have now had 15 years' experience with plant breeders' rights but it is only recently that many agricultural and vegetable species have been afforded protection. We started in 1965 with just five species subject to plant breeders' rights: these were wheat, oats, barley, potatoes and roses. It is perhaps appropriate to look at the contribution in the cereal sector because this is where the commercial breeder has been most active, certainly in the UK. Plant breeding is after all a long term process and one is unlikely to obtain results out of investment in plant breeding except after a very appreciable time. I think that we are now beginning to see the results of the substantial increase in investment in private sector plant breeding in the UK, in cereals in particular.

What has in fact happened in the UK during these fifteen years? First of all we have seen a sharp increase in the number of varieties coming forward for protection in all species subject to plant breeders' rights. We started off with 107 varieties in the first full year of the system in 1966 and this reached a peak of 408 in 1978, with a slight fall in 1979 for particular reasons connected with a problem we had with Chrysanthemum testing. We do not of course yet have the figures for 1980 but overall there has been a substantial increase in the number of varieties coming forward for protection. Secondly, the number of private sector firms and companies engaged in plant breeding has increased from the ten or so which were members of the British Association of Plant Breeders in 1967 to 23 currently. So there are more than twice as many firms involved in plant breeding in the agricultural and vegetable crop sectors as there were shortly after the introduction of our plant breeders' rights system. Thirdly, investment in private sector plant breeding has increased sharply in the more recent years. It is very difficult to get figures from companies indicating their investment programmes in plant breeding and it is perhaps not surprising that they are reluctant to divulge them, but here again the British Association of Plant Breeders collected certain information which showed that there had been a 500% increase in investment in plant breeding over the last five years. This is a very substantial increase. Unfortunately wo do not have access to the actual figures but, as the Committee on Transactions in Seeds envisaged, the greater the investment in plant breeding the more likely we are to have successful improved varieties in the end. Fourthly, we now see substantial improvements in varieties coming from the private sector. If we look at Mrs. Silvey's study again this shows that the rate of improvement in wheat and barley has accelerated since the late 1960's and it is proceeding at a very rapid pace now. The improvement has indeed been most rapid in probably the mid to late seventies.

In spring barley, which is the most extensively grown crop in the United Kingdom, the private sector has taken over the lead from both the State breeders in the UK and from the foreign breeders. If we look at the advisory recommended list of spring barley varieties issued by the National Institute of Agricultural Botany six out of the nine varieties on the fully recommended list are varieties bred by the United Kingdom private sector breeders; the same is true for three out of the seven varieties on the provisionally recommended list. All of the recommended varieties of wheat and barley have been produced in the last fifteen years, plant breeders' rights having been granted in respect of all of them, and it is taken for granted that a new variety is subject to protection.

Some of the improvements over the last fifteen years have been achieved in the State sector, particularly in wheat, and it can be argued of course that these improvements result from factors quite beyond the influence of plant breeders' rights. But even here it could be argued that the contribution of the State sector is to a certain extent influenced by the increased competition which is provided in the private sector. It is also true that the government itself in the UK derives a return from its investment in plant breeding by the charging of royalties on State bred varieties. So, to the extent that the royalties on the State bred varieties flow back into the exchequer, it is perhaps arguable that investment in State plant breeding is increased as a result of the plant breeders' rights system, and not cut back as it might be in periods of financial stringency.

It is also relevant to point out that the initial improvement following from the introduction of our legislation arose from the introduction into the United Kingdom of varieties bred abroad. The Act did in fact encourage very significantly the establishment in the UK of companies which did very little else initially than evaluate varieties bred abroad. They could hope to attain some reward from the commercialization of these varieties and therefore they were prepared to put in a substantial investment in evaluation programmes. It is interesting that many of these companies which started off by introducing foreign varieties developed their own specialized breeding programmes and are now producing varieties bred in the UK. I think this is perhaps a relevant point for countries which currently do not have any private sector breeding effort and are wondering what the value of a plant breeders' rights system may be for them. Our experience, I think, is that only by establishing a plant breeders' rights system do you actually encourage companies to even consider introducing varieties and investing any money in the evaluation of foreign varieties. This in turn can lead them to establish their own private breeding programmes.

It is clear too that the commercial plant breeders themselves value the plant breeders' rights system and they are continually pressing us for an extension of the system to additional species so that they can plan ahead in the hope that they will obtain some reward. This indeed is causing some problems for the official testing authorities in that we shall very soon reach the limits of our capacity and we shall have to look very carefully at where our testing resources are going to be allocated. It is nevertheless very good for agriculture generally.

I do not think I could say that the information we have so far proves beyond any doubt that the plant breeders' rights system has achieved the objectives which it set out to achieve, but I think any reasonable observer would accept that it has made a major contribution to productivity. Certainly the information points much more strongly in this direction than it does in the direction pointed by the opponents of the system. If you take a reasonable view of the situation now, we can say that it suggests that the objectives of the legislation are being achieved.

I should like to finish with just two further comments. Firstly, I think a lot of the criticism of the plant breeders' rights system has been directed at the system in isolation. But of course the system does not operate in isolation. It is a system which is designed to encourage investment in private sector plant breeding but it also needs to be supported by public measures taken to give independent advice to farmers on the quality of new varieties. We have no requirement under the plant breeders' rights legislation that the new variety shall be an improvement on existing varieties. It is expected that there will be an improvement because there is no point in investing in programmes which do not lead to an improvement. But we have in the United Kingdom a system of varietal evaluation which has been shown to provide major benefits to the agricultural industry, and it is only varieties recommended by the various testing authorities which are widely sold in the United Kingdom. This provides a major degree of protection for the farmer and it ensures that plant breeders will indeed breed varieties which are better than existing varieties, otherwise they do not obtain any reward. As I said earlier in respect of wheat and barley, all the varieties which are on the recommended lists of the various testing authorities are now protected varieties and indeed it is clear that seed of non-recommended varieties is simply not sold in the United Kingdom in any significant quantity. So, if a breeder wants to obtain a financial reward he really has to show that his variety is a distinct improvement over existing varieties. This is an important point, I think, in defending the system against ill-informed criticisms such as we have seen in "Seeds of the Earth."

