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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	
	ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE	AGP:CGR/73/40 March 1973
	ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION	

FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

TIMETABLE

Monday, 12 March

Registration in FAO Building "A"

8.30-9.30

PROCEDURAL MATTERS

1. Opening of the Conference by Mr. A.H. Boerma,
Director-General, FAO
2. Election of Chairman
3. Adoption of Agenda
4. Designation of drafting committee

9.30

SCIENTIFIC TOPICS

Agenda

- item 5. Surveys of Genetic Resources (Convenor: O.H. Frankel)

- Survey of crop genetic resources in their centres
of diversity - O.H. Frankel (AGP:CGR/73/7)
- Present situation of wheat genetic resources in
Syria, Iraq, Iran, Afghanistan and Pakistan -
H. Kuckuck (AGP:CGR/73/39)
- The African survey - J.R. Harlan

Agenda

- item 10. Genetic Resources Centres (Convenor: O.H. Frankel)

14.30

- Genetic resources centres - Functions, responsi-
bilities and international cooperation - O.H. Frankel
(AGP:CGR/73/21)
- A regional plan for germplasm collection, con-
servation and evaluation - E. Kjellqvist
(AGP:CGR/73/20)

VMI/D6663

- IRRI's role as a genetic resources centre
T.T. Chang (AGP:CGR/73/12)
- A global network of genetic resources centres - an
urgent need for sustaining agricultural advance
M.S. Swaminathan (AGP:CGR/73/38)
- Genetic resources centre for Ethiopia - M. Mengesha
- Germplasm conservation of wheat and maize - K. Finlay

Tuesday, 13 March

Agenda

- item 6. Distribution and organization of genetic variation 9.00
in plant population (Convenor: D.R. Marshall)
- Optimum sampling strategies in genetic conservation
D.R. Marshall and A.H.D. Brown (AGP:CGR/73/29)
 - Population structure and the effects of breeding
system - S.K. Jain (AGP:CGR/73/19)
 - Population structure and the effects of isolation
and selection - A.D. Bradshaw (AGP:CGR/73/15)
 - Distribution of disease resistance in Ethiopian
barleys - C.O. Qualset (AGP:CGR/73/30)

Agenda

- item 7.1 Practical problems in exploration 14.50
(Convenor: J.R. Harlan)
- Introduction - Erna Bennett
 - Practical problems in exploration - seed crops
J.R. Harlan (AGP:CGR/73/35)
 - Practical problems in exploration - vegetatively
propagated crops - J.G. Hawkes (AGP:CGR/73/6)
 - Practical problems in exploration - tree crops
J.T. Sykes (AGP:CGR/73/37)

Wednesday, 14 March

Agenda

- item 7.2 Recent and proposed exploration missions 9.00
(Convenor: J. León)
- Reading University plant collecting expeditions
to north-eastern Brazil - Barbara Pickersgill
(AGP:CGR/73/3)
 - Recent and proposed exploration missions in West
Africa - L.K. Opeke (AGP:CGR/73/28)
 - Recent and proposed exploration missions in the
USSR - D. Brezhnev (AGP:CGR/73/2)

- Report from Germplasm Resources Laboratory, USDA
H. Hyland
- Recent and proposed exploration activities of the
Izmir Centre - H. Ayla Sencer (AGP:CGR/73/17)
- Recent survey and exploration in rice - T.T. Chang
(AGP:CGR/73/18)
- Exploration of genecentres of groundnuts (Arachis
hypogaea L.) - A. Krapovickas (AGP:CGR/73/5)
- Exploration in Indonesia - Setijati Sastrapradja
- Plant exploration and collection by Canada -
R. Loiselle (AGP:CGR/73/36)
- Exploration of potatoes in Chile, Bolivia and Peru
C. Ochoa (AGP:CGR/73/34)
- Recent exploration in cacao - J. Soria

Agenda

item 8. Evaluation (Convenor: D. Bommer) 14.30

- The search for disease and insect resistance in
rice germplasm - T.T. Chang (AGP:CGR/73/11)
- Evaluation for disease resistance - A. Dinooor
- Screening for cold and drought resistance in cereal
breeding - V. Dorofeev
- The identification of high-quality protein variants
and their use in crop plant improvement - D.E.
Alexander (AGP:CGR/73/31)
- Screening for oil and fat quality in plants -
G. Röbbelen (AGP:CGR/73/32)
- Secondary metabolites and crop plants - R. Hegnauer
(AGP:CGR/73/33)

Thursday, 15 March

Agenda

item 9. Conservation (Convenor: J.G. Hawkes) 9.00

- Problems of long-term storage of seed - E.H. Roberts
(AGP:CGR/73/4)
- Genetic maintenance in stored imbibed seeds
T. Villiers (AGP:CGR/73/16)
- Long-term storage of meristem cultures for gene
banks - G. Morel (AGP:CGR/73/25)
- The problem of genetic stability in plant cell and
tissue cultures - F. D'Amato (AGP:CGR/73/24)

- Technical aspects of tissue culture storage for genetic conservation - G.G. Henshaw (AGP:CGR/73/22)
- Principal methods for maintaining viability of plant materials in liquid nitrogen - A. Sakai (AGP:CGR/73/13)
- The role of protective substances and subcellular structures in preserving frozen plants - T.I. Trunova, O.A. Krasavtsev and G.I. Tutkevich (AGP:CGR/73/23)
- Root culture as related to vegetative conservation N.V. Obroucheva
- Possible long-term cold storage of woody plant material - B. Howard (AGP:CGR/73/8)
- The storage of germplasm in the vegetative form of tropical roots and tubers - F.W. Martin (AGP:CGR/73/14)
- Genetic principles of conservation in reserves and national parks - R.F. Dasman

Friday, 16 March

Agenda

item 11. Documentation (Convenor: D.J. Rogers) 9.00

- Requirements of information management systems for genetic resources centres - D.J. Rogers (AGP:CGR/73/9)
- Genetic resources centre documentation: delimitation of the problems - B. Snoad (AGP:CGR/73/26)
- Descriptors and thesauri for world GRC documentation L. Seidewitz (AGP:CGR/73/27)
- The genetic resources centre: information as a critical dimension - a cost/effectiveness analysis of a system TAXIR on GRC information problems - G.N. Herish and D.J. Rogers (AGP:CGR/73/10)
- Documentation of genetic resources - types of information, uses and international cooperation C.F. Konzak

CONCLUDING MATTERS

Agenda

item 12. Adoption of recommendations 14.30

	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	AGP:CGR/73/42 March 1973
	ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE	
	ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION	

FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES
(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

CONFERENCE TECHNIQUE DE LA FAO
SUR LES RESSOURCES GENETIQUES VEGETALES
(Organisée avec le concours du Programme biologique international
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CONFERENCIA TECNICA DE LA FAO SOBRE
RECURSOS GENETICOS DE PLANTAS DE CULTIVO
(En cooperación con el Programa Biológico Internacional del
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	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	AGP:CGR/72/1 July 1972
	ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE	
	ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION	

FAO TECHNICAL CONFERENCE
ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

PROVISIONAL AGENDA

PROCEDURAL MATTERS

1. Opening of the Conference
2. Election of Chairman
3. Adoption of Agenda
4. Designation of the drafting committee

SCIENTIFIC TOPICS

5. Surveys of Genetic Resources
6. Population Genetics - scientific aspects
7. Exploration
8. Evaluation
9. Conservation
10. Genetic Resources Centres
11. Documentation

CONCLUDING MATTERS

12. Adoption of recommendations and report

	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	AGP:CGR/73/7 February 1973
	ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE	
	ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION	

Item 5 of the
Provisional Agenda

FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

SURVEY OF CROP GENETIC RESOURCES IN THEIR CENTRES OF DIVERSITY

O.H. Frankel

Convenor, IBP Committee on Plant Gene Pools

SUMMARY

The nature and significance of plant genetic resources, as the essential raw materials for present-day and future crop improvement, are now generally recognized, as is the urgent need to survey, and where necessary to salvage and to conserve what is left. This involves for the most part the collecting of seeds or of vegetative material and placing them into conditions of safe-keeping, at the same time making them available for immediate use to agronomists and plant breeders.

The survey of genetic resources is intended to identify areas where relevant material is still available, and the extent to which it is threatened with displacement. The main emphasis has been on primitive (or traditional) cultivated material, but it is recognized that some wild relatives of various Mediterranean crops are threatened with extinction, as are important wild species in Meso and South America. Priorities, by region and crop species, followed the priority list of the FAO Panel of Experts on Plant Exploration and Introduction. The surveys were conducted by experts within, or familiar with the various regions, or by specially commissioned consultants. Organization and costs of the survey were shared between FAO and IBP. Some priority areas and crops had to be left out, either because promised contributions failed to arrive in time, or because experts were not available. It is hoped that this report will encourage scientists to offer information which will fill the gaps. Such contributions would be included in further issues.

More than any other of the regions of genetic diversity the Mediterranean has experienced extensive genetic erosion to the extent that it can be generally considered as a region of former diversity. However, a surprising amount of variation has been found in the Mediterranean islands of Cyprus and Sicily, though this is by no means a certain indication that the same applies to other islands of the Mediterranean. This is probably associated with the fact that in both these islands primitive races have paid a notable part in the production of the modern varieties cultivated there at the present time.

In the Near and Middle East there exists an emergency situation with regard to primitive varieties of wheat in all countries, including Afghanistan, where two years of drought has drastically altered a formerly secure situation, and even there Mexican introductions are now making a drastic impact in the southern part of the country. In all other countries primitive varieties are now found mainly in remote and mountainous areas, and even there only sporadically. Pulse crops in this region are not equally hard pressed, with the exception of lentils in Turkey, and possibly lentils and lupins in the Lebanon. However, primitive fruit varieties are under pressure in Turkey, and especially in Pakistan.

Reports on African crops, in addition to listing the distribution of primitive cultivation, allot priorities for collections on grounds of representation - or its absence, in collections, as well as on grounds of progressive erosion.

Wild coffee in the Ethiopian rain forest, the traditional source of seed, is threatened with extinction since the area under forest is shrinking rapidly. Further collecting of such material may call for urgency.

For Latin America, the survey includes a discussion on corn races which shows them at least in Mexico, where the primitive varieties are withstanding the impact of new cultivars and are still maintained by the Indian farmers. Quite a different picture is found in Peru in the case of potatoes, where the low resistance to foliar disease is determining the change from the primitive cultivars, highly susceptible, to the new resistant and high-yielding varieties. In cacao a survey shows the present status of the hybrid population in relation to the primitive types, some of them like Criollo, disappearing very quickly. A glimpse of the general situation in Latin America gives an idea of the complexity of the crops that occur in this continent, pointing out some specific cases where conservation action is most needed.

The surveys of the most important field crops of India characterize the principal types now cultivated, the areas of remaining primitive cultivation, and provide information on the status of existing collections and the needs, and urgency, for further collecting activities.

Several tropical fruit species in Malaysia and Indonesia are in a similar position, and the conservation of valuable gene pools calls for the preservation of some undisturbed forest areas.

	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	AGP/CGR/73/39 March 1973
	ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE	
	ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION	

Item 5 of the
Provisional Agenda

FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES
(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)
Rome, 12-16 March 1973

PRESENT SITUATION OF WHEAT GENETIC RESOURCES IN
SYRIA, IRAQ, IRAN, AFGHANISTAN AND PAKISTAN

H. Kuckuck

SUMMARY

The present situation regarding the process of replacement of primitive varieties by advanced cultivars, the preservation of native genetic material, breeding activities and multiplication facilities, is quite different in the countries concerned. To give only two examples: in the main areas of wheat growing in Pakistan the replacement of primitive varieties is more or less completed; the state of plant breeding and seed multiplication is very advanced, but preservation of genetic material is unsatisfactory; only some working collections are available. By contrast, in Afghanistan very great variation is still prevalent in the field, but activities in plant introduction, plant breeding and preservation are in the very beginning.

Whilst evaluating the populations in the field the author made the following observations:

1. Local varieties/populations have names only in certain instances and these are based on prevalent characteristics such as awlessness, colour of the glumes or grains, etc.
2. The same variety/population has some times different names and may exhibit different variation in different areas.
3. Several varieties can be met in the same village.
4. The exchange of primitive varieties between the villages and over long distances of approximately 1 000 km has become more frequent in the past 20 years because of better roads and more communication facilities.

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- In all countries a great readiness is met to intensify activities in plant exploration and to establish facilities for preservation and utilization of the native germplasm and last but not least to participate in international cooperation.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

GENETIC RESOURCES CENTRES - FUNCTIONS, RESPONSIBILITIES AND INTERNATIONAL COOPERATION

O.H. Frankel

Convenor, Committee on Plant Gene Pools, IBP

SUMMARY

This paper discusses the organizational aspects of exploration, conservation, and utilization of genetic resources.

The overall aim and purpose of any type of organization, either national or international, must be to secure the availability of the widest range of genetic resources to all potential users including those now living as well as future generations. The FAO Panel of Experts on Plant Exploration and Introduction uses the term "genetic resources centre" for institutions concerned with the maintenance of a collection of genetic stocks. It distinguishes "conservation centres", which are concerned with long-term conservation, and "working collections" which are mainly concerned with evaluation and utilization. Some institutions perform both tasks; some are solely conservation centres; a much larger number maintain working collections.

