BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

The Department Of Agriculture Can Minimize The Risk Of Potential Crop Failures

The Nation's crops are vulnerable to damage from disease, insects, and adverse weather conditions which could limit crop production.

The Department of Agriculture is responsible for reducing the vulnerability of the Nation's crops, but it has not fully determined the risks or taken adequate steps to minimize them. Decentralized management of its plant resources has effectively limited the development and implementation of an integrated program.

GAO recommends that the Secretary of Agriculture centralize control over the Department's genetic resources and develop a comprehensive plan for their use.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the need for improved management of plant genetic resources to minimize crop damage due to disease, insects, or adverse weather conditions. We made specific recommendations to the Secretary of Agriculture to improve the management of these resources.

Copies of this report are being sent to the Secretary of Agriculture and the Director, Office of Management and Budget.

Milton J. Socolar

Acting Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

THE DEPARTMENT OF AGRICULTURE CAN MINIMIZE THE RISK OF POTENTIAL CROP FAILURES

D I G E S T

Most of the Nation's primary food crops are grown from only a few plant varieties, increasing the risk of major losses from severe disease, insect infestation, or adverse weather conditions. The Department of Agriculture has a number of programs meant to reduce the risks resulting from these crops' vulnerability. However, the Department does not adequately assess the risk or take adequate steps to minimize it.

Because producers use relatively few high-yielding varieties, plant vulnerability has increased over the past 50 years. A group of Federal/State/private programs called the National Plant Germplasm System has been established to reduce this vulnerability and to further improve plant varieties. However, this system lacks a sense of direction and purpose and does not have effective, centralized management.

A plant species, such as corn, consists of plants that share many similar characteristics which are generally capable of interbreeding. A variety is a strain of that species having a defined genetic makeup. Plants are susceptible to stress factors such as disease, weather, or insects. This susceptibility is largely determined by genetic makeup. Therefore, if an individual plant is susceptible to infestation, then all plants of the same variety are generally susceptible. Planting many crop varieties (genetic diversity) minimizes the chances of a particular infestation affecting a large portion of the crop. Conversely, planting a smaller number of varieties increases the risk of major loss. (See pp. 1-2.)

A landmark study by the National Academy of Sciences in 1972 demonstrated the vulnerability of major U.S. crops. (See p. 28.) This study was made in response to the 1970 corn blight--the result of genetic vulnerability--which destroyed 15 percent of the Nation's corn crop representing $500 million to $1 billion in losses to U.S. farmers.

Collectively, all domestic and wild plants make up the genetic resource base--a pool of genetic material or germplasm. The genetic resource base or inventory ideally provides two benefits: (1) a source of variety (genetic variability) to reduce the risks of vulnerability and (2) a source of plant germplasm for evolutionary development and directed breeding of plant material.

Using these resources in plant breeding techniques has led to significant increases in crop yields--increases from 33 percent to over 400 percent over the last 45 years. The use of these improved crop varieties has reduced the number of varieties worldwide as farmers switched to the higher yielding strains. (See p. 4.)

THE NATIONAL PLANT GERMPLASM SYSTEM

The Department of Agriculture recognizes both the risks associated with genetic vulnerability and the opportunities afforded by diversity. Because the Nation's major crops have been developed from plants not native to the United States, the Department, in association with State experiment stations, land-grant colleges, and private curators (germplasm storekeepers), has long maintained a series of germplasm storage units which generally collect, store, and distribute plant germplasm. This system--the National Plant Germplasm System--is supposed to meet national needs for plant genetic resources. The system is expected to maintain a plant resource base which can be used to improve and develop plant varieties for future use and serve as a resource to protect the present crop base. (See p. 9.)

As currently organized and managed, however, this system does not determine the risks of genetic vulnerability or adequately perform the housekeeping chores of collection, maintenance, and evaluation of germplasm stock. The system's inadequacy is primarily attributable to the decentralized management of germplasm resources, which effectively prohibits the development and implementation of an integrated germplasm development, maintenance, and research program.

The system's various programs have a relatively high degree of separation from one another. The organization chart shows a maze of programs with numerous interconnecting lines. (See p. 15.) The chart accurately depicts the complexity of the organization but fails to show the degree of independence among the programs.

The regional and interregional plant introduction stations are cooperatively managed by Agriculture and the States. The Federal portion of the stations is managed by different regional directors within Agricultural Research. Other Federal facilities and programs such as the Federal plant introduction stations and the Plant Genetics and Germplasm Institute, are managed by the appropriate regional director. (See pp 16-17.)