The second and final point which I wish to make is that the plant breeders' rights system has not so far excited any substantial criticism from the final user, the farmer. He appears to be prepared to pay the rates of royalties charged on new varieties because these are varieties which offer him substantial benefits. We have as a matter of interest a system for indexing cereal royalty rates and this is now being extended to potatoes. The system is participated in by representatives of plant breeders, the seed trade and the farmers' organizations, and they appear to be reasonably happy with the system as it currently operates. Indeed it was rather interesting that when we introduced protection recently for oilseed rape, which is a comparatively new crop in the United Kingdom, the initiative did not come entirely from plant breeders. It came indeed from one of the farmers' organizations. They wanted greater investment in plant breeding in this crop, they saw the benefits and they therefore wanted protection to be extended to this crop as soon as possible. I think, therefore, that it can be said that our system does at least have the general support of the farmers' organizations. This is perhaps another important point to bear in mind when dealing with the criticisms made in "Seeds of the Earth."

[Original: English]

THE INFLUENCE OF IMPROVED CROP VARIETIES AND HUSBANDRY METHODS ON INCREASING CEREAL YIELD*

by

Valerie Silvey, National Institute
of Agricultural Botany (NIAB), Cambridge, United Kingdom

National average yields for wheat and barley in England and Wales, published annually by the Ministry of Agriculture, Fisheries and Food (MAFF), show upward trends for both crops from a 2.5 t/ha level in the nineteen forties to present national average yields of about 4 t/ha for barley and 5 t/ha for wheat. Estimates of the proportion of the national increase in cereal yield attributable to the adoption of new varieties in the period 1947 to 1975 have been published. The results are summarised and updated below.

The trends in national yield for barley and wheat respectively are shown by the upper curves in figures 1 and 2. Annual national average yields can fluctuate considerably as a direct result of seasonal factors. To reduce this potentially distorting effect these national yield curves are based on five-year moving averages; thus the 1977 yield is an average of MAFF yields 1975-79. The lower curves, calculated by combining annual records of the relative popularity of wheat and barley varieties with their relative yields in NIAB trials, estimate the increase in yield due to the adoption of new varieties. The difference between the upper and lower curves reflects the additional yield increase produced by improvements in other factors. Cumulative increases in yield attributed to variety and to other factors are shown at ten-year intervals.

The five-year national average barley yield increased from 2.31 t/ha in 1947 to 3.85 t/ha in 1977. It is estimated that adoption of improved varieties and use of better husbandry methods account for 32% and 35% respectively of the total 67% yield increase.

From 1947 to 1957 a 16% yield increase resulted from the use of stiffer strawed new varieties like Herta and Proctor which outyielded their predecessors by at least 10%. A further 15% increase can be attributed to increased use of fertilisers, chemical herbicides, better seed dressings and combine harvesters.

* Reproduced from Phoenix, Bulletin of the Agriculture Development and Advisory Service (ADAS), No. 102, June 1980, pp. 1-5, by kind permission of the editor and of the author.

Between 1957 and 1967 the widespread adoption of Proctor and similarly high yielding varieties contributed a further 5% to the national yield. However, many of the new varieties being commercialised in the sixties possessed specific disease resistances which were rapidly overcome by new pathogen forms. The beneficial effect of the higher yielding varieties could therefore be counterbalanced by disease problems which probably depressed the variety effect on increasing yield at this time. A far greater, 20% contribution to national yield increase is attributed to husbandry factors, a major one being the increased use of nitrogen fertiliser made possible by the existence of stiffer strawed varieties, less prone to lodge than their predecessors.

The area under barley doubled between 1957 and 1967 and this provided increased opportunity for new, more virulent, races of pathogens to increase and varieties--like Zephyr and Julia--with specific resistances were especially vulnerable. Nevertheless from 1967 to 1977 a further 11% increase in national yield is attributed to the adoption of barley varieties such as Sultan, Mazurka and Aramir which outyielded Proctor by at least 10%. The proportion of barley acreage sown with winter varieties rose from 7 to 25% in the seventies. New winter barleys outyielded Maris Otter by over 10% and have a potentially important contribution to make to national yield increases.

Figure 1 shows no extra contribution to national yield due to improved husbandry (other factors) since 1967. However, the high yield increase to be expected from recently commercialised varieties is dependent upon using the best husbandry techniques and diversification strategy in order to counteract the hazards arising from intensive cereal cropping and the lack of durable disease resistance. "Other factors" continue to operate but apparently rather in a corrective than in an additionally productive role for the time being.

Wheat

The five-year national average yield of wheat rose from 2.42 t/ha for 1947 to 4.69 t/ha for 1977. Of the total 94% increase in yield it is estimated that improvement in husbandry methods accounts for 38% while 56% is attributable to the use of the better varieties.

Other factors than variety are estimated to have contributed 36% to the increase in wheat yields nationally between 1947 and 1967. This is very similar to the 35% increase achieved for barley in the same period and no doubt arises from improved husbandry practices already discussed for barley.

The period 1947-67 brought an estimated 26% increase due to variety and saw the establishment of Cappelle Desprez as undoubted market leader, commanding 25-65% wheat seed sales for fifteen years.

Between 1967 and 1977 a further remarkable yield increase of 30% is estimated to be attributable to variety, notably to Maris Huntsman which outyields Cappelle by 20% and has accounted for between 20 and 30% of winter wheat seed sales since 1974. Spring wheat varieties generally accounted for less than 10% wheat acreage in recent years and higher yielding newcomers make little impact on national yield increases.

There has apparently been only 2% additional increase in yield since 1967 due to factors other than variety. Wheat and barley growers share problems arising from intensive cropping and lack of durable resistance in new varieties but have clearly achieved high standards of crop management in producing the overall remarkable yield increases.