A relatively small number of conservation centres could, between them, maintain the world's germplasm. That this is possible and practicable has been shown by the few now in action. However, for reasons of convenience and safety, there should be, at least, duplication of conservation sites, which is easy enough in the case of seeds.

Working collections, on the other hand, should be distributed as widely as possible so as to bring available and potentially useful variation to all users. Evaluation in many sites, when linked through an appropriate documentation system, is of mutual benefit. Distribution and regeneration of seeds and maintenance of vegetatively reproduced stocks should be responsibilities of a cooperating network of working collections in close cooperation with the appropriate conservation centres.

Liaison and coordination, in the Panel's words, "is required (i) for setting and maintaining standards, (ii) for attaining adequate coverage on a regional and global scale while avoiding undue duplication of effort, (iii) for establishing working links and facilitating exchanges of information between centres, (iv) for providing world-wide information on conserved material".

It is obvious that at the institutions mainly concerned with the study, exploration and conservation of germplasm, genetic resources centres as a whole are primarily concerned with the exploration and collecting of material not yet adequately covered in collections. They must carry the responsibility for identifying and preserving material exposed to the danger of extinction. Those in or near to centres of genetic diversity have particular advantages in this regard.

The paper discusses forms of organization and the nature of participation on a national, regional and global scale, the role of institutions operating beyond the boundaries of a particular country, and the responsibilities and activities of the liaison organization. It also discusses recent moves at national, regional and international levels, including the establishment of national and regional gene banks, the proposal of a regional cooperative link in the Middle East, the recommendations of the UN Conference on the Human Environment held in Stockholm last year, and the proposal of a regional and national network of genetic resources centres comprised of institutions in the centres of diversity and elsewhere.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

A REGIONAL PLAN FOR GERMPLASM COLLECTION, CONSERVATION AND EVALUATION

E. Kjellqvist

Agricultural Research and Introduction Centre, Izmir, Turkey

SUMMARY

The regional plan includes Turkey, Syria, Iraq, Iran, Afghanistan and Pakistan.

It aims:

- (a) To carry out a systematic plant exploration programme in the participating countries on a cooperative basis;
- (b) To provide safe, long-term storage of seed and other materials in order to preserve the genetic resources of the region both for its own use and that of the rest of the world;
- (c) To provide a regional documentation centre;
- (d) To provide facilities for short-term storage of working collections and introductions in each of the member countries;
- (e) To provide regional cooperation in the evaluation and utilization of the germplasm material so collected.

Each country will be engaged in its own section of a coordinated overall plan concerned with plant exploration and utilization.

Working collections will be maintained as required in the member countries, and a complete set of all collections will be maintained under long-term storage at Izmir, Turkey, where facilities for this are already available.

The documentation centre will also be maintained at Izmir, with a computer-based information storage and retrieval system.

The participating countries will each establish a small germplasm unit, preferably in the agency responsible for plant introduction.

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Local personnel will receive short initial field training in Turkey, followed by a period of one year at the University of Birmingham, England, where they will study for the M.Sc. degree in Conservation and Utilization of Plant Genetic Resources.

The combined seed collections will be available to all member countries and to the international community.

Subsamples of seed collections will be prepared at Izmir for safe keeping in other gene banks. The Izmir Centre will also be the recipient of samples from other regional centres.

Rejuvenation of seed stocks will be planned regionally on the basis of optimal ecological conditions.

Annual meetings of professional staffs will develop work programmes and provide opportunities for exchange of information. Their venue will rotate among participants.

GENERAL PLAN FOR REGIONAL COLLECTION, CONSERVATION AND EVALUATION

The following objectives are proposed for the Regional Centre for Conservation and Evaluation of Plant Genetic Resources in Turkey.

SUMMARY

The Regional Centre for Conservation and Evaluation of Plant Genetic Resources in Turkey will be established in Izmir.

The objectives are:

- (a) To carry out a systematic plant collection programme in the region, based on a comprehensive survey of the flora.
- (b) To provide data, long-term storage of seed and other material in order to conserve the genetic resources of the region both for the use of the plant community and for the use of the plant community.
- (c) To provide a regional conservation centre.

(d) To provide facilities for short-term storage of working collections and herbaria in the region.

(e) To provide regional documentation in the form of a library and a herbarium.

Each country will be engaged in the work of a coordinated overall programme with plant collection and evaluation.

Working collections will be maintained as required in the member countries, and a complete set of all collections will be maintained under long-term storage at Izmir, Turkey. Working facilities for the already available.

The documentation centre will also be maintained at Izmir, with a complete set of all collections and a complete set of all collections.

The participating countries will each maintain a small herbarium and a library of the working collections for plant collection.

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Rome, 12-16 March 1973

IRRI'S ROLE AS A GENETIC RESOURCES CENTRE

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SUMMARY

From 1962 to 1972, the International Rice Research Institute assembled a collection of 20,000 rice cultivars and 2,000 accessions of genetic testers, mutants and wild forms through acquisition by correspondence, assistance to field collection projects, and direct participation in field collection. Excellent assistance and cooperation was received from national and international institutions. Through seed increase, characterization, evaluation, cataloguing, seed distribution, and preservation, valuable gene-pools were made available to many national rice research programmes. Seeds drawn from the IRRI stocks have restored hundreds of indigenous varieties to several national collections. International exchange of seeds was promoted by IRRI's services as a gene bank and centre for research and documentation. Recently many national centres have taken action to conserve indigenous rice germplasm with IRRI coordinating and pooling both financial and technical resources from various agencies. These activities increase the need to train technical personnel for maintaining and evaluating genetic stocks. Adverse environment conditions in the tropics make it essential to store seed stocks at more than one centre. More international collaboration is needed to complete a global network consisting of several regional centres (gene banks), a crop-specific institute, and cooperating national centres.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES
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Rome, 12-16 March 1973

A GLOBAL NETWORK OF GENETIC RESOURCES CENTRES -
AN URGENT NEED FOR SUSTAINING AGRICULTURAL ADVANCE

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SUMMARY

The damage caused to maize production in the United States in 1970 by the "T" strain of *Helminosporium maydis* and the havoc caused by the Tungro virus to the high-yielding rice varieties in the Philippines in 1971 and 1972 and in Indonesia in 1972 have all underlined the urgency of diversifying the genetic base of the high-yielding varieties of cereals and millets. It has also become clear that if primitive cultivars and wild relatives of crop plants are screened extensively for new selection parameters like protein properties, photosynthetic pathways and ideal ideotypes, it may be possible to locate hitherto unrecognized genes.

A recent example is the identification in Sweden of the "Hiproly" character (high protein cum high lysine) in a barley strain from Ethiopia.

In India, there is a great wealth of genetic material in rice, maize, cotton and several medicinal and ornamental plants in the Himalayan region. Rice collections from North Eastern Himalayas have revealed new sources of dwarfing, drought resistance, cooking quality such as rapid cooking, and resistance to several pests and diseases. Similarly, the maize collections from Sikkim have shown variability for multi-cob and other interesting characters. There is also considerable scope for the genetic improvement of plants like *Dioscorea deltoidea* and *D. floribunda*, which are valued in the oral contraceptive industry for their diosgenin content.

The changing micro-environment of plants, as represented by the high-yield per day concept, brings in its wake new pest and disease problems and new requirements of plant architecture and growth rhythm. This need has accelerated the urgency of collecting, preserving and utilizing the germplasm resources of all economic plants. This task is also important from the viewpoint of preserving for the benefit of the present and future

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generations the fruits of thousands of years of natural and human selection. It is hence that the Technical Advisory Committee to the Consultative Group on International Agricultural Research has advocated the establishment of a global network of genetic resources centres, where all the important genetic material relating to plants of economic value can be maintained, studied and catalogued, using a uniform system of classification. In addition, it is hoped that a few genetic resource sanctuaries representing natural ecological milieux which have promoted the origin and maintenance of considerable genetic variability in crop plants can be established. This will help to draw from such sanctuaries new variability periodically and to provide an opportunity for examining the mechanisms responsible for explosive genetic diversity in some areas.

SAMPLING &
POPULATION PROBLEMS

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OPTIMUM SAMPLING STRATEGIES IN GENETIC CONSERVATION

D.R. Marshall and A.H.D. Brown
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SUMMARY

Many factors restrict the number of samples which can be handled effectively in genetic conservation programmes. The modest financial and personnel resources which can be mobilized for the collection, classification and storage of genetic stocks as well as the limited capacity of plant breeders to evaluate and exploit the conserved material are of particular importance in this regard. Consequently, to be fully efficient, genetic conservation must be directed towards the preservation of the maximum amount of useful genetic variability while keeping the total number of samples within these practical limits.

The full definition of optimal sampling strategies requires a complete account of the genetic diversity within and between populations of the target species. Such knowledge is generally lacking, and this precludes a precise solution to the problem. Nevertheless, a number of principles can be deduced from what we already know about the factors affecting genetic variation in nature. These principles, together with practical considerations, can be brought into a discussion of the many contentious questions in the literature on collecting techniques.

The number of alleles per locus provides the simplest measure of genetic diversity for the purposes of exploration and conservation. Tightly linked, co-adapted complexes can be regarded as "alleles" of a "supergene" and in the present context are no different in principle from alleles at a single locus. Therefore the most efficient strategy is that which maximizes the number of alleles per locus in the collected sample.

The first decision facing the plant explorer is the number of plants to collect at each sampling site. Since excessive sampling at any one site limits his opportunities to discover and sample other, perhaps more valuable sites, it is argued that the appropriate procedure is to take the smallest "representative" sample possible. It can be shown that a random sample of 60 plants is required to include with 95% certainty, an allele which occurs with frequency greater than 0.05 in a population. This calculation suggests that the minimum representative sample is often smaller than is commonly supposed. The enrichment of random samples with either rare phenotypic deviants or with plants growing in rare and distinct microhabitats is an equivocal practice. A cardinal rule of procedure is that such enrichment should not be at the expense of the size of the random fraction.

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Once the minimum representative sample size has been defined, then the next strategic decision facing the plant explorer is the choice of sampling sites within the target area. Obviously, a large number of genetic and ecological factors, as well as practical considerations, affect this decision. These factors, and their implications in the development of efficient sampling procedures, are discussed in some detail.

The third decision facing the plant explorer concerns the maintenance of the collected samples. A central issue here is the relative merits of maintenance as stored seed compared with that by propagation in bulk populations. A reassessment of this issue is now required in the light of the increased availability of long-term storage facilities and a clearer insight into the goals of conservation.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

POPULATION STRUCTURE AND THE EFFECTS OF BREEDING SYSTEM

S.K. Jain
University of California, Davis, California, U.S.A.

SUMMARY

The genetic structure of a population is determined by the complex interplay of various ecological and genetic parameters. Our primary interest here is to develop some generalised descriptions based on deductions from theory and surveys of experimental examples, with special reference to crop genera. Breeding systems, characterised by the rates of outbreeding and inbreeding have been widely discussed in the literature in terms of the devices regulating them, evolution of mixed strategies toward achieving a compromise between adaptedness and adaptability, and their role in variation patterns. In this paper, some of the generalizations arising from these discussions will be re-examined with the help of some new models and recent experimental findings.

Four points emerge from this re-examination:

1. The breeding system of most species is often more variable than usually depicted by its modal description. For example, outcrossing rates in predominantly autogamous species vary widely among different localities, seasons, genotypes etc. such that the predictions of levels of heterozygosity, rates of gene flow and scale of local differentiation, all become probability statements.
2. Comparative variation studies in closely related species indicate that autogamy leads to lower levels of heterozygosity within demes, greater inter-population differentiation and increased colonizing ability, but whether or how these relate to loss of adaptability, or rates of speciation is not clear. Examples are drawn from recent studies on Avena, Bromus, Trifolium, Festuca, Lupinus, Leavenworthia, Clarkia and Hordeum.
3. Phenetic hypotheses must be distinguished from the phylogenetic ones in discussions of the presumed consequences of the derivation of inbreeders from outbreeding ancestors. This is particularly relevant to changes under domestication and man-made environments.

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4. A population is both a breeding unit and a local ecological unit so that population structure must be analyzed in terms of both genetic and ecological characteristics of a species. Population subdivision and gene flow, regulation of numbers, and drift, on one hand, and both biotic and abiotic factors of the environment on the other, must be investigated more often than in the past. Only then can we hope to relate population structure and genetic system analyses to the systematic survey, collection and the maintenance of germplasm.

POPULATION STRUCTURE AND THE EFFECTS OF GENETIC SYSTEMS

University of California, Davis, California, U.S.A.

SUMMARY

The genetic structure of a population is determined by the complex interplay of various ecological and genetic processes. Our primary interest here is in those cases where the population is subdivided into two or more breeding units, each with its own genetic system. The genetic structure of a population is determined by the complex interplay of various ecological and genetic processes. Our primary interest here is in those cases where the population is subdivided into two or more breeding units, each with its own genetic system. The genetic structure of a population is determined by the complex interplay of various ecological and genetic processes. Our primary interest here is in those cases where the population is subdivided into two or more breeding units, each with its own genetic system.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

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Rome, 12-16 March 1973

POPULATION STRUCTURE AND THE EFFECTS OF ISOLATION AND SELECTION

A.D. Bradshaw
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SUMMARY

There are three major forces than can cause change of gene frequency in populations, selection, gene migration, and genetic drift. Each of them can have profound effects but whether they do or not depends considerably on the structure of the populations.