These facilities and programs, although designated as part of a national system, are independently administered. A national coordinator within Agriculture Research keeps track of program activities. "Overseeing" the entire system is the National Plant Germplasm Committee, which also helps coordinate program objectives and advises the system. However, neither of these parties has any administrative control over program budgets, personnel, or activities. Those who do have such authority, such as the regional and area directors, are not members of the oversight committee.

The net result is a set of components that is not really a system at all. Rather, it is an aggregate of regional and local efforts loosely bound together by common interests but effectively separated by organizational boundaries.

More importantly, the system lacks a sense of direction and purpose. There is no planning function, except at individual program units. Several basic questions about germplasm protection and preservation have not been addressed: What are our germplasm resources? How vulnerable are they? How much germplasm is needed? What priorities must be set to meet these concerns with limited available assets? (See p. 22.)

OTHER PROBLEMS

GAO performed a limited review of the collection, storage, and maintenance functions of the plant germplasm system. The problems experienced by the system in these areas included: (1) the lack of systematic collection of new germplasm, (2) inadequate storage facilities, (3) incomplete and sporadic evaluation of the distinguishing characteristics of stored germplasm, and (4) possible permanent loss of some genetic stock which is not regularly replenished by periodic growing out of seed. (See pp. 17-21.)

CONCLUSIONS

The present system does not comprehensively address the real risks of genetic vulnerability. Potential crop failures are a national and international concern, and the regional efforts have not added up to an effective national program. Critical policy questions have not been addressed, indications are that germplasm protection and preservation mechanisms are inadequate, and comprehensive plans have not been made to cope with present and future problems. The system's organizational structure cannot sufficiently address these problems, and the Department's recent

changes to germplasm management are unlikely to solve the problems.

RECOMMENDATIONS

GAO recommends that the Secretary of Agriculture place planning, budget, and other management functions for the Department's germplasm activities under a central authority which could be placed within the Department's Science and Education Administration. Further, the Secretary should direct the Science and Education Administration to develop a comprehensive plan to assess the genetic vulnerability of U.S. crops; determine gaps in existing germplasm collections; assure that desirable genetic characteristics of individual species are made available; and develop an information system for disseminating information on collections and evaluations. Such planning is essential even if management of the system is not centralized. (See pp. 26-27.)

AGENCY COMMENTS

The Department of Agriculture agreed with GAO's recommendation that a comprehensive plan for genetic resources should be developed and established a working group to develop specifications for such a plan. The Department disagreed with GAO's conclusion that the lack of such a plan was due to poor system management. It further believed that recent changes to the management of the germplasm system should make GAO's recommendation for centralized management unnecessary. (See p. 25.)

The Department stated that a lack of resources has prevented them from developing a comprehensive genetic resources program. The Department did not state how much such a program would cost. A Department germplasm task force is currently developing a proposal for a long-range plan on genetic resources which should address this question.

The Department has made recent management changes to provide a better focal point for program management. (See p. 24 and app. II.) The system, however, remains decentralized although the Department's Science and Education Administration-Agricultural Research could impose central authority over the system through direct intervention. This has not been done on a systematic basis.

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ABBREVIATIONS

ARPAC	Agricultural Research Policy Advisory Committee
ARS	Agricultural Research Service
GAO	General Accounting Office
GRIP	Germplasm Resources Information Project
NAS	National Academy of Sciences
NPGC	National Plant Germplasm Committee
NPGRB	National Plant Genetic Resources Board
NPGS	National Plant Germplasm System
NSSL	National Seed Storage Laboratory
OTA	Office of Technology Assessment
SEA	Science and Education Administration
SEA-AR	Science and Education Administration-Agricultural Research
SEA-CR	Science and Education Administration-Cooperative Research
USDA	Department of Agriculture

CHAPTER 1

INTRODUCTION

U.S. agricultural production is seemingly boundless. America not only supplies sufficient food for its own population but also exports tremendous amounts of basic foodstuffs to other parts of the world. Crop production is largely taken for granted, yet many of our major crops are vulnerable to severe disease, insect infestations, and adverse weather conditions that could damage significant portions of the crops and reduce production levels. This vulnerability is caused by the lack of genetic variability within a crop. This report looks at the threats of genetic vulnerability and Federal efforts to protect against such hazards.

PLANT CHARACTERISTICS

Plant characteristics are mostly determined by two factors: genetic makeup and environment. Genetically identical plants can have markedly different appearances because of variations in such things as weather or soil conditions. The genetic makeup of a particular plant determines that plant's response to a given environment.