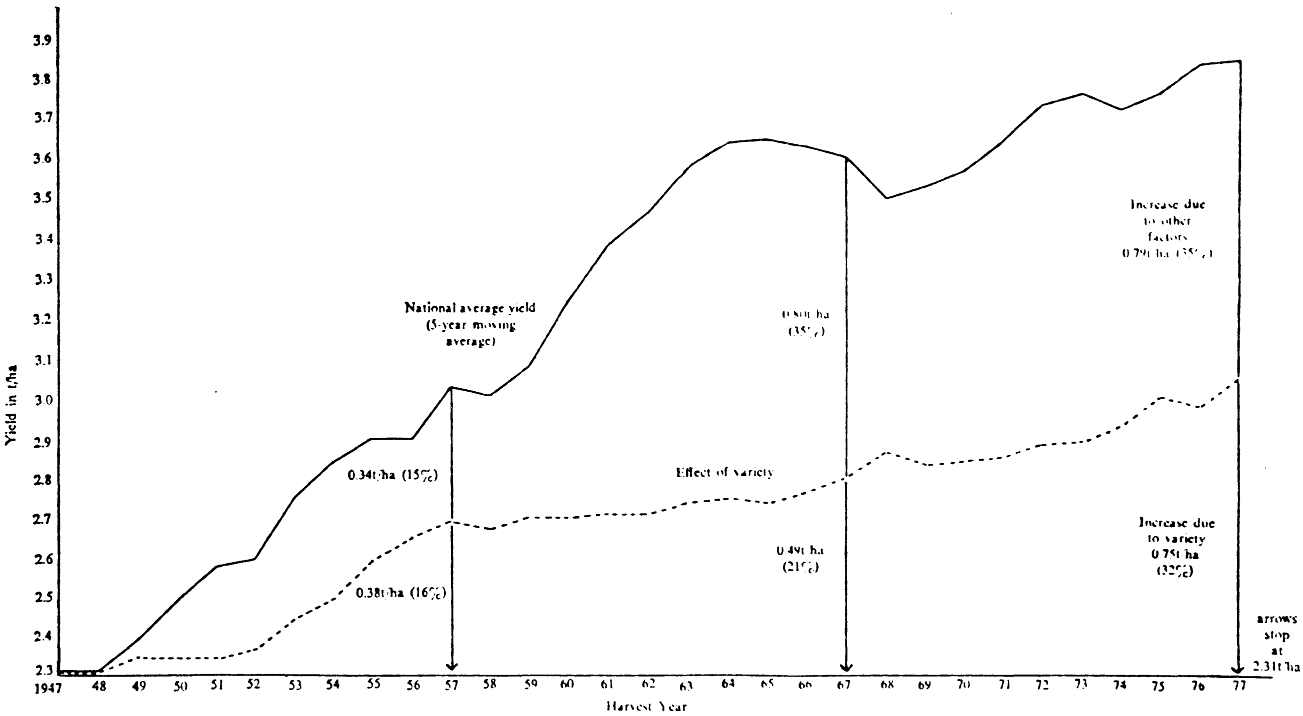
The Future

Modern varieties in widespread use, such as Huntsman, Flanders, Georgie and Athos outyield those popular in 1947 by 30 or 40%. More than half that improvement has resulted from varieties commercialised in the last 15 years. Consideration of the varieties currently recommended by the NIAB (NIAB Farmers' Leaflet No. 8, 1980; obtainable from Huntingdon Road, Cambridge), shows that Plant Breeders are producing varieties with even higher yield potential. Winter wheats still in the provisionally recommended stage, Virtue, Brigand and Avalon, promise to outyield by 5% the highest yielding of the fully recommended varieties, such as Armada.

Similar yield increases are indicated by comparison of new spring barleys like Koru and Triumph, with Goldmarker which heads the fully recommended list.

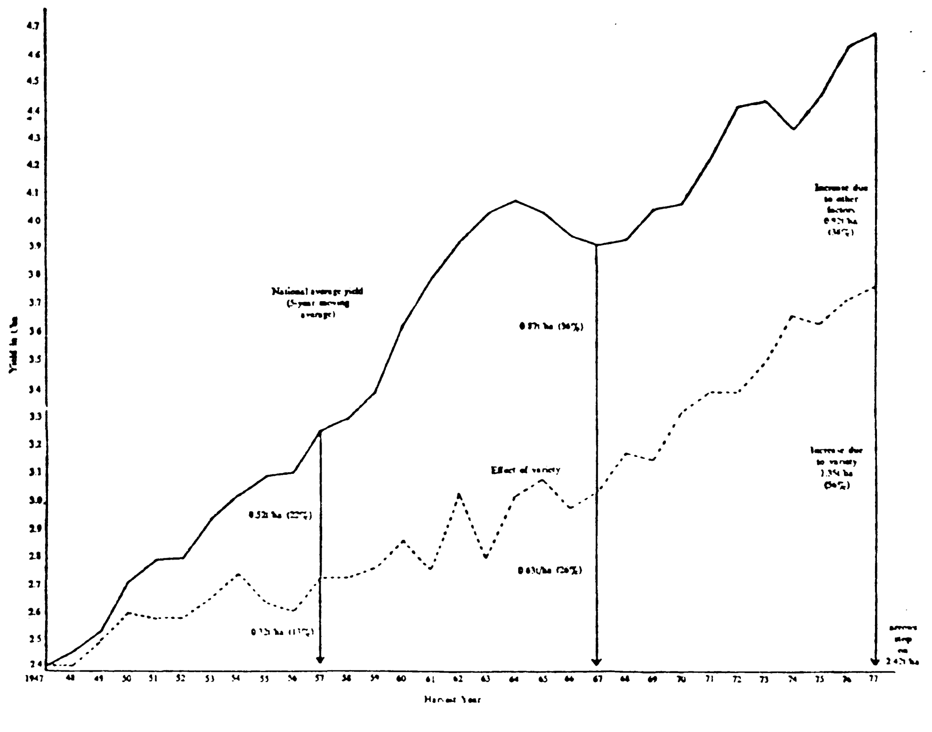
Given the encouraging experience of yield trends in the seventies the industry has every reason to hope for an even more productive combination of excellent husbandry and cereal varieties in the eighties.

Spring and Winter Barley 1947-77 *Figure 1*



The increasing trend in the national average yield of barley in England and Wales (t/ha) and the estimated effects of variety and other factors on achieving the increase 1947-77.

Winter and Spring Wheat 1947-77 *Figure 2*



The increasing trend in the national average yield of wheat in England and Wales (t/ha) and the estimated effects of variety and other factors on achieving the increase 1947-77.

EUROPEAN COOPERATIVE PROGRAMME FOR THE CONSERVATION AND EXCHANGE OF CROP GENETIC RESOURCES

by

Dr. G. de Bakker

Thank you for giving me the opportunity to explain in a few words the aims, achievements and plans of the European Cooperative Programme for the Conservation and Exchange of Crop Genetic Resources. I think its work plan is closely related to the matters considered this morning. I have the feeling that conservation of genetic resources and the use of those conserved resources for plant breeding are very much related to the rights that you want to give to the breeders.

We may assume that in almost all European countries there is an understanding that the conservation of genetic resources, either for immediate use by plant breeders or for more long-term conservation for our future generations, is of very great importance. In recent years we have come to realize that there is a danger around the world that those resources are gradually disappearing. Most European countries are in some way actively engaged at the national level in collecting and conserving these genetic resources and the sense of having an international European programme, supported financially by UNDP and scientifically by the FAO, has therefore sometimes been questioned. After visiting a number of countries in Europe, there is more and more agreement with my view that the genetic resources of our crop lands, as has already been said this morning, are not a national matter alone but one of global or general importance. Because of that it might be possible to do a better job by organizing genetic resources conservation and documentation as a joint effort, which would be more efficient. Governments face the problem of economic recession and in a number of countries it is difficult to find the money for new activities, but if we can do the work together then the costs might be less. That is why last December, here in Geneva, a more or less unanimous decision was taken to start this European Cooperative Programme.