The general effects of selection are obvious: it is the prime cause of genetic change. But the rapidity and far reaching effects of selection on plant populations are only now being appreciated. It is clear that selection can totally change the genetic constitution of a population in a few generations. Not only will there be change in the characters being selected but because linkage can give rise to correlated response there may well be changes in other characters not subject to selection. However selection rarely seems to lead to fixation of genes, so back selection can occur.

By contrast migration is usually considered to be a conservative force: gene flow between populations will tend to prevent divergence of gene frequencies between them. However while this is true in theory, in practice gene flow is found to cause little restriction to divergence between populations on which selection is acting differently. This is because gene flow by pollen or seed is very small between populations at normal plant densities: distances of 100 metres reduce gene flow to below 2% in most species, a level easily overcome by selection. However the low levels of migration that do occur over very long distances can be important, in allowing genes arising in one population to be transferred to other populations where there is selection favouring them.

Genetic drift is only of importance in populations consisting of fewer than 100 individuals. Most plant populations are much larger than this, especially when dormant seeds are taken into account. Populations do sometimes go through brief periods of very small size, just a few individuals, which could lead to drift by what is known as the founder effect. However, unless genetic fixation has occurred gene frequencies can soon come back into equilibrium with selective pressures.

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From this it can be concluded that the genetic structure of a plant species is dominated by the pattern of selection no matter what the population structure. It has been found repeatedly that the pattern of genetic differentiation within species follows that of the environment. This is true even over very short distances of a few metres.

But there are a few inexplicable variations in the genetic pattern within species which seem not to be determined by selection. The causes are difficult to determine: they could be isolated mutations, genetic drift, correlated response or some other undetermined factors. Since important characters can be involved we would need to know more about these possible causes.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

DISTRIBUTION OF DISEASE RESISTANCE IN ETHIOPIAN BARLEYS

C.O. Qualset

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California, Davis, California

SUMMARY

The barley yellow dwarf disease was discovered in California in 1951 and was subsequently identified throughout the world. This disease had a devastating effect on barley, wheat, and oat production. It was determined that the disease was caused by an aphid-transmitted virus. It was first identified on barley and hence became known as the barley yellow dwarf virus disease (BYDV).

Resistance was unknown but a search of the world collection of barley showed that only Ethiopian barleys had resistance. Genetic studies with more than 10 of the Ethiopian varieties indicated that resistance was controlled by a single gene and that all varieties had the same gene for resistance. This gene was easily transferred to varieties adapted to California with resultant yield increases of 15-30%.

A detailed study of all available Ethiopian varieties was made and the results will be presented in this paper. Resistance was found in 19% of the varieties. Morphologic and maturity characters were examined in more than 600 collections. Character associations showed that resistance was most often associated with lax spike, late maturity, white aleurone, short-haired rachilla, long glume awn, and covered caryopsis.

Only limited data concerning the geographic and altitudinal origins of the varieties was available, but from the collections made by H.V. Harlan in Ethiopia in 1923 it appeared that resistance had evolved in high-elevation sites in Ethiopia.

Further work was done on eight other diseases of barley and resistance to all of these diseases was found in the Ethiopian collection. It was determined that varieties with multiple resistance occurred much more frequently than expected by chance. Thus, natural selection for resistance to more than one disease seems obvious.

Information on ecological conditions of the sites from which barley has been collected in Ethiopia is clearly lacking. The incidence of fungal, viral, and insect pathogens in Ethiopia has not been determined. New collections must be made to

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obtain a more extensive sample of the germplasm and to develop fundamental information on the evolution of disease resistance and character combinations in barley. Ethiopia is ideally suited for such research because of (1) the great genetic diversity of barley found there, (2) the large range of climatic and edaphic conditions in a relatively small area, (3) limited introduction of foreign varieties up to the present time, and (4) a large diversity of pathogens as evidenced by the variation in susceptibility to many barley diseases.

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PAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

PRACTICAL PROBLEMS IN EXPLORATION - SEED CROPS

J.R. Harlan

SUMMARY

Some of the practical problems that confront plant explorers are : political climate, local cooperation, transportation, timing, sampling, shipping collections and plant quarantine.

I shall not deal here with political climate or local cooperation, but it is obvious that if the explorer is denied a visa or barred entry to the region in which collections are to be made, there is nothing that can be done. On the other hand, local cooperation and participation can be enormously helpful. Apart from these considerations, transportation is the chief limiting factor and one that provides a constant source of problems. It is essential that the explorer have control over his transportation, but local resources may be extremely limited, entirely deficient or expensive. These problems must be worked out by each explorer on each occasion in the best way possible.

For our major crops, the readily accessible material has been largely sampled. Little can now be gained by visiting markets or driving along the highways. What remains to be collected is mostly in remote and inaccessible places. Collecting by foot, horseback or canoe, however, is very slow and sampling a large region requires either repeated campaigns or massive efforts with multiple collecting teams.

Timing is critical. Collections should be made during the harvest season to obtain field information. In seed crops, one can usually obtain samples of stored seed in off season, but information is very restricted. For wild materials, however, it is absolutely essential to be in the right place at the right time. To do this consistently is almost impossible, and the explorer frequently finds he is either too early or too late.

The best, most systematic and most complete collections should come from resident collectors who live in or near the regions to be sampled and who can more often be at the right place at the right time. If material is missed one season, it can be collected another. Resident collectors should know the material and terrain much better and, over a period of years, should be far more effective than the expedition type explorer from outside. They do, however, require financial support and encouragement from outside the region.

The potential value of a collection cannot be assessed in the field. Without a priori information on the usefulness of the material, the collector is supposed to assemble a good sampling of genetic diversity, avoiding at the same time undue redundancy. Variation may be considerable within a field, among fields of the same area and between areas. Variation in crops is often closely associated with ethnic groups, elevation, rainfall and soil types. It is necessary to make judgements as to how to sample a single field, fields of a local area and the areas that should be sampled. These subjective judgements are based on minimal information, intuition, guesswork and sometimes experience, but not on sound experimental evidence.

Shipping seed collections is easy compared with handling vegetative material, but quarantine restrictions have caused undue problems in some countries. Plant introduction programmes can usually succeed only where they are carried out with the full cooperation of the plant quarantine service.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

PRACTICAL PROBLEMS IN EXPLORATION - VEGETATIVELY PROPAGATED CROPS

J.G. Hawkes

Department of Botany, University of Birmingham

SUMMARY

Collections of vegetative material may be in the form of rhizomes, tubers, roots, bulbs, corms or cuttings. Since each propagule is the same genotype as the parent plant, vegetative collections need to be more extensive than seed collections. For instance, one parent plant of an outbreeding species can provide as many distinct genotypes as there are seeds; on the other hand if vegetative organs are collected only one genotype per plant is possible.

Other difficulties with vegetative material are (1) it is more bulky than seed material, (2) more care is required to keep it alive during an expedition and during transmission to the gene bank, (3) quarantine regulations at entry point may pose great difficulties, (4) the variability is difficult to estimate with underground organs which need to be dug up before they can be seen, (5) when flowers and leaves are present the underground organs are not ready for collection and hence the collector needs ideally to visit a field twice, and (6) what may appear to be a population of plants may in fact be a single clone exhibiting different phenotypes growing under environmental differences.

On the other hand, vegetative collections may show ranges of cytotypes of reduced fertility, which may throw light on gene flow, hybridization, etc. Seed collections may represent only a small part (the highly fertile one) of the range of variability. Even low fertility genotypes may be of value to the breeder and are therefore worth collecting as vegetative material.

Exploration techniques vary somewhat between wild and cultivated material. Wild species samples should not be taken too close together for fear of sampling the same clone several times. Practical experience indicates that 10 to 20 samples in each square kilometer are useful, to be repeated over the sampling area at a density conditioned by factors such as topography, population density, observed variability, etc. The value of this technique needs experimental verification.

Under primitive agriculture single clone cultivation does not exist, though the situation is changing rapidly through the adoption of selected or highly bred cultivars. To explore an area for cultivated material it is

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

PRACTICAL PROBLEMS IN EXPLORATION - TREE CROPS

J.T. Sykes

Department of Horticultural Science, University of Guelph

SUMMARY

There are numerous problems in the collection of tree crops. These include survey and exploration tactics, sampling, documentation and collection procedures, and the multiplication and establishment of collected accessions. Since vegetative propagation must be practised, plant quarantine and conservation problems are, similarly, quite important.

Exploration strategy depends on surveys of plant populations. Regional production data considered in relation to climatic parameters may indicate important collection areas. Interpretation of aerial photographs and, in future, multi-spectral sensing, where economically feasible, may facilitate species identification and delineation of populations.

Plants of wild species are usually widely dispersed throughout large and frequently inaccessible areas. Very large numbers of accessions are obtained from populations randomly sampled in relation to factors affecting variability. Non-random sampling is therefore sometimes inevitable. This relies on empirical judgement of characters and although morphological differences may be undetectable, genetic diversity is neither minimal nor absent in such populations.

Primitive varieties may be collected within limited confines from orchards but scattered and isolated specimens are more usually encountered. Some varieties may, with minimum manipulation, be commercially utilized elsewhere. Local co-operation can be jeopardized if commercial exploitation through plant patents is either evident or suspected.

Collection priorities must be determined, for specific characters and between wild species and primitive varieties. This is a very real problem when human or physical resources are limited, especially since sites must be visited more than once annually for flower or fruit evaluation and possibly later for obtaining propagating material. Tree performance records are also required over several years.

The variability in morphological and physiological characters of many ornamental and fruit species has not yet been fully exploited. Individual plants or clones show differential responses in their propagation or when exposed to extreme environments.

Plants potentially useful *per se* as rootstocks or as breeding material for rootstocks are other collection objectives, differing from but complementary to those relating to conventional breeding programmes.

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Budwood and various types of cuttings are usually collected for propagation but even dormant, mature shoots have a limited longevity. Such material is very expensively acquired. Therefore success in its propagation must be ensured to minimize the number of samples per tree collected and to guarantee that the complete array of collected accessions is available for conservation.

Loss of material, due to insufficient numbers collected or unsuccessful propagation, is inexcusable. Very close liaison is essential between the collector and the propagator. The organization, facilities and personnel at the centre where propagation is carried out should be of the highest calibre.

Virus diseases are a major concern. Their presence may severely restrict, due to quarantine regulations, the free exchange of germ plasma.

Phenotypic expression and sampling intensity of collected accessions are related respectively, to the climate and the area available at the sites selected for long-term conservation. Trees have a long life-cycle and for regions with a high plant population density the "crop reservation" concept for in situ conservation merits consideration.

PROG. QUANTITATIVE
MISSOURI

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(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

READING UNIVERSITY PLANT COLLECTING EXPEDITION TO NORTH-EASTERN BRAZIL

Barbara Pickersgill

SUMMARY

In 1972 the Department of Agricultural Botany at the University of Reading organized an expedition to the drought polygon of north-east Brazil to collect seed of grain legumes, cottons and wild species of Arachis and Manihot for use in plant improvement programmes in Brazil and other climatically equivalent parts of the dry tropics. In addition, Capsicum, Lagenaria and wild species and primitive cultivars of cotton were collected for evolutionary studies on these crops.

The expedition was in the field from January to March 1972, during the early part of the rainy season. The route covered Pernambuco, northern Bahia, eastern Piauí, Ceará, Rio Grande do Norte and Paraíba. Collections were made from experiment stations, markets, local farmers and wild plants, as appropriate.

The most common grain legumes in the area were Phaseolus vulgaris, P. lunatus and Vigna sinensis. P. vulgaris and V. sinensis varied considerably in seed colour, habit and time to maturity. As a result of recent road-building programmes in the north-east, beans and other crops are increasingly shipped in from the south, probably replacing locally-adapted cultivars. A small collection of legumes used for forage was also made. A wild species of Arachis was found abundantly throughout Ceará and Rio Grande do Norte and is apparently related to wild species further south in Goiás.

The most important cultivated cotton in the north east is mocó (Gossypium hirsutum var. marie-galante), a perennial tetraploid which can be grown without irrigation because it evades or survives drought. Seeds of recently improved cultivars as well as of older relict forms of mocó were obtained. Annual G. hirsutum, which has been introduced more recently (post-1840), and verdão cottons (with greenish fuzz), which may represent G. hirsutum with some introgression from G. barbadense, were also collected. Additional localities were found for an apparently wild tetraploid (G. caicoense), intermediate in many respects between G. hirsutum and

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G. barbadense, capable of crossing with both, and of considerable interest in reconstructing the origin and evolution of the tetraploids.

There are at present adequate collections of Manihot esculenta in various research stations in South America, but the wild species, which are possible sources of disease resistance, are markedly under-represented in living collections. The expedition obtained small amounts of seed of 2 or 3 wild species.

The chili peppers collected belonged mostly to the Capsicum chinense/frutescens complex, although introduced non-pungent forms of C. annuum were widespread and C. baccatum, which is characteristically a more southern species, appeared to be spreading in the north-east.

Lagenaria is widely used for containers and fishing floats in north-east Brazil. Edible forms, eaten as a vegetable, still survive but as relict cultivars only. The Brazilian gourds appear to be originally derived from Africa, with a possible later introduction from Asia.