A plant species--such as corn--is composed of plants sharing many of the same characteristics and generally capable of interbreeding. A plant variety is a strain of that species having a definite genetic makeup. Thus, while the genetic makeup of corn permits a wide range of variability, the genetic makeup of a particular variety of corn will limit variability. Collectively, the entire set of wild and domestic plants within a species is often referred to as plant genetic resources. Often the term "germplasm" is used for plant genetic resources.

Because plant reaction to environmental conditions or stress is determined by the plant's genetic makeup, a variety susceptible to a particular form of stress is said to be vulnerable to that stress. Because plants are susceptible to a wide variety of stress agents, vulnerability is compounded if a particular variety or a small number of varieties dominate crop production.

For example, the genetic characteristics of variety A and variety B may leave them vulnerable to leaf fungus, but variety C may be resistant. If crop production is dominated by A and B, then that crop is vulnerable to

leaf fungus. It is widely accepted that crops are vulnerable if planting is dominated by a small number of varieties. Genetic variability can minimize crop vulnerability. Genetic variability means that a plant species has a large number of varieties.

IMPORTANCE OF GENETIC RESOURCES TO U.S. AGRICULTURE

The domestic and wild plants which remain today represent the world's entire plant genetic resources. 1/ The genetic resource base--whether maintained in the wild or in storage--is the primary source for future crop improvement and is one defense against natural and manmade threats to crop survival. As agricultural production has become more managed, more industrialized, and more manipulative of natural resources, the level of risk increases, making the continued protection and maintenance of U.S. genetic resources critically important.

By definition, genetic resources are critical to crop evolution in any part of the world. This is especially true for the United States where the only native food crops of any importance are sunflowers, cranberries, blueberries, strawberries, and pecans. All of our primary food crops were introduced from nonnative sources. For example, corn, introduced to early American settlers by the Indians, came from Mexico and Central America.

The United States has depended on the genetic resources of the rest of the world to develop its agricultural base. While much crop improvement has taken place in the United States, this improvement has been made not by natural or human selection from a variety of native species, but primarily by human selection from a relatively limited genetic pool of imported germplasm.

The United States has long recognized its dependence on nonnative germplasm. American consuls were instructed in the early 1800s to collect seeds and return them to

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1/This report deals primarily with germplasm resources for food crops. Plants are used and have enormous potential to be used for other purposes, such as fuel, fiber, and pharmaceuticals. While this report does not deal directly with nonfood plants, much of the material covered would also apply to the availability of their germplasm.

the United States. This function was the responsibility of the U.S. Patent Commissioner from 1836 until the U.S. Department of Agriculture (USDA) was established in 1862. In 1898 USDA established an Office of Seed and Plant Introduction and, following enactment of the Research and Marketing Act of 1946 (60 Stat. 1082), established regional and interregional plant introduction centers which are the core of current USDA germplasm activities.

EFFECTS OF PLANT BREEDING ON AGRICULTURAL PRODUCTION

The application of modern plant-breeding techniques, such as inbreeding and hybrid crosses, and the subsequent increase in agricultural technology rapidly changed the nature of agricultural production. Plant breeders developed improved crop lines which were vastly superior to earlier lines. Farmers quickly adopted the new varieties to the exclusion of earlier varieties for good reasons: (1) the producers' natural desire to grow high-yielding varieties, (2) consumer and processor demand for uniform products, and (3) technological considerations for sowing and harvesting crops by mechanical means.

These improved varieties dramatically increased crop productivity. An estimated 20 to 30 percent of the increased yield over the period covered in the following table is attributable to genetic improvements. Advances in agricultural technology, such as better pest management, new cropping techniques, and improved fertilizer, were responsible for the rest of the increase.

Increase in Average Yield Per Acre For U.S. Crops 1930-75

Crop	Unit	Average yield per acre 1930	Average yield per acre 1975	Percent of increase
Wheat	Bushels	14.2	30.6	115
Rye	Bushels	12.4	22.0	77
Rice	Bushels	46.5	101.0	117
Corn	Bushels	20.5	86.2	320
Oats	Bushels	32.0	48.1	50
Barley	Bushels	23.8	44.0	85
Grain sorghum	Bushels	10.7	49.0	358
Cotton	Pounds	157.1	453.0	188
Sugar beets	Tons	11.9	19.3	62
Sugarcane	Tons	15.5	37.4	141
Tobacco	Pounds	775.9	2,011.0	159
Peanuts	Pounds	649.9	2,565.0	295
Soybeans	Bushels	13.4	28.4	112
Snap beans	Cwt. a/	27.9	37.0	33
Potatoes	Cwt.	66.0	253.0	283
Onions	Cwt.	159.0	306.0	92
Tomatoes:				
Fresh market	Cwt.	61.0	166.0	172
Processing	Tons	4.3	22.1	413
Hops	Pounds	1,202.0	1,742.0	45

a/Hundredweight.