The programme started officially on 1st October, just a few days ago. On that date the UNDP and FAO signed the project document for the programme since more than

* Executive Secretary, European Cooperative Programme for the Conservation and Exchange of Crop Genetic Resources, Geneva

eight countries had signed the document and that was the requirement before it could become officially operational. In the months since I started working here, about half a year ago, we have been preparing a preliminary work plan that we hope to present to the first Governing Board meeting in Geneva at the end of this year. That plan is based, I would say, on the principle of decentralization of responsibilities for genetic resources conservation in Europe. I stress the concept of decentralization because some views have been expressed that we should have a centralized system of conservation of genetic resources. I feel, however, that it would be much better to use the knowledge, the expertise and the equipment that is already available in the European countries.

In order to arrive at a good conservation system for our agricultural and horticultural crops we must utilize as much as we can the knowledge, the equipment and the collections that are, let us say, the best that we have in Europe. We are going to discuss during next December's meeting the idea of assigning responsibility for one or more crops to specific institutes in Europe, asking them to act not only for themselves but for the whole European area, or in certain cases perhaps for Southern Europe or Western Europe as ecological zones, or, together with another institute, for another ecological zone in Europe.

Such institutes must already have a very good collection and would need to increase it by exchange with other institutions or by sending out collecting expeditions to get better material. This morning we heard that for a number of crops we need more botanical species and wild species. It would be the task of such institutes to organize that for their specific crops. Secondly, they would be responsible for good conservation so they must have or they must build up the necessary conservation facilities. In the third place they should be responsible for documentation. I consider the documentation of the germ-plasm to be extremely important. What is the sense of having a collection if you do not know what it really contains. You must have a good documentation system, and that means more than the registration number, the botanical name and the most obvious taxonomic characters of an accession. There must be in the documentation system a description of the most important characters that are important for today's and for tomorrow's plant breeders. So, the appointed institutes should be organizing, either themselves in their own institute or together with other institutions, good evaluation trials. I am saying quite a lot with what I have just described but I am very hopeful that the institutions that will be invited or will offer themselves to become leaders in the European field for crop genetic resources conservation and documentation, will be willing to accept such ideas. From what I have seen and heard this is the only way to come to a real European cooperation, because then you will have a real division of the work.

The second point I should like to stress is that the way to a better exchange between Eastern Europe and Western Europe must be opened. When you talk to people in this business, in this profession, usually the reply is that they can get along well enough with their neighbours. In the socialist republics of Eastern Europe there is the COMECON Group for genetic resources. They meet a few times per year and there is quite good cooperation, but their contacts with Western Europe are only incidental. In Western Europe the EEC Commission has set up the EEC Genetic Resources Group, and in Northern Europe, the Nordic Gene Bank has been started by the five Nordic countries. There are said to be difficulties in getting really good contacts with Eastern Europe and I hope that the European Cooperative Programme, since it is one of the very few programmes that I know of that really on a governmental level connects professionally in an operational way Eastern European socialist countries and Western European capitalist countries, will help to overcome these difficulties and to achieve better cooperation. My experience, in the few months that I have been working for this programme, is that the activities and the interest in genetic resources collection and conservation is greater in Eastern Europe than in Western Europe. In Eastern Europe there are large collections and the number of scientific personnel working in this field is greater than in most Western European countries. They may work in a different way but there is a lot of interest and they are very eager to improve their contacts with Western European countries. So I hope that this will happen.

The last thing that I would like to mention is that we hope also to build up some kind of training in this field. There are a number of new techniques that must be used, techniques for conservation of material and techniques for documentation with the aid of computers. For a number of countries the use of computers in this area is rather new. Since most countries are just starting we hope very much that we can establish a system that makes it possible to exchange information with and request samples from gene banks participating in the programme, in an easy way. I hope very much that this will be possible. It is not necessary for everybody to buy the same make of computer. One can do with several computer systems but one must use a number of management rules in order to ensure compatibility.

I am always available, either now or after the meeting, to give more information if needed.

[Original: English]

GERMPLASM CONSERVATION SYSTEMS IN THE UNITED STATES OF AMERICA AND THE CONTRIBUTION BY THE PLANT VARIETY PROTECTION OFFICE

by

Mr. B.M. Leese, Jr.*

Modern agriculture depends upon a coordinated system to introduce, evaluate, and maintain the germplasm obtained from the world's resources. These needs require an efficiently organized effort to assure that Federal, State, local institutions, and private breeders get the germplasm they need. The U.S. Government recognizes the need for a continued search for adaptable crops. In 1819, American consuls overseas were urged to send useful plants back to the U.S. From 1836-1862 the U.S. Patent Commissioner introduced new plants as a routine policy. With the establishment of the U.S. Department of Agriculture in 1862, plant exploration was accelerated, and a section developed for seed and plant introductions.

Collecting, identifying and assembling genetic resources requires national and international cooperation. The preservation, evaluation, and distribution of germplasm and catering for the needs of all breeders for introduced germplasm are functions of the National Plant Germplasm System (NPGS) which must be coordinated through cooperative Federal-State research programs.

The NPGS is a coordinated network of institutions, agencies, industry and research units in the U.S. which works cooperatively to introduce, maintain, evaluate, catalog, and distribute plant germplasm. Financial and administrative support comes from the Science and Education Administration, U.S.D.A., State agricultural experiment stations, commercial breeders and seed and nursery trade interests.

The key elements of NPGS are: (1) the Germplasm Resources Laboratory at Beltsville, Maryland; (2) the Plant Introduction Stations at Glenn Dale, Maryland, and Savannah, Georgia; (3) the State-Federal Potato Introduction Station, Sturgeon Bay, Wisconsin; (4) the National Seed Storage Laboratory (NSSL), Fort Collins, Colorado; (5) the Mayaguez Institute for Tropical Agriculture, Mayaguez, Puerto Rico; and (6) a large group of Federal, State and private germplasm collections located throughout the U.S. All of these collections are considered working collections except the NSSL. The NSSL is an archive and is used only as a source when material is not available from the working collections.

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With the opening of the NSSL in 1958, a national storage program for the permanent preservation and conservation of seed stocks was available for the first time in the history of U.S. agriculture. The NSSL is a specially designed three-level structure situated on the Colorado State University campus. The building houses research laboratories, growth chamber rooms, seed storage facilities, workshops, administrative offices, and a library. The seed storage rooms can handle as many as a half million seed lots. More than 95,000 seed samples are in storage under controlled temperature and humidity environments. These seed samples include obsolete varieties, current varieties, breeding lines, genetic stocks and domestic and foreign collected germplasm. Once seed is accepted by the NSSL, it becomes the property of the Federal Government. In other words the material is available to all who need it.