Duplicate sets of all the material collected (with the exception of the gourds and chili peppers) have been left in Brazil. Most of the material has already been distributed to interested institutions in Europe, the Americas, Africa and Australia, with appropriate precautions over quarantine.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

RECENT AND PROPOSED EXPLORATION MISSIONS

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Cocoa Research Institute of Nigeria

SUMMARY

The West African sub-region, or the Guinean Zone, is the primary centre of variation for African rice, *Cola* sp., oil palm, *Funtumia* sp., Robusta coffee, yams, African mahoganies and other important species. Also it has become a secondary centre of variation for cocoa, rice, maize, chillies, etc.

This zone has not been thoroughly exploited for the purposes of conserving the germplasm for which the sub-region constitutes both the primary and secondary centres of variation.

Reference is made to past and recent explorations which have resulted in creating large gene pools of cocoa, kola, coffee, maize, rice and pulses at isolated spots in West Africa. The maintenance of these gene pools in most cases is unsatisfactory; with the dissolution of the West Africa Research Organization (WARO), most of the valuable germplasm of rice, collected at the Rice Research Station, Rokpur, Sierra Leone, maize, collected at Moor Plantation, Ibadan, Nigeria, under the control of the defunct West African Maize Rust Research Unit, and cocoa, under the control of the West African Cocoa Research Institute, Tafo, Ghana and Ibadan, Nigeria (also now defunct) have been lost.

It is suggested that:

- (a) Internationally controlled germplasm centres be created in West Africa under the sponsorship of FAO for each of the major crops of that sub-region.
- (b) Immediate intensive collection expeditions be mounted for the whole of the sub-region to rescue the valuable germplasm that is being progressively destroyed as a result of increasing urbanization, deforestation, population growth, industrialization and general economic development.

WIA/D5900

Since there is an International Quarantine Centre at Moor Plantation, Ibadan, Nigeria, it appears that there should be no serious problems in undertaking the proposed expeditions provided that FAO gives the leadership in terms of the organization, financing and execution of the project.

The experience of the N.I. Vavilov All-Union Research Institute of Plant Industry (USSR) and the practice of the Institute in sending exploration teams to the main agricultural regions of the Soviet Union for purposes of plant collection should serve as a guide in this project.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

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Rome, 12-16 March 1973

RECENT AND PROPOSED EXPLORATION MISSIONS

D. Brezhnev

SUMMARY

The exploration, evaluation and conservation of genetic resources of agricultural crops and dissemination of seeds and planting material to breeders are the main tasks of N.I. Vavilov All-Union Research Institute of Plant Industry.

For this purpose the Institute arranges exploration missions every year to the centres of origin and diversity of agricultural crops in this country as well as in the countries of South America, Asia, Africa and in Australia. In the last five years specialists of the Institute have surveyed Afghanistan, Turkey, Iraq, Pakistan, Sudan, India, Japan, Mongolia, Ethiopia, Algeria, Morocco, Tunisia, Guinea, Mali, Senegal, Kenya, Somalia, Burundi, Mexico, Chile, Peru, Brazil, Tanzania, Uganda, Bolivia and Ecuador. Several dozens of missions surveyed different regions of the USSR (the Caucasus, Central Asia, the Far East).

As a result of this activity nearly 30,000 samples of cereals, grain legumes, industrial crops, oil and fodder crops, vegetables, fruit and small fruit crops, and potatoes have been introduced to the collection. All seed samples and cuttings are recorded and maintained in the Institute's collection.

Moreover the Institute exchanged a lot of material with the scientific institutions of 80 foreign countries. For the last five years this activity helped to introduce over 10,000 samples to the collection.

All explored material is carefully evaluated by geneticists, physiologists, botanists, biochemists, cytologists, phytopathologists, entomologists and other scientists.

Breeding institutions of the country widely utilize the germplasm collection. Every year the Institute disseminates dozens of thousands of samples, which serve as raw materials for new varieties.

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Exploration missions will continue in the future. In the coming years we plan to send missions to Argentina, Colombia, Venezuela, South Yemen, Guatemala, Honduras, Nicaragua, Canada, Korean People's Democratic Republic and Madagascar. New missions will be sent to Australia, some African countries, countries of the Middle East and Scandinavia.

At the same time we shall carry on the exchange with all countries of the world interested in such activity.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

RECENT AND PROPOSED EXPLORATION ACTIVITIES OF THE IZMIR CENTRE

H. Aylā Sencer

SUMMARY

The exploration activities of the Izmir Centre started as early as 1964; and intensive and systematic collections of cereals (wheat, barley, rye, oat), grain legumes (bean, broad bean, pea, chick-pea, cowpea, lentil) and their wild relatives as well as vegetables, spices and forage crops were made from 1968.

The principles applied to exploration are as follows:

- Priority is given to crops and areas according to threat of extinction and economic importance;
- Maximum genetic variation should be covered, taking account of ecological conditions and agricultural systems;
- Herbarium specimens are used for taxonomic identification of the collected material and to show genetic variation existing in the collections;
- Information concerning the origin, habitat, etc. of the collections is recorded in a standard way which enables the computerization of the data;
- Time and facilities are utilized in a most efficient way;
- To illustrate the methods and techniques of exploration as it is done by the Izmir Centre, the exploration of a genus (Secale L. - rye) which includes both a cultivated crop and its wild and weedy relatives will be presented.

The Centre has conducted vegetation surveys in some of the national park areas of Turkey; survey of specific group of plants (i.e. wild ornamental plants which grow on the mountains of Turkey and are of high economical value) and crop specific surveys (i.e. Ceratonia siliqua L. - carob tree) parallel to its plant collecting activities.

WM/D5426

As mentioned previously, priorities are given to crops and areas on the basis of threat of extinction. The areas where the crops mentioned above and their wild relatives have not yet been explored to the extent needed are the Central Anatolian Region and the higher parts of the Taurus and Pontus mountain ranges above 700-800 m. It is intended to explore these areas in 1973.

Crops which have not yet been explored and should be considered seriously for the near future are: tree fruits (apple, peach, apricot, cherries, pears, plums, grapes, pistachio, almond, hazelnut, fig, pomegranate) and oil and industrial crops (sunflower, hemp, flax, linseed, sesame, safflower, tobacco, rice, corn, sorghum, millet).

PROJECT AND RESEARCH ACTIVITIES OF THE TUNIS GROUP

Dr. A. H. H. H.

PLANT

The objectives of the Tunis Group are to study the flora and fauna of Tunisia and to collect and preserve the plants and animals of the country. The group will also study the distribution and ecology of the plants and animals of the country.

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Rome, 12-16 March 1973

RECENT SURVEY AND EXPLORATION IN RICE

T.T. Chang
International Rice Research Institute

SUMMARY

Exploration for primitive rice cultivars in the Jeypore Tract of Orissa (India) during the late 1950's was the first organized effort to survey and to conserve diverse and indigenous rice germplasm. From 1958 to 1964 The Rockefeller Foundation supported Japanese geneticists and taxonomists in exploring and collecting wild taxa and primitive forms of the genus Oryza in East and West Africa, South and Southeast Asia, and Latin America. Since 1964 the International Rice Research Institute has helped Chinese, Indian, and Japanese researchers in collecting wild and primitive types in West Africa and in tropical Asia. IRRI has also made an extensive survey of the composition of national collections in major rice-growing countries. By coordinating financial and technical resources from several international and national organizations, a programme was developed in 1970 by several national rice research programmes in tropical Asia, USDA, USAID, and IRRI under the International Rice Collection and Evaluation Project to canvass those areas where no or little previous efforts were made to sample the rich genetic diversity. The main objective is to acquire minor varieties, primitive types, and wild species.

During 1971 and 1972 extensive collection efforts were made in Indonesia, Khmer, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and South Vietnam through international collaboration. About 5,300 cultivars and 35 wild populations were collected. In 1973 and later, similar efforts will be extended to Bangladesh, Burma, East Malaysia, and Laos. A survey and collection programme will be developed for West Africa so that O. glaberrima, its wild relatives, and African wild species of the genus can be conserved by international cooperation.

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Rome, 12 - 16 March 1973

EXPLORATION OF GENE CENTRES OF GROUNDNUTS (*Arachis hypogaea* L.)

by

A. Krapovickas

School of Agriculture and Veterinary Science, Corrientes, Argentina

ABSTRACT

The peculiar manner of multiplication of the genus *Arachis* minimizes gene flow creating small populations with different genetic variabilities.

All species produce underground fruit which limits dispersal possibilities to a few metres per year except in cases where propagules are unearthed while rivers are in spate. On the other hand the ecological requirements of the various species are very restricted, since they are restricted to certain types of soil. If one adds to this the fact that reproduction is mainly autogamic except for some infrequent pollination by bees, we see that there are many effective isolation mechanisms. For these reasons, in respect of *Arachis* more than for other groups with greater opportunities for dispersal, it is necessary to sample extensively from many populations in order to determine the pattern of variability of this taxon.

Basic information on the distribution of *Arachis* species is found dispersed in herbariums, but only rarely are the specimens complete, lacking the underground parts of the plant generally, that is, the pods, fruits, rhizomes or root systems which are essential for the taxonomy of the genus. For these reasons it was necessary to follow a broad plan of exploration covering the entire area of this genus in order to determine the limits of its species and their interrelationships.

Living plant material from collections made by Ramos Otero (1933 and 1939), Archer (1936) and Stephens and Hartley (1948), pioneers in exploration of *Arachis* species, is available. But information was still partial because these explorers concentrated their activity mainly to the basin of the La Plata from Mato Grosso (Brazil) to its mouth (Uruguay). In 1959 together with Gregory and Pietrarelli, the author of this paper began a methodical exploration of the whole area of *Arachis*, visiting practically all places where herbarium samples of this genus had been collected. In 1959 the author covered northern Argentina,

central Brazil, eastern Paraguay and eastern Bolivia. In 1961 the states of Minas Gerais, Goiás, Mato Grosso in Brazil were visited, as well as northeastern Paraguay and finally in 1967, the Brazilian states of Bahia, Pernambuco and Ceará. In addition to these trips others were made with Hammons, Langsdorf, Pietrarelli and Hemsy, covering Uruguay and the Brazilian states of Rio Grande do Sul, Paraná, São Paulo and Mato Grosso. In this way the first phase of the work, studying known *Arachis* material in the field, was completed. The programme must be completed by discovering new localities of the genus on the basis of the experience gained.

To give a concrete illustration, the trips made pointed to the possibility that the area of this genus may extend into the northwestern Mato Grosso, since around Cuiabá, just on the margin of this zone, at the limit of one of the trips, six taxa belonging to three sections of the genus were found. Such variability within the geographic limits of this genus is difficult to find. Similarly, Bolivia seems to hold many surprises for the explorer. Existing evidence points to the foothills of the Andes as a possible source of origin of cultivated peanuts. About five taxa are known to occur between Santa Cruz de la Sierra and northwestern Argentina, to which should be added at least one new species, found in 1971 on an expedition sponsored by FAO. In all these trips many samples and specimens of cultivated peanuts were collected, from which it has been possible to establish five centres of genetic variation of *A. hypogaea*. From the results obtained so far the need for exploring the eastern slopes of the Andes, Bolivia, Peru and as far as Colombia, is evident, because at present practically no information is available on these areas.

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Rome, 12-16 March 1973

PLANT EXPLORATION AND COLLECTION BY CANADA

R. Loiselle
Central Office for the Plant Gene Resources of Canada
Canada Department of Agriculture
Ottawa, Ontario

SUMMARY

Following the FAO/IBP Technical Conference on the Exploration, Utilization and Conservation of Plant Genetic Resources held in Rome in 1967, a work planning meeting was held in Ottawa in 1968 to assess the situation in Canada with particular reference to need and organization. It was noted at the meeting that very few of the important agricultural crops grown in Canada are native to Canada. Most of them originated as introductions from Europe or Asia. However, it is a fact that where Canadian species have been studied intensively, the results have been good and justify clearly further exploration among native and naturalized species. One of the meeting recommendations was that a national programme of exploration and collection be conducted in Canada with immediate attention to be given to certain plant materials which may be in imminent danger of extinction and that, in addition, Canada sponsor programmes of plant exploration in countries which may have material of value to Canada but which has not been collected and made available on an exchange basis. Other recommendations adopted at the Ottawa meeting were in connection with the maintenance of useful material from working collections, breeding programmes and land races; a standardized system for recording, storage and retrieval of information on genetic resources; and national and international exchanges of plant germ plasm.

The above recommendations were considered by the Executive of the Research Branch of the Canada Department of Agriculture and led to the establishment of an integrated national programme for the recording, utilization and conservation of Canadian plant gene resources. A central office was created in October 1970 to look after the day to day operations of the programme and a national advisory committee was appointed in April 1971 to provide general direction and to set priorities.

The Canadian programme on Plant Gene Resources has been in existence for a relatively short time and although it has not been concerned in any organized way with activities in connection with plant exploration and collection, it is an accepted fact that considerable work has been done already or is in progress in Canada. Working collections of cereal, horticultural and forage crops are maintained by 179

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individual scientists. Approximately 86,000 stocks are represented in these collections. Collecting expeditions of native forage species of northern grasses are being conducted in Alberta. Collections of native strawberry (*Fragaria chiloensis*) clones are being made along the coast of British Columbia. Collections of the native North American red raspberry (*Rubus idaeus strigosus*) are being made to obtain breeding material with winterhardiness, fall fruiting habit and disease and insect resistance. Foreign expeditions to collect land races and wild species of oats were conducted in 1964, 1966 and 1970. The 1964 expedition explored many areas in the Mediterranean region; the 1966 collection was made in Israel; and the third expedition covered mainly the Middle East. The Canada Department of Agriculture now maintains the largest world collection of wild species of the genus Avena.