Source: USDA.

The net effect of this switch to higher yielding varieties has been a reduction in the number of plant varieties planted in the United States. A National Academy of Sciences' (NAS') study in 1972 indicated that U.S. crops are dominated by a relatively small number of varieties for each species. This data, shown in the following table, was current for 1969 and, according to USDA, has not been updated. More recent surveys for corn and sorghum are being made by a private seed trade association.

Acreage and Farm Value of Major U.S. Crops and Extent to Which Major Varieties Dominate Crop Acreage (1969 Figures)

Crop	Acreage	Farm value	Number of varieties		Percent of acreage planted to major varieties
			Total	Major	
	(millions)				
Beans, dry	1.4	$ 143	25	2	60
Beans, snap	0.3	99	70	3	76
Cotton	11.2	1,200	50	3	53
Corn (note a)	66.3	5,200	b/97	c/6	71
Millet	2.0	(d)	(d)	3	100
Peanuts	1.4	312	15	9	95
Peas	0.4	80	50	2	96
Potatoes	1.4	616	82	4	72
Rice	1.8	449	14	4	65
Sorghum	16.8	795	(d)	(d)	(d)
Soybeans	42.4	2,500	62	6	56
Sugar beet	1.4	367	16	2	42
Sweet potatoes	0.13	63	48	1	69
Wheat	44.3	1,800	269	9	50

a/Corn includes seeds, forage, and silage.

b/Released public inbreds only.

c/These are the predominant public inbreds. The actual number of varieties is much greater as these lines are crossed with each other and with private inbred lines.

d/Not shown in source.

Source: "Genetic Vulnerability of Major Crops," National Academy of Sciences, 1972.

GENETIC VULNERABILITY AND VARIABILITY

After World War II, U.S. agricultural technology and improved plant varieties spread rapidly to other nations. As in the United States, these improved varieties displaced

older, lower yielding varieties. The relative genetic uniformity of these new varieties, as compared with the displaced varieties, decreased the world's plant germplasm resources. In other words, serious genetic erosion occurred, resulting in genetic vulnerability.

Genetic variability is generally accepted as the best defense against vulnerability, but it is not a guaranteed defense. The scale of production is important. A particular crop can be considered genetically diverse and yet be regionally vulnerable if one variety of that crop is prevalent in localized areas. The question of how much germplasm to maintain has not been answered. It is an important question because of the dependence of successful plant breeding on genetic diversity, the need to minimize the risks of genetic vulnerability, and our inability to predict future stresses on existing crops. An adequate evaluation of how much germplasm is needed would require (1) a knowledge of the extent of diversity within a species and an understanding of the potential utility of the genetic variability in meeting specific breeding goals and (2) development, through research, of a forecasting capability to predict the likelihood of unusual stress conditions. Thus, even if plant breeders know the amount of germplasm needed to meet current goals, we still do not have the capacity to predict future needs.

The impact of genetic vulnerability can be quite dramatic. The Irish potato blight of 1845, caused by a parasitic fungus (Phytophthora infestans), decimated the population of Ireland, killing or exiling hundreds of thousands of people. Almost 12.5 percent of the population died of starvation and another 19 percent emigrated (most to the United States). Thus, a rather common fungus had a tremendous sociological impact on both Ireland and the United States. Other examples of the effects of genetic vulnerability include the loss of most of the chestnut trees in the United States and the continued loss of elm trees.

The Southern corn leaf blight epidemic of 1970 brought into public focus the reality of the theoretical risks associated with genetic vulnerability. Corn breeders in the early 1900s discovered that hybrid corn greatly outyielded inbred corn lines. Because corn is self-pollinating, corn plants had to be detasseled by hand to produce the new varieties. The development of male sterile plants allowed breeders to avoid this expense because hybrid crosses could be made from other plants without the risk of self-pollination. Corn produced in this manner soon dominated U.S. corn production.

In 1969 and 1970 most of the U.S. corn crop proved vulnerable to Helminthosporium maydis, race T, which destroyed 15 percent of the crop--losses approached 50 percent in some States. This event set the stage for greatly increased consideration of the risks associated with genetic uniformity and Government response to those risks.

OBJECTIVE, SCOPE, AND METHODOLOGY

We initiated this review to assess the effectiveness of USDA efforts to protect plant genetic resources. We gathered material through interviews with appropriate USDA officials, seed industry representatives, State extension service personnel, officials of 3 of the 4 regional plant introduction stations, officials of the National Seed Storage Laboratory (NSSL), and public and private germplasm users (plant breeders and researchers). We also analyzed various USDA publications and memoranda and the assessments of genetic vulnerability published by NAS, USDA's Agriculture Research Policy Advisory Committee (ARPAC), USDA's National Plant Genetic Resources Board (NPGRB), and the Office of Technology Assessment (OTA).