We are dedicated to all programs that are concerned with the collecting, identifying and preserving of plant germplasm. The early part of my career was spent with the U.S. Department of Agriculture and Rockefeller Foundation in the classification of germplasm from all parts of the world and as a plant explorer in the Americas and Africa. My interest and the awareness of the need to preserve and record the attributes of our plant resources had much to do with me becoming a variety specialist and later the Commissioner of the Plant Variety Protection Office.

The Plant Variety Protection Office (PVPO) was established by a Congressional Act on December 24, 1970. The Act offers legal protection for 17 years to developers of new and distinct varieties of plants. The PVPO has set up a computerized system for identifying characteristics of all the varieties that are or have been recorded in research publications. In this manner we check and make quite sure that the new varieties protected under our plant variety protection system are different to already produced and distributed varieties.

Standardized description forms are compiled and reviewed by national and international agronomy and horticultural organizations. Through the excellent cooperation of these organizations and government agencies, pertinent characters of each crop were made computer compatible. In other words we have tried to set up objective descriptions of all the varieties and have placed those descriptions in the computer. In the description of the variety we require information about the pedigree and novelty of the variety. Along with this information, a 2,500 viable seed sample is furnished to serve as the authentic voucher sample. This viable seed sample is stored at the National Seed Storage Laboratory and is available on request for new breeding materials.

[Original: English]

REPORT OF DISCUSSIONS

prepared by the Office of the Union and approved by the speakers

1. The lectures and statements were followed by a lively discussion which was presided over by Mr. H. Skov, President of the Council of UPOV. Mr. Skov was assisted by a panel comprising the three speakers (Dr. J.T. Williams, Professor G. Fischbeck and Mr. P.W. Murphy), Dr. G. de Bakker and Dr. H. Mast, the Vice Secretary-General of UPOV. The general course of the discussion and some observations thought to be deserving of retention are reproduced in the following paragraphs.

2. In thanking the speakers for their very interesting papers, the President said that he wished to underline what had been said about the ownership of and access to germ-plasm. The International Convention for the Protection of New Varieties of Plants recognized, as part of the philosophy underlying plant variety protection, that germ-plasm was the heritage of mankind and thus could not be appropriated in any way. In paragraph (3) of Article 5 of the Convention it was provided that even protected varieties could be used "for the purpose of creating other varieties" and that such use did not require the prior authorization of the breeder.

3. The President went on to say that he had taken part in many discussions about breeders' material and collections of wild material in the hands of private and public plant breeders. There were those who claimed that it was against the public interest for a right of restriction to exist on access to such material. In his view that was quite another problem, the answer to which depended not on the Convention, nor on legislation based thereon, but on respect for private or public property. He had asked plant breeders in Denmark and Sweden whether they wished to restrict access to material. They had indicated that they favored the exchange not only of material but also of all available information and that their policy in that respect had not been influenced by the UPOV Convention.

4. With reference to the European Cooperative Programme for the Conservation and Exchange of Crop Genetic Resources, the President said that he wished to stress that there was no wish to form a closed circle. The work was currently being funded by the United Nations Development Programme and the idea was that the achievements should be available for all the world.

5. Dr. Williams said that although the European Cooperative Programme was something very new it certainly was not the first cooperative programme. One had existed for the countries of the Near East since 1966, there was a very successful one for the Mediterranean countries, and since 1976 there had been another very successful one for countries in South-East Asia. Taking into account also the programme in the United States of America, cooperative programmes within India and one emerging in Brazil, the picture around the world was far larger and more encouraging that might have been assessed from his paper.

6. Dr. Mastenbroek (President, International Association of Plant Breeders for the Protection of Plant Varieties (ASSINSEL)) said that he believed that everyone in the plant breeding profession favored the activities of the gene banks. It seemed that even the opponents of plant variety protection were not against such activities. The costs of the salaries of research workers, equipment and storage were enormous. The costs of evaluating the material collected and stored would be even greater. In his opinion the gene banks should request the cooperation of other institutes, universities, public plant breeding stations and even private plant breeding firms. Such cooperation had started on a very small scale in the Netherlands where the Foundation for Plant Breeding had asked breeders to evaluate certain material for it. It had been agreed that the outcome of that evaluation would be available to all interested breeders in the Netherlands.

7. The President said that he had the honor to be the current Chairman of the Nordic Gene Bank. It had similar arrangements with private plant breeders in the Nordic countries.

8. Dr. Kjellqvist (Director, Nordic Gene Bank) fully endorsed the plea that gene banks should establish the closest links with scientific institutions, universities and plant breeders, both public and private. That had been a basic philosophy for

the Nordic Gene Bank and the response from all parties had been so encouraging that the cooperation could not be bettered. In his view a gene bank could not function without a continuing dialogue between the scientists and the ultimate users. Unless that dialogue became a matter of routine the gene bank would become a seed store or a museum. Professor Fischbeck's paper had contained a striking example of the problems that any gene bank would face when trying to formulate a global programme for the storage of material, namely the choice between the concepts of gene alleles and genotypes. Dr. Kjellqvist believed that anyone setting out to store plant material should give serious consideration to the gene allele concept. The Nordic Gene Bank had accepted it in principle and would demand a justification for any sample to be included in its collection.

9. Professor Fischbeck referred to the importance of the European Cooperative Programme. The evaluation of primitive material was and would be a very complex task and the need to work together, even with private plant breeders, was acknowledged. The benefits of such evaluation work, although not immediately apparent, would ultimately be of great importance. Breeders, of course, preferred to work with material known to them. As commercial varieties were superseded they could readily be preserved in the gene banks. Breeding lines, however, with certain characteristics that were easily inherited and that had been used repeatedly, were frequently lost. Such material was among the best evaluated of all plant material and it would be valuable to discuss further with private breeders how, even with due regard for their interests, it could be included in the European Cooperative Programme, how it could be used and how information about its genetic characteristics could be incorporated in the documentation system. Professor Fischbeck believed that some pioneering work in that direction was justified and that such work might subsequently have an application in other regions.

10. Dr. Böringer (Federal Republic of Germany) said that he agreed with Professor Fischbeck's remarks about breeding lines. The greatest care should be taken to see that such material was deposited in gene banks. Dr. Böringer believed that to be an important point and a vital one for the member States of UPOV. They had to come to terms with the reproach that plant variety protection in connection with national variety lists might somehow contribute to an impoverishment of genetic resources. In his opinion private plant breeders would cooperate in discussing that question and, where State breeding institutes were concerned, there should be no difficulty in quickly obtaining samples.