The above summary of the work of the Department of Agriculture in the field of plant genetics is intended to give a general impression of the scope and nature of the work being done. It is not intended to be a detailed account of the work of the Department. For a more detailed account of the work of the Department, the reader is referred to the report of the Department of Agriculture, 1970, which is available from the Department of Agriculture, Ottawa, Ontario.

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(In cooperation with the International Biological Programme of
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Rome, 12 - 16 March 1973

EXPLORATION OF ~~SOME~~ POTATOES IN CHILE, BOLIVIA AND PERU

C. Ochoa
Universidad Nacional Agraria, La Molina, Lima

ABSTRACT

The Andes, Mexico and Central America constitute a vast, genetic reservoir of primitive cultivated potatoes and wild species. Yet this valuable material, still not fully used, is in danger of gradually disappearing. There are various reasons for this, such as pests, fungal, bacterial or virus diseases, drought, excessive rainfall, floods, earthquakes, introduction of genetically improved cultivars, and conscious and unconscious selection practised by the indigenous farmers, etc.

Generally speaking, genetic erosion seems much most serious in the diploid group. Forms such as "Rambramina", "Ila", "Clavelina", "Chojllu", "Puyhuen", and others of *S. stenotomum* have disappeared or are found with difficulty. For reasons of altitude and limited use, the hybrid species *S. x Juzepczukii* and *S. x Curtilobum* are the ones that have suffered most. In the tetraploid group of *S. tuberosum* ssp. *andigena*, cultivars such as "Chilope", "Montanera", "Tornasol", "Naranja", "Sajma" that have disappeared forever might be mentioned.

Potato exploration requires a detailed knowledge of its taxonomy and ecology. Very often expeditions cover only the areas of easiest access while many isolated areas have not been properly explored. Ethnobotanical data are absolutely essential - the common names, the uses, and whatever observations the indigenous population may contribute, in order to document collections more fully. In this connection a knowledge of the main languages of the areas where potatoes are grown, namely, Quechua and Aymara, is extremely useful.

The responsibility for safeguarding the invaluable germ plasm of potatoes does not lie solely with the so-called underdeveloped Andean countries that lack funds to defray the considerable cost of such investigations. Likewise the genetic resources of indigenous food crops do not belong to these countries alone either, but are life-giving resources for the whole of humanity. Therefore if we truly wish to safeguard this material for the use and benefit of all those who need it, urgent action should be begun immediately in the form of well equipped mass expeditions for the requisite field work and the subsequent storage, assessment, and permanent distribution among qualified technical staff, which calls for the collaboration and help of the main research institutes throughout the world.

Recently the Centro Internacional de Papa (International Potato Centre) was established at Lima, Peru, with the necessary financing and a board of directors composed of distinguished European and U.S.A. experts. One of the aims of this centre is to undertake urgent action to save the native genetic potential of potatoes, followed by evaluation and distribution on a world-wide scale.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

THE SEARCH FOR DISEASE AND INSECT RESISTANCE IN RICE GERMPLASM

T.T. Chang, S.H. Ou, M.D. Pathak, K.C. Ling and H.E. Kauffman
The International Rice Research Institute, Manila, Philippines

SUMMARY

Five to ten thousand accessions in the IRRI collection of rice cultivars and wild species have been screened for high levels of resistance to each of the major diseases and insect pests. The diseases included blast, tungro virus, grassy stunt virus, bacterial leaf blight, sheath blight, and bacterial leaf streak. The insect pests included the stem borers, leafhoppers, planthoppers, and, recently whorl maggots. Testing for varietal resistance is made by mass screening under screenhouse or field conditions or both. Resistant accessions are repeatedly tested to ascertain the true nature of resistance. An intensive search among 6,000 cultivated strains and over 100 wild forms led to the identification of a strain of *Oryza sativa* which is the sole source of resistance to the grassy stunt virus. Different races of a pathogen are often included to provide information on race-cultivar interactions. Through multi-disciplinary cooperation, cultivars with multiple pest resistance have been identified and used in the breeding programmes at IRRI and elsewhere. Controlled feeding tests led to the separation of a cultivar's reaction to a virus from its response to the related insect vector. Detailed studies on the blast fungus have revealed the complex nature of genetic variability arising from single conidial isolates. Resistance to an insect pest could be partitioned by elaborate experiments into the components of non-preference, tolerance, and antibiosis. Intercrosses among resistant sources provided a genetic cataloguing of diverse genes controlling resistance. The research at IRRI has stimulated the interest of national research centres in testing indigenous rice germplasm, in extending the evaluation to other insect pests and diseases, and in promoting international cooperation. Extensive tests of a large number of genotypes at many sites is essential in obtaining broad-spectrum resistance to a particular disease or pest.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

EVALUATION OF SOURCES FOR DISEASE RESISTANCE

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SUMMARY

The current status of breeding for disease resistance implies that new and different sources of disease resistance should be continuously mobilized. Most of the potential sources are nowadays present in primitive varieties and in wild plants. To mobilize them efficiently needs sound and reliable methods of collection and evaluation. Since these valuable sources are facing extinction in many parts of the world (4) it is very urgent to outline and follow an international operation for the collection and preservation of this valuable material.

The problem of preservation of germplasm seems to be much more complicated when disease resistance is concerned. Most other desirable traits can be distinguished, selected and preserved. Resistance to disease is like a magic "black box". Resistance cannot be recognized without the use of the problematic pathogen. The problematic pathogen of today is different in different geographical areas, and the problematic pathogen of tomorrow is unknown. Therefore, the preservation of resistant germplasm for tomorrow cannot depend on today's evaluation.

A. The problem of selecting resistant material

Resistance is a common phenotype of many different host genotypes and can also be commonly conditioned by different genotypes of the parasite. In many reported cases, resistance is dominant and epistatic. Therefore, once caused by one gene the existence of other resistance genes might be masked. The identifiable resistance depends on the pathogenic strains used for the identification.

A.1 Specific resistance against pathogens with stable races. Specific resistance depends on specific genes. The more variable the pathogen population is, the smaller are the chances of detecting specific resistance, since many unimportant pathogen genotypes will attack it and mask genes of narrow range but of much importance. Therefore selection for specific resistance should be done regionally, with relevant single biotypes. Relevant biotypes of pathogens should include biotypes with the least number of virulence genes and a few super races under strict isolation. The analysis by the use of these tester biotypes can be made more efficient by adopting a recent development of a computer analysis of data (3). The international survey of virulence should guide regional centres of screening and suggest the relevant pathogenic testers.

A.2 Specific resistance against pathogens with unstable races. Pathogens of this type are heterokaryotic, they recombine and dissociate unexpectedly (1,5). Screening for resistance against them might be erratic (5). Efforts should be made to establish pure lines of the pathogens in order to identify building blocks for a more sophisticated combined resistance.

A.3 Non-specific resistance can be detected almost anywhere by any composition of biotypes, by quantitative greenhouse tests and/or by epidemiological field observations (7).

B. Collection of and selection from primitive cultivars and wild plants

World collections and international nurseries of different crops are being quite wastefully used for mass selection in the field or greenhouse. Change of methodology will enable a renewed, more efficient selection. The inclusion of important material from primitive cultivars and wild plants in world collections depends on reliable methods of collection and evaluation.

B.1 Selection in situ is sometimes favoured (6). It cannot be recommended for selection of specific resistance because of (a) lack of information on the pathogens present including irrelevant biotypes; (b) absence of epiphytotics in the particular area or season; (c) an appreciable lapse of time between selection and maturation. Selection in situ for horizontal resistance is acceptable depending on repeated visits in the area and tagging of selectants.

B.2 Random collection in situ and directed selection elsewhere should be adopted at least for specific resistance. Collected material can be selected programmatically, differently, in different centres, for both specific and non-specific resistance. Valuable sources can thus be recovered and geared into world collections.

B.3 Mapping of origins of resistance will guide future explorers and enable intensive collection of valuable and variable material. Systematic collection and screening for resistance of wild oats in Israel yielded reliable distribution maps of resistance (2).

C. Suggestions for more efficient utilization of resources

C.1 Mapping of resistance in important regions of origins of cultivated crops.

C.2 Organization of regional centres for the evaluation of resistance. Exchange of plant material between centres will substitute the exchange of pathogenic cultures and/or the directional production of super races.

C.3 More intensive research on the genetics of virulence and aggressiveness of pathogens for better understanding of tactics of control by disease resistance.

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ORGANISATION DES NATIONS UNIES POUR
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ORGANIZACION DE LAS NACIONES UNIDAS
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PAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

THE IDENTIFICATION OF HIGH QUALITY PROTEIN
VARIANTS AND THEIR USE IN CROP PLANT IMPROVEMENT

D.E. Alexander
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SUMMARY

- I. Introductory remarks
- II. Maize
 - A. Historical aspects of protein improvement
 - 1. Selection for quantity (Illinois High Protein)
 - 2. Circumstances preceding the Nelson-Hertz discovery of the effects of opaque-2
 - B. The opaque-2 case (characteristics of the mutant, breeding procedures, practical application on the farm, nutritional value in non-ruminant diets, prospects for the future)
 - C. The floury-2 case
 - D. Other possibilities
 - 1. Selection for L/P ratio in dents
 - 2. Multi-aleurone layer
- III. Barley (Swedish Hiproly case, summary of breeding and feeding experiments)
- IV. Oats (*Avena*) brief description of screening attempts, nature of variation in the species
- V. Soybean
 - A. Trypsin inhibitor case (variation, genetics of variants, feeding experiments)

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- B. The long-chain sugars (analytical methods, variation, genetics) (Brief)

VI.

Analytical procedures

- A. Tryptophan analysis
- B. THBS scheme
- C. Quantitative analysis of zein in maize
- D. Biological system (Leuconostoc mesenteroides)
- E. Automatic A. A. analysers (limitations, appropriate use of)

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(In cooperation with the International Biological
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SCREENING FOR OIL AND FAT QUALITY IN PLANTS

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SUMMARY

The agronomical production of plant oils and fats, which is mainly concentrated in tropical and subtropical regions, is presently undergoing drastic changes. Simultaneously, the various requirements of the world fat market in respect to quantity and quality of plant oils fluctuate according to the changing industrial and nutritive utilization. Plant breeding programmes have been efficient in increasing the oil contents in plant seeds and fruits, respectively. But selection for quality was successful in only a few cases where definite demands were formulated by the processor. In some instances, vast genetic variability appears to be exploitable, but in others physiological reasons limit variation. This is indicated by the major, not overlapping groups of oil crops with specific metabolic characteristics, the basic principles of which are not yet fully understood. Successful screening, however, largely depends on an intelligent evaluation of the physiological mechanisms. It is, on the other hand, bound to the development of quick, cheap and simple analytical techniques.

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Rome, 12-16 March 1973

SECONDARY METABOLITES AND CROP PLANTS

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Van de Rijks Universiteit, Leiden, Netherlands.

SUMMARY

1. Introduction : secondary metabolites and man

Plants used as spices and for technical purposes ; old and new medicinal plants
with impact on the development of modern medicine.

2. Secondary metabolites and plant systematics

Metabolites as taxonomic characters. Plant form and plant metabolism evolved
together. Therefore, the system of plants is a most useful guide for plant
exploration. Examples are given of genus characteristic spectra of secondary
metabolites, especially referring to Ulmus, Malus, Salicaceae, Ranunculaceae
and Solanaceae.

3. Genetically controlled variation of secondary metabolites

Metabolic variation within conspecifics permits selection and breeding for the
production of specific compounds and for metabolites and metabolic pathways
evolved in different types of resistance. It will be referred to experimental
examples of genetically controlled metabolites like cyanogen glucosides,
phenols, terpenes and alkaloids.

4. The biological meaning of secondary metabolites

Broad view on ecological functions, of substances important in resistance
characters of Malus, Pyrus, Ulmus and Urtica. "Evolution strategy" of the
Ranunculaceae and Rosaceae in relation to substances of resistance.

5. Remarks concerning conservation

Recent results of phytochemically analysed genera show the extent of the losses
which would be incurred if they had been totally eradicated. From the practical
point of view, every species lost implies a definite loss of a genetic potential,
of which the significance for man, in most instances, cannot be adequately estimated.

CONSERVATION

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FAC TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

PROBLEMS OF LONG-TERM STORAGE OF SEED AND POLLEN FOR GENETIC RESOURCES CONSERVATION

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SUMMARY

According to their viability response to environmental factors in storage, seeds may be divided into two groups. The vast majority of species would seem to fall into a major category where decrease in temperature, moisture content and oxygen pressure lead to an increase in viability period. (There may be a limit to this general rule so far as moisture content is concerned. Detrimental effects may occur below 2% moisture and beneficial effects may occur on full imbibition; but these deviations are of little significance in normal storage practice.) There is, however, a second smaller category of species whose seeds are damaged if the moisture content is decreased below some relatively high initial moisture content which may be 12% or more. Much less is known about this category which includes some of the larger seeded tree seeds, and further research is urgently needed.

In the case of the larger orthodox group it has been found that the complete pattern of loss of viability in relation to temperature may be defined by three equations; consequently it is possible to predict the percentage viability after any period under any set of storage conditions. The three equations contain four constants, the values of which have to be determined for any species in order to construct a nomograph which can then be used as a useful guide to the design of long-term seed storage systems. This has been done, so far, for five species - Triticum aestivum, Hordeum vulgare, Oryza sativa, Vicia faba and Pisum sativum.