Our analysis of the specific programs and policies designed to assure or enhance the protection of plant genetic resources indicated early on that a lack of planning, poor organizational control, and overly narrow system objectives were more limiting to the germplasm system than were the actual operations of the system's physical facilities. Thus our review focused more on the management of the system. Our analysis of that management centered around three major tasks:

--Development criteria for system objectives and testing those criteria against stated and actual objectives of the germplasm system.

--Comparison of goals and objectives for the system as established by USDA's long-range plan for germplasm with actual system performance.

--Contrasting operational goals as established by system participants with actual system operations.

We did not fully explore problems in germplasm collection, storage, and evaluation. Our evaluation of these functions focused on measuring or determing how well these functions were conducted in accordance with self-imposed standards; that is, standards of performance established by the system itself. We briefly discuss these issues in chapter 2.

Our review of international cooperation in protecting genetic resources was limited due to a lack of readily available information and the extensive travel which would have been required to obtain such information. This is an important topic which has received limited attention from USDA.

CHAPTER 2

ORGANIZATION AND MANAGEMENT OF THE NATIONAL PLANT GERMPLASM SYSTEM NEED TO BE IMPROVED

As indicated in chapter 1, genetic variability is important not only to reduce the risk of genetic vulnerability but to enhance the continued development of our crops. Genetic variability thus offers a unique opportunity to provide not only an insurance program (for vulnerability) but an asset enhancement program (crop productivity). Because most germplasm needed for U.S. crops is not native and natural habitats are rapidly disappearing in geographic areas over which the United States has little influence, germplasm preservation and maintenance in the United States becomes an institutional problem if we choose to maintain genetic diversity.

USDA has long recognized the responsibility of genetic diversity. To help deal with the risks and achieve the benefits and to coordinate germplasm activities, USDA relies on the National Plant Germplasm System. As currently organized and managed, however, NPGS does not assess the genetic vulnerability of U.S. crops 1/ or adequately perform the housekeeping chores of collecting, storing, and evaluating germplasm stock. The system's inadequacy is primarily attributable to the decentralized management of germplasm resources, which effectively prohibits the development and implementation of an integrated germplasm development, maintenance, and research program. Further, long-range planning has not been done, and the system's objectives have not been sufficiently comprehensive to cover all issues which NPGS should address.

DEVELOPMENT AND CURRENT STATUS OF THE SYSTEM

USDA has formally collected, cataloged, and distributed plant germplasm since 1898. This effort was accelerated with the enactment of the Research and Marketing

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1/USDA stated that genetic vulnerability was determined by scientists working with the major crops. We saw no current evidence to support this. For example, we requested an update of the chart on page 5. This chart indicates genetic vulnerability but was prepared in 1969. USDA could not update the chart.

Act of 1946 which led to establishment of regional and interregional plant introduction stations. These stations are cooperatively managed by Federal and State Governments and are augmented by three Federal plant introduction stations. The National Seed Storage Laboratory was established in 1958 to provide long-term preservation of seed stocks.

The viability of these activities was not seriously challenged until the 1970 corn blight. Subsequent reviews of genetic vulnerability by such groups as the National Academy of Sciences and ARPAC raised serious questions about the risks of genetic vulnerability and implicitly questioned USDA's response to that risk. (See app. I for an overview of the various studies addressing these questions.)

Until 1972 the germplasm program within USDA was centrally controlled, mostly within the Agricultural Research Service (ARS). 1/ ARS' new crops research branch directed the plant introduction center in Beltsville, Maryland; the National Seed Storage Laboratory; and the Federal portion of the regional and interregional plant introduction stations. Other crop researchers at Beltsville maintained some germplasm collections and conducted germplasm research.

Most USDA officials we interviewed had mixed feelings about this centralized organizational structure. They felt that with greater central control, a decision made about maintenance or collection could be implemented. However, they said that under this structure, the users (breeders) controlled the collections and had a limited outlook on the ultimate objectives of genetic resources and their value. Some officials said they felt that inadequate attention had been paid to the larger questions of long-term maintenance and improving genetic diversity.

In 1972 ARS was reorganized and responsibility for research was divided among the existing four regions with rather limited oversight from a National Program Staff. The elements of the germplasm program were no longer centrally controlled but were under the direction of regional and area directors who were responsible for numerous activities, including germplasm.