11. Dr. Böringer asked Dr. Williams for clarification of the reference in his paper to the reluctance of some beet breeders to allow samples of their material to be distributed too quickly by the gene banks. Dr. Böringer noted that very few member States of UPOV afforded protection to sugar-beet varieties.

12. Dr. Williams explained that there had been discussions with a view to encouraging sugar-beet breeders to deposit in gene banks samples of the germ-plasm used in their breeding programmes. Breeders had been active in collecting wild material, particularly from coastal areas of Europe, and, having invested their own money in that work, were reluctant to make the material available to others. There, perhaps, was an example of restriction in the exchange of material based on considerations other than plant variety protection, but it was a very special case and should not be over-emphasized. Dr. Williams believed that it should be possible to resolve the difficulties by way of dialogue between the breeders and other interested parties, for example by providing in appropriate cases for a moratorium of five or ten years before distributing samples of material deposited with the gene banks.

13. The President said that he had the feeling that at least in some crops breeders who could obtain protection for their end product, the new variety, were more willing than they otherwise would be to release early and wild material to the gene banks for free exchange.

14. Dr. Kjellqvist remarked that representatives of a private firm in Sweden had recently told him that because of plant variety protection they would feel much more free to supply a gene bank with material that they had incorporated in a breeding programme. It seemed that plant variety protection promoted a speedier exchange of material.

15. Dr. Leenders (Secretary-General, ASSINSEL) said that the International Association of Plant Breeders for the Protection of Plant Varieties could agree with Dr. Kjellqvist's statement that the readiness to make material available increased according to the availability of plant variety protection. It must, however, be remembered that plant breeding was an industry. Breeders would cooperate if it was in their interests to do so, and it generally was.

16. Dr. Kjellqvist referred to the statement made by Dr. de Bakker and in particular to the emphasis placed on documentation. It was of prime importance to have a documentation and information system that enabled there to be a dialogue between gene banks and users, and between gene banks themselves, so that information and material could be exchanged easily. In its endeavors to develop a suitable system the Nordic Gene Bank had found the various UPOV Guidelines for the Conduct of Tests for Distinctness, Homogeneity and Stability very useful. There might, however, be a need to discuss in a wider circle the question of compatibility of input and output. Dr. Kjellqvist hoped that agreement could be reached about the use of descriptors and noted that the UPOV Test Guidelines could serve as an important basic document in discussions to that end.

17. Mr. Virion (Poland), also referring to Dr. de Bakker's statement, said that efforts were being made in Poland to organize decentralized gene banks, principally in State breeding enterprises and in institutes charged with making the most important collections to provide plant breeders with basic material for their work. The Ministry of Agriculture in his country favored the development of international cooperation in the exchange of material and documentation.

18. Dr. Böringer, noting Dr. Kjellqvist's remarks about the UPOV Test Guidelines, said that he believed that there had been a strong interaction between the studies in UPOV and the work in the gene banks to establish descriptors for the classification of material. Dr. Williams had pointed out in his paper that the collections of wild material still posed some problems. Dr. Böringer said that he had discussed that matter extensively with experts from the International Wine Office. He believed that the characteristics of interest in wild material were not the same as those of interest in bred varieties and that one should therefore proceed with the greatest care. Having gained some insight into the work of a gene bank he was under the impression that too much emphasis was placed on descriptors and not enough on actual evaluation of material. It seemed to him that with the existing means it was, as a general rule, impossible to even try to classify efficiently with the help of the descriptors all the material deposited in gene banks. It was not possible for the time being to carry out intensive evaluation and many assumptions had to be made. He was therefore pleased that the discussion had brought out the fact that the key to success lay in more intensive evaluation. That would enable plant breeders to make greater use of the gene banks. Dr. Böringer believed that the discussion had

also made it quite clear to the member States of UPOV that they should pay more attention to interactions between the collection, storage and exchange of plant material and plant variety protection. It might be possible for institutions carrying out tests in connection with plant variety protection to be linked more closely with those doing evaluation work. It would not be right to burden private breeders with the latter task. Their priorities were quite different.

19. Mr. Hutin (France) said that it should be recognized that the growing network of gene banks was needed not only because of the risks of genetic erosion in relation to wild or developing species but equally because the conservation of collections of genetic material, which had been a part of the traditional activities of the breeders, was becoming too burdensome for them. That task therefore had to be ceded to other organizations specializing in such work. He believed, as a consequence, that it would be illusory to think that breeders, and especially private breeders, could in every case immediately give up their original plant material. What was possible, in Mr. Hutin's view, was to alert breeders so that if they could no longer bear the burden of conserving certain materials they would, as an automatic reaction, pass them to the conservation centres. Mr. Hutin also drew attention to the problems of conserving and distributing information. He agreed with Dr. Böringer that it was perhaps a vain hope to incorporate in one information system all requirements, whether in relation to plant variety protection or to the classification of wild species. Progress in the use of computers, however, might allow the accumulation in a single system of the divergent needs without seeking to provide an identical solution to them. Mr. Hutin therefore believed that a great effort was needed in the better application of computer methods.

20. Professor Fischbeck said that he wished to revert briefly to the question of the participation of private breeders and breeding institutes in evaluation work. In his experience private breeders were agreeable, in principle, to participate and to work on the basis of the standard descriptors. In some cases, however, they were unwilling to incur heavy additional costs. It was therefore necessary to restrict the information required from evaluation to that which might be obtained through the normal routine evaluation of breeding materials. Also, Dr. Williams had referred to a possible need to provide, when appropriate, for a moratorium of five or ten years before making publicly available material that had been well evaluated by a breeder.

Professor Fischbeck said that in the absence of such an arrangement he could understand that breeders might be reluctant to disclose information about some new valuable property perhaps discovered during non-routine evaluation of plant material.

21. Mr. Bradnock (Canada) said that he wished to thank the Council of UPOV for organizing the Symposium. He had very much appreciated the useful and impartial information provided by the various speakers and flowing from the discussions. A number of references had been made to the misleading nature of information contained in the publication "Seeds of the Earth. A Private or Public Resource." Mr. Bradnock wondered whether that publication could at least be given some credit for promoting the development of gene banks and germ-plasm conservation programmes.

22. The President said that the publication had exerted no influence whatsoever on the programme of the Nordic Gene Bank. The preparatory work had been started long before the appearance of the publication.

23. Dr. Williams said that in the past the subject of genetic resources had been a somewhat academic one. Now it was mentioned in the daily press of many countries. The impact of "Seeds of the Earth", however, had been completely muddled between the need to collect and conserve primitive germ-plasm and plant breeders' rights, and that was to be regretted.