The amount of work required to determine the four constants for any species is relatively small: theoretically only four germination tests are required, though in practice more tests are desirable. There is now a need to determine the constants for a wide range of species and to investigate the extent to which the values can be altered by genotypic differences, or environmental differences during seed formation.

In the orthodox species, the relationship between storage conditions, loss of viability and accumulation of mutations is now reasonably well known. Irrespective of the length of the storage period, small losses of

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viability are associated with a significant accumulation of mutations in the surviving seeds, and this mutation needs to be taken into account in the design of seed stores for genetic stocks.

In spite of the fact that the survival curves for pollen are quite different from seed survival curves, there is some indication that loss of pollen viability may be a very similar process to loss of seed viability. There is a need for much more quantitative multifactorial work on the effects of storage conditions on pollen viability in order that desirable storage conditions can be defined more clearly.

According to the present state of knowledge, it is not possible to predict the rate of loss of viability of pollen stored under different conditions. The rate of loss of viability is determined by a number of factors, including the species of plant, the age of the pollen, the storage conditions, and the duration of storage. It is therefore necessary to study the effects of these factors on the viability of pollen stored under different conditions. This study should be carried out for a number of species of plants, and for a range of storage conditions, including different temperatures, humidities, and durations of storage. The results of this study should be used to develop a system of storage conditions which will ensure the maximum viability of pollen stored under different conditions. This system should be based on the results of the study, and should be used to guide the storage of pollen for genetic stocks.

The present state of knowledge is not sufficient to enable a system of storage conditions to be developed which will ensure the maximum viability of pollen stored under different conditions. It is therefore necessary to carry out a study of the effects of storage conditions on the viability of pollen stored under different conditions. This study should be carried out for a number of species of plants, and for a range of storage conditions, including different temperatures, humidities, and durations of storage. The results of this study should be used to develop a system of storage conditions which will ensure the maximum viability of pollen stored under different conditions.

In the present state of knowledge, it is not possible to predict the rate of loss of viability of pollen stored under different conditions. The rate of loss of viability is determined by a number of factors, including the species of plant, the age of the pollen, the storage conditions, and the duration of storage. It is therefore necessary to study the effects of these factors on the viability of pollen stored under different conditions.

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Seed

FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

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GENETIC MAINTENANCE IN STORED IMBIBED SEEDS

T.A. Villiers

SUMMARY

Seeds in the soil have been observed to retain their viability for long periods of time whereas when stored air-dry, they deteriorate more or less rapidly according to the conditions of storage. Seeds stored air-dry accumulate genetic damage which can be observed both as mutations in the plants produced, and also as chromosome aberrations seen in the cell divisions following germination.

Increases in moisture content and availability of oxygen, and rise in temperature all increase the rate of loss of viability and the rate of accumulation of damage. However, the trend of increasing damage with rise in moisture content cannot be extrapolated to the fully imbibed state, and therefore the enhanced survival of seeds in the soil has been a paradox. Laboratory experiments have been conducted to simulate field conditions and results have been obtained which support ecological observations.

What, therefore, is the difference between seeds stored air-dry and seeds stored in a hydrated condition? It is suggested that because enzyme action is retarded or prevented in the former, the normal cellular activities of macromolecular repair and structural maintenance are unable to take place.

DNA repair activity is well documented in prokaryote organisms and there is much evidence for its occurrence in higher organisms. Membrane and organelle turnover have been demonstrated to occur in a wide variety of organisms.

Stored, air-dry tissues are therefore assumed to accumulate various types of damage, including genetic damage, which must be made good within a very short time during imbibition if the seeds are to survive and germinate successfully. In addition, the repair enzymes themselves, or those parts of the genome responsible for the production of repair enzymes, might have suffered damage.

It should therefore be possible to predict that if seeds are stored in a fully imbibed condition, they should maintain their viability for a long period of time compared with those stored air-dry; the DNA should not

degenerate; the enzymes, lipids and membranes should not degenerate; chromosome aberrations, and genetic damage in the form of mutations should not increase.

Results will be presented showing that the above predictions are correct, and also evidence that in addition to this maintenance, there may be actual repair of small amounts of damage which had accumulated before the seeds were imbibed for wet-storage experiments in the laboratory.

It is therefore concluded that air-dry tissues deteriorate because of their inability to maintain the genome and other systems in functioning order in the same manner as in hydrated metabolizing cells. In addition, during imbibition, hydrolytic enzymes may be released because of the deterioration of membrane systems, causing the original damage to be amplified.

The significance of the above theory lies in the provision of an explanation for the prolonged survival of seeds in natural habitats, and in providing reasons for the deterioration of seeds in air-dry storage.

It is well known that seeds in the air-dry state are able to survive for long periods of time without showing any signs of deterioration. This is due to the fact that the metabolic processes in the seed are almost completely arrested. The enzymes which are responsible for the breakdown of the stored food materials are inactivated, and the membranes which surround the organelles are intact. As a result, the seed is able to maintain its viability for long periods of time. However, when the seed is imbibed, the metabolic processes are reactivated, and the enzymes begin to break down the stored food materials. This process is essential for the growth of the embryo, but it also leads to the deterioration of the seed if it is not properly stored. The theory proposed here is that the deterioration of the seed is due to the inability of the seed to maintain its metabolic processes in a functioning order in the air-dry state. This is because the membranes which surround the organelles are not able to maintain their integrity in the absence of water. As a result, the enzymes are released, and the stored food materials are broken down. This leads to the deterioration of the seed, and ultimately to its death. The theory proposed here is that the prolonged survival of seeds in natural habitats is due to the fact that the metabolic processes in the seed are almost completely arrested. This is because the membranes which surround the organelles are intact, and the enzymes are inactivated. As a result, the seed is able to maintain its viability for long periods of time. However, when the seed is imbibed, the metabolic processes are reactivated, and the enzymes begin to break down the stored food materials. This process is essential for the growth of the embryo, but it also leads to the deterioration of the seed if it is not properly stored. The theory proposed here is that the deterioration of the seed is due to the inability of the seed to maintain its metabolic processes in a functioning order in the air-dry state. This is because the membranes which surround the organelles are not able to maintain their integrity in the absence of water. As a result, the enzymes are released, and the stored food materials are broken down. This leads to the deterioration of the seed, and ultimately to its death.

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LONG-TERM STORAGE OF MERISTEM CULTURES FOR GENE BANKS

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SUMMARY

Meristem culture techniques have been successfully applied to the production of virus-free clones and to clonal propagation of several species of cultivated plants, but the possibilities of this method are far from being exhausted.

As far as long-term storage is concerned several steps will be discussed. First, the excision of the apical meristem, its growth in a nutrient medium and its development into a plantlet; then the clonal multiplication of these plantlets; finally the long-term storage and the use for gene banks.

1. Culture media have now been developed to support the growth of the stem apices and their development into plantlets. The nutritional requirements are fairly simple for most of the herbaceous plants and consist of a mineral solution with a high potassium content, a sugar and a growth regulator - gibberellic acid.

Woody species are more exacting, several media of different compositions having to be used sequentially to obtain the development of a plantlet from the meristem.

2. Propagation in vitro at very high speed has been achieved for many horticultural plants: orchids, chrysanthemums, lilies, grapes and willows. The techniques vary according to the nature of the plants. It presents the great advantage of producing germ- or virus-free plants.

3. The long-term storage of these plantlets cultivated in vitro has not so far been extensively studied. The limited experience obtained with a few species: vine, orchids and lilies, indicates that it is possible to store a clone for an unlimited period of time with a minimum of care, only one or two transfers a year being necessary.

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In the case of the grape, we have now more than 15 years of experience and can easily store 200 cultivars in six replicates on a surface of only one square metre. The expenses of two transfers a year, and the conditioning of the culture room (light and temperature) will be much less than keeping the collection in the field, and the germ-free plants can be propagated for use at high speed after years of storage.

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THE PROBLEM OF GENETIC STABILITY IN PLANT CELL AND TISSUE CULTURES

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SUMMARY

Unlimited growth of plant tissues and cells can be achieved by means of in vitro culture techniques. The most convenient and economic form suitable to the long-term maintenance of in vitro cultures is the callus. In Phanerogams, calli can be obtained from a great variety of plant materials: seeds; excised embryos; ovaries; differentiated portions of roots; shoots; rhizomes; tubers; bulbils; leaves; tumour tissues; pith parenchyma; secondary phloem; pericarp and endocarp of fruits; endoperm; female gametophytes of Gymnosperms; pollen grains.

The nuclear conditions obtained in the cultures are the result of two main components: (i) the nuclear conditions occurring in vivo in the species considered and (ii) the effect of the culture medium, especially the auxin-cytokinin balance. In ca. 95 percent of the plant species so far investigated, chromosome endoreduplication (endopolyploidy) is generally a concomitant of cell differentiation in vivo. In these species, the mixoploid (diplo-polyploid) condition of the calli is due to the in vivo pre-existing endopolyploidy, to which endopolyploidization occurring in the course of in vitro culture may be added. Since gene duplication in polyploid cells allows survival of aneuploid derivatives, which might also have selective advantage, the calli may happen to comprise an array of cells with very different chromosome numbers. If and when plants are regenerated in vitro from such cultures, two possibilities seem to obtain:

1. In vulgare wheat, rice and carrot, only diploids are obtained, but it is not known whether they may bear gene and/or chromosome mutations (chromosome structural changes are known to occur in the callus of some species);
2. In many other species, diploid, polyploid and aneuploid plants are regenerated. The greatest variability in chromosome numbers among regenerated plants has been found in tobacco and sugar cane.

In species having no endopolyploidy in vivo, e.g. Crepis capillaris, a satisfactory stability at the diploid state can be observed; long-term culture, however, favours polyploidization.

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Although some auxin-cytokinin combinations can affect the composition of the proliferating cell population of a culture by selectively favouring some chromosome complements, e.g. diploid versus polyploid, it is not known whether such treatments might allow a preferential regeneration in vitro of plants with a particular chromosome constitution, or, more generally, with a particular genotype.

Thus, while genetic stability in callus culture (and most probably also in systems of liquid culture) is far from being approached, calluses represent an extraordinary reservoir of genetic variability to be exploited for breeding programmes.

Considering the genetic stability of the meristem cell line in plants, the in vitro culture of shoot apical meristems ("meristem culture") appears to be a first-choice method for the long-term conservation of a given genetic stock. In vegetatively propagated plants, the ability of the meristem culture to free clones of viruses adds to the merits of this technique.

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TECHNICAL ASPECTS OF TISSUE CULTURE STORAGE FOR GENETIC CONSERVATION

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SUMMARY

It is not possible to apply the orthodox gene-bank procedures to certain plant species for various reasons such as limited seed viability, unavailability of seed, inefficient vegetative techniques etc. For these species it is important to evaluate other techniques including tissue culture procedures.

There are a number of technical problems which would have to be overcome before tissue culture storage techniques could be used routinely. Some of these problems, such as the procedures for establishing cultures from particular plants and regenerating plants from the cultures, are common to all those applied areas in which it is anticipated that tissue culture techniques will be valuable, e.g. vegetative propagation, anther culture to produce haploid plants, and somatic hybridisation with protoplasts.

There are however two, possibly related, problems which are particularly critical with regard to the long-term storage of plant genetic material; plant tissue cultures tend to be genetically unstable and if they are maintained over long periods there is often a loss of morphogenetic potential. The causes of the gross changes at the chromosomal level are not understood, but there are indications that this might be, at least in part, an extension of the *in vivo* situation in which endopolyploidy occurs regularly in the somatic cells of many plant species. In tissue cultures the selective pressures being quite different from those in the intact plant, a wider or different range of variants might survive or even become dominant. There is also evidence that certain culture media or regimes affect the chromosome complement of the cell population. It is not clear yet whether the loss of morphogenetic potential by many tissue cultures is caused by the concomitant genetical changes, but there is some evidence that with certain tissues the process is reversible, suggesting that it can have a physiological basis.

It is possible, therefore, that the problems of genetic instability and loss of morphogenetic potential might not be unsurmountable but all the evidence suggests that a short-term solution might not be easily achieved,

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in which case it is almost certainly preferable to examine techniques which avoid these problems altogether. For example, it might be preferable to concentrate on organ cultures, rather than callus or cell cultures, so that the selective pressures operating in the cell environment are more similar to those operating *in vivo*.

The most obvious way of avoiding problems of genetic instability, and perhaps the most attractive technique from the gene-bank point of view, is to reduce the rate of cell division to zero. Unfortunately this is not easily achieved at normal temperatures without damage to the cells, particularly over a long period of time. It would seem therefore that the possibility of storing plant cells at low temperatures, a common procedure with micro-organisms and animal cells, should be examined very carefully. Almost certainly it will be essential to store the cells at the temperature of liquid nitrogen, because of the possibility of ice-crystal growth in the cells at electric refrigerator temperatures.

There has, in fact, been a small number of brief reports in the literature indicating that some tissue culture cells can survive for some time at the temperature of liquid nitrogen if they are cooled at a suitable rate in the presence of certain 'cryoprotectants'. It is important, now, that the precise conditions for successful liquid nitrogen storage of a range of plant tissue culture cells should be established and that the cultures stored in this manner should be tested for genetic variability and morphogenetic potential.