1/In 1978 ARS and three other USDA agencies became part of a new organization, the Science and Education Administration. ARS is now called SEA-Agricultural Research (SEA-AR).

In 1974 the Administrator of ARS ordered the creation of a national coordinating system to bring some degree of order to the germplasm program. This system--the National Plant Germplasm System--includes a coordinating committee, the National Plant Germplasm Committee (NPGC). NPGC has two representatives from the SEA-AR's National Program Staff, the four State agricultural experiment stations' regional administrative advisors, the four regional coordinators, the Plant Introduction Officer, a representative from SEA's Cooperative Research (SEA-CR) staff (formerly the Cooperative State Research Service), and a representative from private industry. The committee's purpose is to coordinate efforts among the cooperating germplasm organizations. None of its members have significant line control over budgets or personnel. The committee can only suggest, not direct.

System objectives

USDA's objectives for NPGS are relatively straightforward: (1) introduction of plant materials into collections, (2) germplasm maintenance, (3) evaluation, and (4) distribution of plant germplasm to users.

--Plant material introduction is achieved by collection, exchange, or contribution of seeds/plants from both U.S. and foreign sources. Germplasm enters the NPGS by going directly to one of the regional centers or, in the case of foreign material, going to USDA's Principal Plant Introduction Officer for subsequent distribution.

--Germplasm maintenance assures that the plant stock stays alive. This is normally achieved by cold storage of the seed and periodic growth of the seed (called grow-out) for replenishment. NSSL is concerned with long-term maintenance.

--Evaluation of genetic resources for morphological (physical characteristics) and genetic traits enables plant breeders to more easily identify desirable characteristics.

--Distribution of germplasm enables new genetic material to be introduced in breeding programs.

The objectives inherently depend on the premise that successful plant breeding is based on a certain level of genetic variability. It is also assumed that adequate stock maintenance will offer some protection against

genetic vulnerability by providing an available source of germplasm diversity.

System participants

A number of participants, representing many diverse elements, are involved in carrying out the NPGS objectives. Following are brief descriptions of the principal administrative, advisory and coordinating, and operating participants.

Administrative entities

Nearly all the Federal germplasm activities are located in SEA. Within SEA, the Agricultural Research and Cooperative Research staffs are responsible for plant germplasm. SEA-CR administers Hatch Act 1/ funds which go to States using formula guidelines. In fiscal year 1980, $1,578,000 in Hatch Act funds were spent on germplasm activities, mostly at the four regional plant introduction stations. SEA-AR's fiscal year 1980 budget included about $7.1 million which was spent for germplasm collection, research, and maintenance and for the Federal portion of the State-Federal regional plant introduction stations.

At the State level, the State agricultural experiment stations allocate Hatch Act funds, and regional technical committees provide guidance for regional germplasm projects. Additional State support is given by various land-grant colleges which often provide facilities and personnel for the State-Federal regional plant introduction stations.

Advisory and coordinating groups

NPGC is the principal advisory body to the germplasm system. Additionally, several other entities provide advice or coordinate germplasm activities. None of these has significant authority over operating decisions within the system.

The National Plant Genetic Resources Board, established in 1975, provides policy guidance to USDA in assessing

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1/The Hatch Act of 1887, as amended (7 U.S.C. 361a), established State agricultural experiment stations and authorized research basic to the problems of agriculture in its broadest aspect.

national needs and priorities for conserving and using genetic resources. This board is composed of individuals having a broad perspective of germplasm issues. Its primary accomplishment is the development of recommendations for a seven-phase program for decreasing genetic vulnerability. This proposal is discussed in more detail in appendix I.

SEA-AR's germplasm coordinating committee primarily reviews applications for domestic and international plant collection expeditions. The germplasm coordinator on SEA-AR's National Program Staff, who chairs the committee, is really the focal point for USDA's germplasm activities.

The Germplasm Resources Information Project (GRIP) is based on a cooperative agreement between USDA and Colorado State University/Laboratory for Information Science in Agriculture. GRIP has four objectives: (1) maintenance control, an inventory of material in the seed collections, (2) information exchange, development of standardized characteristics for different crop species through crop advisory committees (these would be used in evaluating the accessions), (3) a registry of germplasm material and related information (such as evaluations), and (4) a management information system. GRIP also acts as a secretariat to the NPGC and NPGRB.

Operating components

Plant introduction stations are responsible for storing, maintaining, and distributing working collections of plant germplasm. They provide the working start for plant breeders seeking new sources of germplasm. Each of the four SEA-AR regions has a plant introduction station cooperatively funded by the States and SEA-AR. These stations are responsible for crops important to their respective regions. Additionally, there is one interregional plant introduction station and three SEA-AR plant introduction stations which perform duties similar to those of the regional stations.