24. The President said that he had noted with satisfaction the statement issued by the Food and Agriculture Organization of the United Nations in its July 1980 "Information Note on the Seed Improvement and Development Programme", in which FAO had set out its position on plant breeders' rights. The President then read out the full text of that statement:

> "FAO is constantly reviewing the question of plant breeders' rights, but in view of the complexity of the subject, FAO has not at this time adopted a position concerning plant breeders' rights. It has noted that those rights do not provide any basis for restrictions on the access by developing countries to the sources or results of plant breeding activities. It has also noted that plant breeders legislation tends to encourage the development of new plant varieties by the private and public sectors, which can have beneficial effects for the world as a whole."

25. The President then asked whether it might be worthwhile to propose a dialogue between UPOV and the International Agricultural Research Centres, such as the International Maize and Wheat Improvement Centre (CIMMYT) and the International Rice Research Institute (IRRI). He understood that the significance of plant variety protection might have been misunderstood at some of those research centres and wondered whether it might be helpful to discuss with them the possible value of protection in respect of the public varieties created by them.

26. Dr. Leenders said that he had discussed plant variety protection matters with representatives of the International Centre of Tropical Agriculture (CIAT) in Colombia. The problem that the International Centres saw was that, having been founded to help the developing world, they could not follow the policy of other plant breeders of applying for protection. So far, to his knowledge, no country in the developing world had an operating plant variety protection system. Furthermore, he understood that much of the material released by the International Centres was lacking in homogeneity and would perhaps not qualify for protection under the standards applied in member States of UPOV. Given the task assigned to them, the International Centres were probably right to issue the material as they did, but by doing so they could give rise to the very problems they were concerned to avoid. They could avoid any risk that there might be that someone would apply for protection in respect of one of their varieties by themselves applying for protection, wherever that was possible. Dr. Leenders believed that private plant breeders would welcome such a course of action. The only other solution that he could see would be for the International Centres to send samples of the material distributed by them in developing countries to the various national plant variety protection authorities so that, being aware of the material, they could reject any application by another party for protection in respect of it. Dr. Leenders confirmed that in his opinion it would be useful to hold discussions with the International Centres.

27. Dr. de Bakker said that the Directors of the International Centres were world leaders in plant breeding. Their opinions had an influence on world opinion and on the views of legislators in some of the countries discussing the introduction of a plant variety protection system. Dr. de Bakker agreed with the idea of trying to open up a discussion. He thought that the best way might be by means of a balanced, low-key note or article, perhaps in an international journal.

28. Dr. Mast said that he also considered that there was a need for discussions between UPOV and the International Centres. He believed, however, that the questions raised by the concern of the International Centres that their material might be misappropriated should first be discussed in the Administrative and Legal Committee of UPOV since they in fact related to a number of quite different situations. He did not see how varieties bred and distributed by an International Centre could be validly appropriated by a private firm under any plant variety protection legislation based on the UPOV Convention. It was quite a different matter, legally and otherwise, if material developed by an International Centre was used by a private firm as a basis--or "initial source of variation", to use the terminology of the UPOV Convention--for the creation of a new variety. For as long as the UPOV Convention allowed for good reasons that even a protected variety could be used in the breeding of another variety, for which protection could then be obtained, it would be very difficult to maintain that such use could not be made of material resulting from research done at a public institution. Besides, he wondered whether such further development of the material was not a good way to enhance the benefits to agricultural production of the results of the research conducted by the International Centres.

29. Mr. Bradnock, referring to the paper given by Mr. Murphy, said that it appeared that there were very few studies on the benefits resulting from plant breeding and, in particular, from the introduction of plant variety protection legislation. He was aware of an analysis made by economists in Canada in an endeavor to show how the benefits from improved varieties of oilseed rape were distributed. The analysis showed that the improved returns went to farmers and to consumers, in roughly equal proportions. In other words, in Canada, where there was no plant variety protection system, there was no return to the breeders of the improved varieties. Mr. Bradnock wondered whether studies had been made in other countries, particularly since the introduction of a system of protection.

30. Dr. Leenders said that he believed that studies had been made in the Federal Republic of Germany, in the Netherlands and in Switzerland. When calculating the return from plant breeding one had to make certain assumptions in view of the difficulty of measuring the effect of such factors as soil and weather. It was generally estimated that the annual improvement in crop yield generated by the use of improved varieties was about 1 per cent. It was perhaps more meaningful to think in terms of

20% in 20 years and to consider the monetary value of the additional crops harvested. Then the costs of plant breeding, of plant variety protection and of UPOV could be seen to be a trifle in comparison.

31. The President referred to current experience in Denmark. There, for example, the newest varieties of oilseed rape had caused a doubling of plantings of that crop from 50,000 to 100,000 hectares. That would have an enormous impact on protein production for animal feed. New techniques and new varieties were bringing almost daily progress in the way of increased yields and changes in the crops being grown.

32. Mr. Murphy said that he would like to add to what had been said by Dr. Leenders. Various calculations in the United Kingdom had put the annual contribution of improved cereal varieties at no less than £20 million, and the current rate of varietal improvement might suggest that the contribution was substantially greater than that.

33. Dr. Mastenbroek said that he greatly appreciated the information given by Mr. Murphy in his paper. He hoped that the study by Mrs. Silvey would receive a wide distribution. He had been pleased, in particular, to learn that a farmers' organization had suggested that oilseed rape should be eligible for protection. That seemed to Dr. Mastenbroek to be a point of utmost technical and political importance and one that should be widely publicized.

34. Mr. Murphy confirmed that the study by Mrs. Silvey had been published in 1978 and could be found at pages 367-384 of volume 14 of the Journal of the National Institute of Agricultural Botany. The study was being updated year by year.*

35. The President said that he wished to draw attention to an information paper entitled "Plant Variety Rights in Australia", published in August 1980 by the Department of Primary Industry in Canberra. In his view that paper was recommended reading.

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* For the latest version available see page 31 of this issue.

36. Mr. Smith (Australia) thanked the President for his kind words. He recalled that in Australia a number of things had happened at the same time. There had been the proposal to introduce legislation for a plant variety protection scheme, the publication of the book "Seeds of the Earth", the proposal to establish gene banks in Australia and the discussion about the patenting of living organisms. All those matters had been mixed up. The Symposium had shown that plant variety protection was not solely about genetic engineering and that should help to put the debate on far more sensible lines.