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PRINCIPAL METHODS FOR MAINTAINING VIABILITY OF PLANT MATERIALS IN LIQUID NITROGEN

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SUMMARY

Seeds of most plants dried to water content below 10% which are not exposed to extremely low temperatures can survive direct immersion in liquid nitrogen from room temperature regardless of rewarming rate. When the fully tolerant dry seeds are allowed to imbibe water fully, they are killed even after slight freezing. Seeds with water content of about 15%, differing considerably according to species, can survive immersion in liquid nitrogen, provided that they are rewarmed rapidly by immersion in water at 30°C after removal from liquid nitrogen. This is also true in the case of pollen grains and some tubers such as *Anemone* and *Ranunculus*. Thus, plant materials such as seeds, pollen, spores and some tubers which resist an intensive dehydration can easily be preserved in liquid nitrogen for a long time.

In the case of the normally hydrated tissue culture cells from hardy species two methods can be used to maintain their viability after immersion in liquid nitrogen: (1) cold acclimation in callus cultures, and (2) treatment by cryoprotective substances of single cells and cell aggregates grown in liquid culture medium. Callus tissues from poplar twigs which were grown on the agar medium described by Murashige and Skoog were found to survive slow freezing to -120°C or even immersion in liquid nitrogen following pre-freezing to -30°C when they were subjected to cold acclimation for 2 months. Suspension cultures of sycamore cells grown in a medium containing 12% (v/v) dimethyl sulphoxide and 10% glucose were also found to survive freezing to at least -70°C, or even immersion in liquid nitrogen after pre-freezing to -30°C. Thus, in hardy species, these callus tissues and cell aggregates grown in liquid culture medium can be preserved in liquid nitrogen. The remaining problem is how to preserve less hardy or non-hardy cells in liquid nitrogen.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 12-16 March 1973

THE ROLE OF PROTECTIVE SUBSTANCES AND SUBCELLULAR STRUCTURES IN PRESERVING FROZEN PLANTS

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SUMMARY

In most higher plants frost hardiness is connected with accumulation of sugars in their tissues and with the transition of the submicroscopic structures into a non-functioning, though stable, state. This is manifested morphologically through reduction of the intricately organized, highly frost-sensitive internal membranes of mitochondria and chloroplasts. Conversely, the membranes of the smooth endoplasmic reticulum multiply and swell in the process, which is conducive to reliable intracellular compartmentalisation as well as strengthening of the cell framework. However, even for extremely stable cells, the membrane system is disturbed in the most dangerous range of negative temperatures. In these conditions preservation of intracellular organisation is ensured by the resulting intensive development of frost resistant gel-like protein structures. Intracellular ice crystallisation is prevented by gel formation, and the protoplast becomes chemically inert and stable even under further increase of the concentration of salts and other dangerous substances.

Towards winter all frost-resistant plants accumulate, in one way or another, large amounts of protective substances, primarily in the form of sugars. Experiments show that inflow of sugars into cells proceeds faster than does the transformation of submicroscopic structures.

Frost hardiness of plants depends not only on how sugars are accumulated but also on how adequately they are distributed. Not only the vacuole but the cytoplasm as well receives the sugars. The sugar content in the chloroplasts of winter cereals goes up two- or even threefold.

Breakdown of the phosphorylating capacity of separated chloroplasts occurs on freezing, i.e. phosphorylation and electron transport tend to segregate. However, as *in vitro* experiments demonstrate, this process can be stemmed by the pre-freezing addition of sugars. These indirect data also show that considerable amounts of sugars must be localised in the cytoplasm of intact cells. It is assumed that the sugars protect the active surfaces of cellular membranes, insulating them from harmful effects of the environment.

The dependence of frost hardiness on sugar accumulation has also been confirmed by direct experiments, in which the frost hardiness of plants increased due to absorption of sugars from the ambient solution.

Coleoptiles and whole plants of winter cereals were used for this purpose. Sucrose-strengthened plants, which were exposed to temperatures about 0°C , improved their frost resistance by $10-15^{\circ}\text{C}$ and could survive temperatures down to -25°C without any significant disruption of their vital functions. In the frozen condition the plants could be preserved alive during the whole winter.

Because of submicroscopic rearrangement and accumulation and adequate distribution of sugars, plants are capable of surviving any frosts of very long duration after being cooled gradually (when the cells are dehydrated by intercellular ice) and extremely low temperatures after very rapid cooling (when cells are vitrified). The vitrification ability of the cells is ensured by stability with respect to the dangerous transition temperature zone between -30°C and -50°C .

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Rome, 12-16 March 1973

POSSIBLE LONG-TERM COLD STORAGE OF WOODY PLANT MATERIAL

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SUMMARY

Current methods for conserving genetic resources rely mainly on collections of living plants, or seed storage. The former method is expensive and subject to extremes of weather such as drought or low temperature injury, while the latter method is convenient, but subsequent seedlings may be genetically different to their parents, and the juvenile period delays their use as breeding material.

Horticulturists concerned with raising and distributing plant material in temperate areas are becoming increasingly dependent upon cold storage to maintain material in optimum condition and to prolong its handling period. Graftwood, rooted and unrooted cuttings and larger rooted plants are maintained in better conditions by this method than when over-wintered in the field. Special stores are used in which plants are maintained bare-root without intimate covering by placing them in a central chamber around which cold air is circulated without passing over and desiccating or freezing the material in store.

An extension of this method whereby successful storage has been achieved of *Malus*, *Prunus* and *Cydonia* spp. as unrooted or rooted cuttings, and *Spiraea*, *Philadelphus* and *Potentilla* as small bushes for one year (thus missing out one growing season) and of *Forsythia* for 20 months, suggests that this technique may have application to genetic conservation. Storage of short or moderate duration might be valuable at regional or national level to reduce the frequency of field trips to obtain locally available material and might be applied at multicrop international centres, possibly in conjunction with a regenerative nursery in which material would be periodically regrown.

Current knowledge of the conditions successfully used in prolonged seasonal storage will act as a guide in investigations of optimal environmental conditions and conditions of the plant material in conjunction with an increased storage duration. Temperature is critical, the optimal level being at or slightly below 0°C, and relative humidity must be maintained as high as possible. Plants in deeper dormancy survive best and for long-term storage there is likely to be a minimal mass for survival which will

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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Rome, 12-16 March 1973

THE STORAGE OF GERMPLASM IN THE VEGETATIVE FORM OF TROPICAL ROOTS AND TUBERS

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SUMMARY

Tropical roots and tubers are staple foods or are used as familiar components of the diet throughout the tropical world. Nevertheless, they have been neither thoroughly studied nor developed to their productive maximum, for they have often been regarded as peasant crops, and have been treated with disdain. Such attitudes are inappropriate in an age when the feeding of the world's population is a major and growing problem.

The principal species of tropical roots and tubers, in estimated order of importance, are:

Cassava	<u>Manihot esculenta</u> Crantz	roots
Yams	<u>Dioscorea</u> sp.	tubers
Sweet potato	<u>Ipomoea batatas</u> L.	roots
Malanga, Taro	<u>Colocasia esculenta</u> Crantz	corms
Potato	<u>Solanum tuberosum</u> L.	tubers
Tannier	<u>Xanthosoma</u> sp.	corms

For each species, some study is needed of the sources and values of germplasm, of the methods of storage, and of the ways germplasm collections can best be utilized.

Tropical roots and tubers have some characteristics in common. They are all perennial plants that have originated as seedlings, have been selected as varieties, and are maintained as clones. In most, the stems and leaves are herbaceous in nature, but in some these can be used as cuttings. In all cases except that of cassava the root or tuber itself is used as the normal propagating material. In cassava it is the woody stem that is planted.

Some possibility exists of preserving germplasm in the form of sexual seed. Frequently this is difficult because of polyploidy, incompatibility and sterility. A more immediate possibility exists in the preservation of the vegetative structures. This can be accomplished in two ways.

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One is the storage of the vegetative organ itself. Herbaceous organs are of little significance in this respect. They are short-lived by nature, and are difficult to store. When the storage organs, including roots, corms and stems serve as perennial resprouting structures, storage should be possible. But in every case storage is now limited by the normal metabolic processes. The storage organs pass through a period of dormancy which is terminated naturally by regrowth at the normal time of planting. Storage for longer periods of time depends upon the ability to change the metabolic pattern of the living tissue. This can be done already to some extent by temperature and humidity control, with controlled atmospheres, and by chemical treatment. In most of the roots and tubers application and modification of existing technology should make possible their storage through at least one growth cycle, the minimum useful extension of storage life.

Another less conventional method which merits the name 'storage' is also feasible. Most of the species in question can be retained in dwarf or juvenile form by restricting their planting areas and pruning regularly. Chemical growth retardants might prove useful in this respect. Planting in small spaces means that large numbers of plants can be stored in small areas. Naturally, maintenance, including periodic replanting, would be necessary.

No easy breakthrough appears possible in any case. Storage of vegetative organs could prove a useful technique in germplasm maintenance, but is not likely to be a cure-all.

Opportunities for use of
computer in many different
functions - not only I.R.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

(In cooperation with the International Biological
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REQUIREMENTS OF INFORMATION MANAGEMENT SYSTEMS FOR GENETIC RESOURCES CENTRES

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SUMMARY

Documentation, which has become the accepted term for the data associated with the accessioned material in gene banks or genetic conservation centres, has slowly accumulated new connotations and concepts. In its simplest sense, documentation is defined as the descriptive information associated with each collection of seeds or other propagating material placed in the gene bank. In its expanded sense, documentation includes all the functions associated with the gathering, filing (or storing) of the information, and the use of the gathered information. There are two interactive aspects of documentation: one passive, the other active. The former aspect deals with placing the information into some storage system, and the latter is concerned with the application or use of the stored information.

As the information associated with collections of genetic materials has grown in complexity, much effort has been expended on the processes of gathering and storing the information, but relatively little attention has been given to the methods of using the data or values of the information which has been stored. In the more expanded sense, documentation becomes an interactive function as important as any other function of the genetic resources centre, requiring study and effort equal to those functions which deal with the genetic resources material itself.

There has been a growing realization of the needs indicated above, and several related or distinct endeavours to improve methods of handling the data have been developed. One of these activities has been the development of computerized information storage and retrieval systems, and these range from relatively simple storage, sorting, and listing systems to relatively complex computer systems which give more flexibility both for storage and retrieving of the stored information. TAXIR is one complex computerized system, developed by a team in the Taximetrics Laboratory including a taxonomic botanist, a mathematician and a systems programmer, which has been used in genetic resources centres. This system is now being tested in a pilot project designed to examine several of the problems associated with

gene bank data. A report on this pilot project will be given at the Rome Conference.

In addition to the computerized information retrieval system for genetic resources centres, there are other requirements in gene banks which can be aided by application of management systems. Management implies the overall control of the functions of documentation, including the construction (or derivation) or good scientific data, the flow of the information from the scientist into a documentation system, and the application of the information both for scientific purposes and for determination of the objectives of the gene bank itself. All of the concepts of management are important, including those dealing with costs of operation, and the efficiency of the gene bank to carry out its mission.

As the movement toward the establishment of world-wide genetic resources centres gains strength, there is obviously a need to examine all the associated problems of documentation before we are faced with the actuality of established centres. Planning in advance, taking into account the rich source of information already at hand in several existing gene banks, is important to efficient utilization of funds which will, at best, be barely sufficient to meet the objectives.

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Rome, 12-16 March 1973

GENETIC RESOURCES CENTRE DOCUMENTATION: DELIMITATION OF THE PROBLEMS

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SUMMARY

During the last decade very active consideration has been given by national and international organizations to the collection, conservation, evaluation and utilization of primitive plant material for agricultural development. At the same time it has been recognized that there is a need to develop efficient computer-based recording systems for handling and analysing all the data which will be amassed. Meetings and discussions have ensured that there will be sufficient standardization of the many techniques and processes associated with the running of genetic resources centres and this uniformity of approach applies equally to information retrieval systems. The 1972 Birmingham Workshop on Information Systems for World Genetic Resources recommended the use of TAXIR (Taxonomic Information Retrieval) system in all genetic resources centres because this sophisticated programme with its free format appears to meet the requirements as visualized at the present time. Flexibility of the programme is essential in order to obviate the need for rigid standardization of all data collecting and processing techniques and so TAXIR is now being appropriately tested in a pilot study on general genetic resources data and on data from three centres for potato research.

This introductory paper is intended to delimit the problems of documentation in genetic resources centres and some of the functions of documentation. The experience which has been gained with data contained in a relatively small Pisum collection, using a simple but effective, computer-based information retrieval system, has provided useful ideas on what to record and how to record it. At the same time, the need for maximum flexibility at all stages has been clearly indicated since it is difficult to anticipate all the demands that will be made on any system.

The establishment of the European Gene Banks, between which there is close cooperation, should be regarded merely as a beginning and the experience with documentation gained in a small number of selected areas in these initial stages of development will prove invaluable. Once enough standardization has been established to allow for the quick and easy interchange of data and material then will come the time for expansion so that a global network of genetic resources centres and allied documentation systems can be developed.

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FAO TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES

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Rome, 12-16 March 1973

DESCRIPTORS AND THESAURI FOR WORLD GENETIC RESOURCES CENTRE DOCUMENTATION

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SUMMARY

The following requirements were recognized when developing the documentation system for a genetic resources centre: flexibility; ease of handling; generally understandable; independence from minutia of rules for data presentation; comprehensiveness; no restriction in the application for a wide range of crops; compatibility with already existing documentation systems of other genetic resources centres, individual breeders and those organizations involved in protection of bred varieties and breeder's rights; data compilation for specific needs; transferability into different languages; capacity to incorporate detailed information about the genetic resources (collection), or general information from other genetic resources centres.