The actual operation of a regional plant introduction station is the responsibility of a station director who is either a Federal employee or is jointly paid from Federal/Hatch Act funds. Operations planning is a function of a regional technical committee (a mixture of State and Federal representatives); an executive committee which acts on matters requiring attention between regular meetings of the technical committee; and a regional coordinator who acts as a liaison with other regional projects, germplasm users, and other cooperating agencies.

The National Seed Storage Laboratory, which is under the direction of SEA-AR's Western region, provides duplicate backup storage for working collections in the plant introduction stations as well as the working stock in world collections. Currently, NSSL maintains about 1,200 varieties totaling 110,000 accessions of seeds. It is the only long-term seed storage facility in the United States and performs considerable research for germplasm preservation.

The Plant Genetics and Germplasm Institute at Beltsville, Maryland, is composed of six laboratories, one of which is the Germplasm Resources Laboratory. Under this laboratory is the Plant Introduction Office. All germplasm acquisitions are processed through this office to be assigned an identification number and to be shipped to the appropriate NPGS unit, the new crops project, and the small grains collection.

Over 30 independent curators of small germplasm collections work outside NPGS. These individual researchers have goals similar to those of NPGS for maintenance and distribution of seed stocks. They cooperate with NPGS to a limited degree and on an informal basis.

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Collectively, these elements make up NPGS. The linkage holding this "system" together is incredibly complex, as shown by the chart on the following page.

PROBLEMS WITH CURRENT SYSTEM STRUCTURE

NPGS' major organizational problem has been its lack of central management authority. As can be seen from the chart 1/ on page 15, the organization of the plant germplasm system is almost impossible to decipher. What cannot be seen from the chart is the relative independence of the system elements. That is not to say the system elements are independent of oversight and control, but that they are relatively independent of one another. Essentially, the system components are managed as follows.

1. The State-Federal, regional, and interregional plant introduction stations are jointly operated. State

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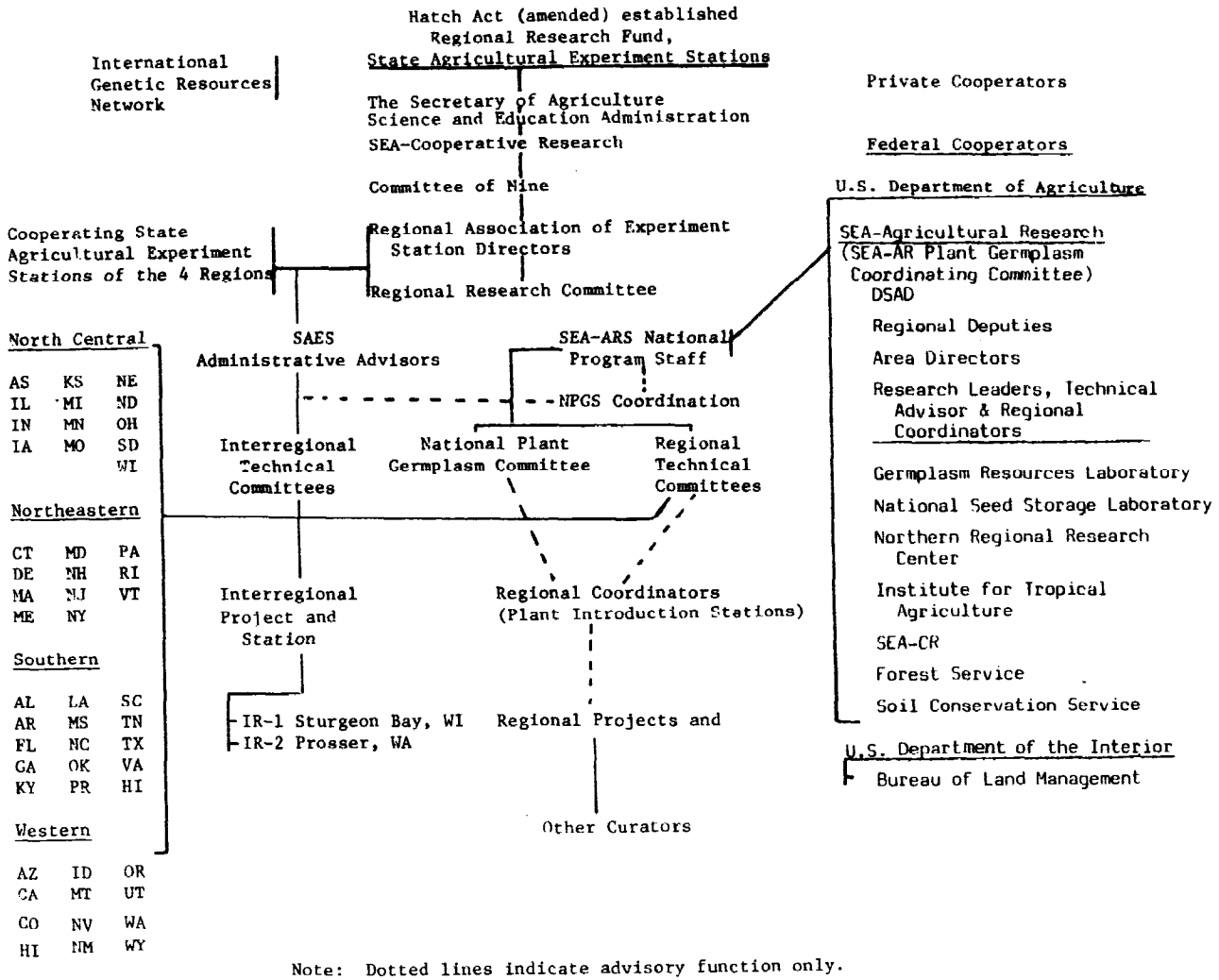
1/USDA felt that this chart did not accurately portray NPGS. They offered a substitute chart which shows only the Federal components of the germplasm system. It does not portray the entire system. This chart is shown in appendix III.