37. Dr. Böringer remarked that much had been said about the depositing of seed samples but that so far there had been no real discussion about the conservation of vegetatively propagated material, which was known to present many technical problems. He was concerned by the risk that advanced material that still had a value for plant breeders would be lost.

38. Dr. Kjellqvist said that the difficult question of conserving vegetatively propagated material was being discussed at the Nordic Gene Bank. The problem had been recognized and the first steps had been taken. Representatives of various museums had been brought into the discussions and had shown great interest. With their help it might be possible, for example, to maintain hundreds of varieties of fruit-trees on former estates and other properties managed by government agencies. Dr. Kjellqvist also described in outline the development of a regional project for the conservation and documentation of berry bushes, of which there was a unique gene pool in the Nordic countries, and the way in which the responsibilities were being shared.

39. The President said that he could recommend the use of museums, especially for the conservation of fruit-trees. In his experience they were very interested in and quite willing to undertake such work.

40. Mr. Heitz (UPOV) drew attention to the fact that there were major differences between sexually reproduced and vegetatively propagated plants with regard to conservation of genetic resources. Genetic resources of sexually reproduced plants could, in general, be stored in the form of seeds, whereas for many vegetatively propagated plants it was necessary to maintain collections of whole plants. In the case of fruit-trees, for instance, that meant that large areas of land had to be made available. In the case of sexually reproduced plants, it was in theory sufficient to conserve a collection of all available alleles of each gene since plant breeding

techniques were now sufficiently developed to enable man to reconstitute almost every desired genotype on the basis of that collection. In the case of vegetatively propagated plants, however, reconstituting a particular genotype was rarely possible and it was therefore necessary to maintain genotype collections. In particular in the case of fruit-trees, genotypic diversity was considerable and three types of material could be distinguished: widespread varieties; locally-grown varieties, i.e. varieties found in a limited number of specimens in the orchards of one or a few villages; unique specimens, i.e. trees that had grown from a seed either naturally or through man's intervention and that possessed a number of characteristics that were sufficiently interesting for man to have kept and grown them. The death of one of such specimens meant the irremediable loss of the genotype. Details on the problems faced in collecting and maintaining genetic resources in vegetatively propagated plants, and on the evolution of those resources during the last five centuries in Belgium, had been published in an article entitled "Variétés anciennes de poiriers et de pommiers. Pourquoi?" by Mr. C. Populer, a phytopathologist at the State Agronomical Research Centre of Gembloux.

41. Dr. Mast announced that it was intended to publish in the UPOV Newsletter an English translation of the article just referred to, which was indeed very pertinent in the context of the problems treated in the Symposium. (In the meantime published in issue No. 23 under the title "Old Apple and Pear Varieties - What For?")

42. Mr. Van Wyk (South Africa) noted that no mention had been made of the importance of the phytosanitary condition of the material being conserved and exchanged. Seed stored must at least be free of seed-borne organisms, and in the case of vegetatively propagated material one should at least start off with virus-free material in view of the need for preservation for long periods in nurseries.

43. The President agreed that the phytosanitary problem was a major one. He was sure that gene banks were aware of the difficult balance that had to be struck since it was clear that the free exchange of material should not be hampered more than was absolutely necessary. In that respect he believed that most laws concerning the importation of plant material provided an exception for material for scientific and similar uses.

44. The President concluded the Symposium by again expressing his appreciation of the papers given and by thanking all who had participated in the discussions.

LIST OF PARTICIPANTS

I. MEMBER STATES

BELGIUM: J. Rigot; R. D'Hoogh

DENMARK: H. Skov; F. Espenhain; E. Kjellqvist

FRANCE: A. Grammont; C. Hutin

GERMANY (FED. REP. OF): D. Böringer

ISRAEL: H. Gelmond

ITALY: S. Samperi; B. Palestini; A. Sinagra

NETHERLANDS: W. van Soest; M. Heuver; K.A. Fikkert

SOUTH AFRICA: J.F. van Wyk; J.U. Rietmann

SPAIN: J.M. Elena; M. Ariza; J.M. Bolivar; J. Ramon Prieto

SWEDEN: S. Mejegård; L. Kåhre; E. Åberg

SWITZERLAND: W. Gfeller; A. Jaquinet; M. Jeanrenaud

UNITED KINGDOM: P.W. Murphy; A.F. Kelly

II. OBSERVERS

AUSTRALIA: F.J. Smith

CANADA: W. Bradnock

CHILE: E. Herrera

INDIA: S. Saran

IRAN: J. Zahirnia

IRELAND: J. Mullin

JAPAN: Y. Matsunobu; O. Nozaki

MEXICO: A. Gonzalez Sanchez; O. Garrido-Ruiz

NEW ZEALAND: J.B. Jackman

NORWAY: L.R. Hansen

POLAND: J. Virion

UNITED STATES OF AMERICA: B.M. Leese; R.J. Hutton

YUGOSLAVIA: D. Jelic

III. INTERGOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS

INTERNATIONAL ASSOCIATION OF PLANT BREEDERS FOR THE PROTECTION OF PLANT VARIETIES (ASSINSEL): C. Mastenbroek; H.H. Leenders

INTERNATIONAL COMMUNITY OF BREEDERS OF ASEXUALLY REPRODUCED FRUIT TREE AND ORNAMENTAL VARIETIES (CIOPORA): R. Royon; P. Favre

EUROPEAN FREE TRADE ASSOCIATION (EFTA): G. Aschenbrenner

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO): J.T. Williams; G. de Bakker

INTERNATIONAL FEDERATION OF THE SEED TRADE (FIS): H.H. Leenders

IV. LECTURERS: J.T. Williams; G. Fischbeck; P.W. Murphy

V. OFFICERS: H. Skov (President of the Council); W. Gfeller (Vice-President of the Council)

VI. OFFICE OF UPOV: A. Bogsch; H. Mast, M.-H. Thiele-Wittig; A. Wheeler; A. Heitz

CALENDAR

1981

UPOV Meetings

May 6 Geneva	Consultative Committee
May 6 to 8 Geneva	Administrative and Legal Committee
June 2 to 4 Wädenswil (Switzerland)	Technical Working Party for Vegetables
June 23 to 25 Edinburgh (United Kingdom)	Technical Working Party for Agricultural Crops
September 22 to 25 Wageningen (Netherlands)	Technical Working Party for Fruit Crops
October 6 to 8 Antibes (France)	Technical Working Party for Ornamental Plants
October 13 Geneva	Consultative Committee
October 14 to 16 Geneva	Council
November 9 to 11 Geneva	Technical Committee
November 11 to 13 Geneva	Administrative and Legal Committee

Headquarters

UPOV has its headquarters in Geneva, Switzerland, near the Place des Nations.

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