After examination of several documentation systems, the system to be presented combined the best features extracted from all the systems examined. A comprehensive listing of the descriptors and descriptor states, called a thesaurus, translated into different languages, gives an idea of how documentation for genetic material should be prepared.

Coding of descriptors and descriptor states in documentation follows standardizations that are already internationally acceptable, conserving space and time by use of abbreviations, letters or numbers. The numbers correspond to the descriptor states, a low number indicating a low expression of a characteristic, and a higher or more intense expression is represented by higher numbers, as follows:

- 1 = very low, very shallow, very small, very early,
very bright, etc.
- 2 = *
- 3 = low, shallow, small, early, bright, etc.
- 4 = *
- 5 = intermediate
- 6 = *

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- 7 = high, deep, big, late, dark, etc.
8 = *
9 = very high, very deep, very big, very late,
very dark, etc.

*Numbers 2, 4, 6 and 8 were omitted because, from a genetic resources centre point of view, it seems impractical. In most cases, very little additional information is gained by incorporation of the intermediate numbers.

The letters H, I, R, S, T may be applied in connection with the coding of descriptors of reactions to pests and diseases, e.g.:

H = hypersensitive
I = immune
R = resistant
S = susceptible
T = tolerant

For a simple yes/no coding, the symbols "+" and "O" may be used, "+" = present, "O" = absent. For those cases of "not uniformly expressed", the symbol "X" may be used as a coded descriptor state.

For international documentation in the world network of genetic resources centres, a multilingual thesaurus and forms for the registration of data will be presented to the conference.

The following two forms were developed for the purpose of recording data on genetic resources. The first form is a simple yes/no coding, and the second form is a more detailed coding, including the use of the symbols H, I, R, S, T, and the symbols +, O, and X.

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Rome, 12-16 March 1973

THE GENETIC RESOURCES CENTRE: INFORMATION AS A CRITICAL DIMENSION A COST/EFFECTIVENESS ANALYSIS OF SYSTEM TAXIR ON GRC INFORMATION PROBLEMS

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SUMMARY

There are many operating genetic resources centres throughout the world. Each differs from any other in its explicit operational characteristics - the methods, procedures and organization used in accomplishing its mission.

There are, however, certain basic implicit operational characteristics which are basic to all GRC's - the function for which it exists: to receive, test, maintain and store genetic resources material and its attendant information; and, to accomplish this so that the material and the information can be shared among users and researchers.

From the implicit operational characteristic that is common to all GRC's and in fact defines what a GRC is, it is clear that one of the most critical dimensions is the operating information management system in each GRC. Most critical is the appraisal/evaluation of this information system to determine whether or not it is effectively assisting in the GRC's mission - or in reality hampering it.

This paper presents the results and methods used in a study (a cost/effectiveness analysis) of the use of the system TAXIR on information management problems for a set of GRC's. Certain techniques were used in evaluating the effectiveness of the system including a set of EXAMINERS, themselves staff members of GRC's around the world.

Several important assumptions and constraints are made in setting up the criteria for the measurement of the system's effectiveness. These are

1. Each GRC has an information management system - no matter how crude or sophisticated. (Each system can be evaluated in terms of its cost/effectiveness and compared with any other system.)
2. The problems faced by each information system are more or less the same as those faced by any other GRC information system.

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3. The information management system specific to a GRC was adopted or developed by the GRC staff to meet certain specific operational needs and constraints.
4. The GRC staff personnel (scientists) should determine the operating characteristics of the information system in order to meet their needs. It should not be "forced" on the staff.
5. Some GRC's are satisfied with their current information system and do not wish to change their procedures.
6. Some GRC's realize that their current information system is not adequate for their present needs and wish to introduce a new system which would be easy to use (no need for constant computer technologist intervention) and which would be highly flexible to handle new problems and new methods.
7. Some GRC's realize that their current system will not handle the increased load which is expected in the near future.
8. Most GRC's realize that their current information system will not be useful in sharing information with other GRC's or users with different systems.
9. Some type of GRC information sharing will be necessary in the short run and will be necessary after some years.

The criteria used to measure costs include:

1. The actual time/equipment costs attendant with the use of the TAXIR system.
2. The actual cost of data conversion from a GRC system to TAXIR.
3. The cost of training an EXAMINER to use the TAXIR system.
4. The projected costs for the installation of TAXIR at a GRC - and the cost of information systems conversion.

The paper concludes in suggesting how the TAXIR system could be employed in a minimum manner to provide a common communication net and service to any GRC should that GRC desire the service while meeting the assumptions and constraints listed above. Some approximations are made to the cost of accomplishing this.

The Appendices include detailed information on the study, a flow chart for an evaluation of a GRC's current information system, and a suggestion for comparative information sharing of such data among the GRC's.

PAC TECHNICAL CONFERENCE ON CROP GENETIC RESOURCES
(In cooperation with the International Biological
Programme of the International Council of Scientific Unions)

Rome, 13-16 March 1973

DRAFT GENERAL RECOMMENDATIONS

1. This Conference, aware of the main recommendations of the Saltville report on the conservation of plant genetic resources prepared by the ad hoc working party set up by the Technical Advisory Committee of the Consultative Group on International Agricultural Research, and aware of the emphasis given by the Stockholm Conference to the need to conserve effectively these resources,
2. endorses the action to be taken by PAC to finance within its Regular Programme budget increased activity on crop ecology and genetic resources by the appointment of additional staff and recommends to the Director-General that the responsibilities of the existing Crop Ecology and Genetic Resources Unit be harnessed and reorientated to fulfil the important role of a plant genetic resources coordinating centre.
3. This Conference, aware of the important work of the PAC Panel of Experts on Plant Exploration and Introduction and having considered the greatly intensified activities in this field and higher priority allocated to the importance of genetic resources at international and national levels and the impending strengthening

bad
word

of FAO's activities ~~recommended~~ to the Director-General if
action is required, warranting the attention of a Committee to
(a) review and report and submit suggestions on policy issues;
(b) to indicate special topics or sectors requiring new priorities;
(c) to furnish guidance on the categories of technical development;
and (d) to foster international collaboration; and further

4. This Conference endorses the action programme proposed by the
Melville Group and the FAO's laurel, as outlined to the Conference
on the following activities: (a) the collection and conservation of
appropriate genetic resources centred throughout the world of economic
crop plant material (and of related wild and weed species), especially
of those immediately threatened with extinction; (b) the safeguarding
of collections in appropriate and approved base collections of genetic
material; (c) the collection and documentation of relevant ^{vent} data and
(d) the strengthening of education and research by the intensification
of reciprocal links between genetic resources centres and universities
and other educational and research institutions.

3. This Conference, aware of growing expertise in genetic conservation
throughout the world, strongly recommends that the FAO ^{with the assistance of}
Committee of Experts ensure consultation with local specialists with
a view to identifying and deciding on priority collection targets and
to maintain genetic reserves (including natural areas), where
appropriate in cooperation with other agencies and organizations.

6. This Conference underscores the importance of the need to focus in genetic resources problems being shown by other countries, particularly the United Nations Environment Programme, UNESCO, the IUCN, the EUCARPIA amongst others and stresses the need for IAC to coordinate technical priorities, spheres of responsibility and functions.

7. This Conference proposes an integration of the interests of United Nations and other bodies in genetic resources conservation, collection, classification, conservation, evaluation and study through the IAC ~~to ensure the provision of~~ facilitation to promote an agreed action programme, and charges ~~IAC to~~ to establish commitments of financial support for relevant institutions - for the most part now existing through international multilateral and bi-lateral funds, and to promote coordination and cooperation with national institutions involved.

8. This Conference recommends that attention be given by the IAC Coordinating Centre to the guidelines given in the Letter Report of the IAC Working Group as modified by the 5th Session of the Panel of Experts, which gives attention to both crop-specific and region-specific centres, as well as co-ordinating the development of national centres and of exploration, training activities and documentation.

Documentation

CONFERENCE RECOMMENDATIONS

9. The Conference recommends that the gene bank projected by Sweden be established as soon as possible.

10. The Conference recommends advance ^{notification to FAO} ~~selection~~ of places for collecting expeditions in order to avoid unnecessary duplication of effort.

11. The Conference recommends that a study of the possibilities of aerial photography ^{and remote sensing} in aid in surveying remote or inaccessible areas should be initiated.

12. The Conference recommends the formation of an international association for genetic conservation ^{ists.}

13. The Conference recommends that support and encouragement should be given to work on ^{in vitro} ~~in vitro~~ cultures, and methods of storage of recalcitrant species especially those of tropical origin.

14. The Conference recommends that material collected should be evaluated for disease and pest resistance in such a way that the information obtained can be used for the preparation of geographical maps of the distribution of resistance.

15. The Conference recommends the organization ^{that FAO coordinates many other measures} ~~that FAO~~ of a coordinated evaluation of disease resistance in such a way as to avoid the shipping of ^{pathogen} ~~pathogens~~ collected from one part of the world to another.

16. While the Conference notes that the preservation of genetic resources demands in most cases storage of plant material in the form of seed it suggests that the possibility of establishing or maintaining genetically dynamic ~~collections~~ ^{populations} might be examined.

17. The Conference recommends that an international information, communication and documentation system should be ~~initiated~~ ^{initiated} ~~immediately~~.

18. The Conference recommends that a publication should be prepared listing all collections held by more than one gene centre in order to provide a guide to the location of duplicated accessions.

19. The Conference recommends that the genetic resources centres be encouraged to organise bilateral or multi-lateral cooperative arrangements for evaluation with appropriate specialist institutions.

20. Many of the problems of plant genetic conservation have close parallels with those of animal genetic conservation. Accordingly it is recommended that a joint meeting should be held where exchange of information according to discipline (e.g. population genetics, ecology, storage of germplasm) is encouraged.

Mon, ~~Mar.~~ 12

FAO Techn. Conf.

Chair -

1. Meneghini -
2. Hambro
3. Bennett
- 4 $\Rightarrow$ Others are the conveners -

Duties

Time of speakers.

Recommendations -

Bennett is convenor & secy of committee

Peter Thompson - chair -

Nominate a person

Fri 12:30.

Publication - Eda Frankel & Hambro.

Mon. Otto - Survey of crop genetic resources

"There was no one to ask about carrots" -

For this reason, not included in the FAO Survey report -

Time of preparation of Survey limited by need to put out the publication for this Conference

Hardly any collections of genetic resources are adequately described.

Such of population samples - mostly individuals, or very small representation -

"Primitives" not collected.

Collections not well kept. Regenerations, not good storage.

i. Reliance on existing collections not well placed.

Info on USSR - though well documented, not included.
also China, for obvious reasons.

Some areas are immediately threatened -

Top priorities in order, establ. by Panel -

1. Near East Mediterranean
2. Ethiopia
3. Meso America -

(3)

Active collections - should be large[#], more than
of base collections.

Functions of base collections.

1. adequate long-~~term~~ term storage.
2. Seed for l.t. stor. not used in active work.
3. Site of collection repr. of pop. from which
drawn.

Active collections.

Prof. leadership + personnel
Distribution capacity -
Quarantine station associated.
Regeneration of seeds in proper environments.
Collaboration

GRC - maintenance of records -

Vanlonia centers of info.
Some have GRCs, others not.

Priorities of centers by Beltrami group -

Near east + mediter.
" " " " Bani

These all
Records Require coordination center
in FAO
Find resources for center required -
Direction + coordination.

IRRI - Chavay Mar. 12

1st stage collection by correspondence -

Now 23,000 of O. sativa.

2000 of mutants + other species -

Also library + documentation center associated.

Natl. govt. been used, in addition to their own.

IRRI + Natl collection relations.

Lot of redundancy -
Encourage netted efforts

Responses + services - now able to send out for
particular problems - soil types, diseases etc.

Basic facilities

1. irrigated fields
2. protected nurseries (screened).
3. Storage + related functions. 3-4°C, 25-40% humidity
9-10 year storage term
4. Duplicate samples at Ft. Collins.

Conservation methods -

IR eval. committee

Technical methods

Search for \$ (AID, et al.)

Training locals -

Manipulation field methods -

Covering different countries. now in Indonesia -

Advice + training of people for GRC maintenance.

Needs a network -

Institute grows 2-3000 varieties every year.

IRRI - a crop specific, fortunate
 budget = single agron. dept. at US Univ.
 has Filipino staff -
 " departmental structure - physiol, disease,
 entomol, etc.

Use, as means of int. coop.

1. Conferences - general + specific -
2. Seed dissemination -
3. Educational aspects - students

Mengerha - Ethiopia - starting from scratch -
 needs all disciplinary assistance
 very rich ecological variation.

Furlong - crop specific CYMMIT - maize + wheat.
 Maize is well under control by lots of
 past efforts -

Are your documents machine-readable?

Wheat - no germ plasma collecting
 but a working (bread) collection.

720 - Mar. 13

Marshall - methods of guaranteeing collection
of all genes in a population -

Reflects methods only for proboscidea -
does not include collection of
herbarium specimens.

A good job for a plan sampling,
and a model useful -

Mar 14 - Exploration reports from various regions -
See program -

USSR - "plans to institute an electronic computer system".