NATIONAL PLANT GERMPLASM SYSTEM



Note: Dotted lines indicate advisory function only.
Source: GRIP briefing papers, April 1980.

input is through regional technical committees and regional administrative coordinators who provide direction for expenditure of Hatch Act funds. The Federal input is through the respective regional coordinators and SEA-AR area and regional directors. These directors have general control over Federal funds and personnel.

2. The Federal plant introduction stations are under the control of the respective area and regional directors.

3. The Plant Genetics and Germplasm Institute is a part of the Beltsville Agricultural Research Center (not shown on chart). A subsidiary of the Institute, the Germplasm Resources Laboratory, is shown on the chart.

4. The coordinator for NPGS is on SEA-AR's National Program Staff. The coordinator, who also chairs SEA-AR's germplasm coordinating committee, is generally (but not always) informed of the activities of the system components but has no management control over them. The committee's function is to serve as a forum to recommend funding for plant explorations on a national priority basis.

5. NPGC reviews the activities of the system components and may make recommendations on budgets, acquisitions, and other matters. Because NPGC has no authority, these recommendations are purely advisory. No member of this committee has line authority over any germplasm program. Their recommendations are made to the Administrators of SEA-AR, SEA-CR, and the regional associations of State experiment station directors.

The net result is a set of components that is not really a system at all. Rather, it is an aggregate of Federal, State, regional, and local efforts loosely bound together by common interests but effectively separated by organizational boundaries. The lack of central authority has led to a number of administrative and operational problems. The following examples are not intended to represent a comprehensive overview of such problems, but they are indicative of the types of problems that NPGS creates or fosters.

1. The lack of management authority in the germplasm system allows local directors to expend funds for other than intended purposes. In 1976 NSSL received a budget increase that included $100,000 to be used for seed

increases 1/ based on an NSSL request and supported by the NPGC. Once the funds were received, NSSL used most of the additional funds for additional staff. The effect on the collection's viability of not using these funds for seed increase is not known. NPGC did not have the authority to require the additional funds to be spent on seed increase. The use of the funds for additional staff was approved by NSSL area and regional directors.

2. In 1976, $80,000 was provided to the Plant Genetics and Germplasm Institute with the understanding that these funds were to be used to improve physical and operational aspects of the small grains collection at Beltsville. Instead, the Institute diverted the funds to other uses. In the meantime the ability of the small grains facility to maintain seed viability has been seriously challenged by a task group established by SEA-AR in 1979 to review that facility and its operations.

3. The plant introduction station at Chico, California, was closed without adequate assessment or notice. ARS originally intended the station to conserve germplasm of fruit and nut trees and woody ornamentals. It was to perform the duties of both a plant introduction station and a clonal repository (for vegetatively propogated crops such as fruit trees). Chico was the sole formal repository of this type in the United States.

ARS' Western regional office decided to close the Chico facility in 1974 because it was perceived as a small station engaged in low-priority work. This decision was made without consulting members of the germplasm system (who for the most part were unaware that Chico's functions had shifted). Since that time, a new, formal clonal repository has been built (supported by State-Federal funds) which in many respects duplicates the former facility at Chico.

PROBLEMS WITH GERMPLASM COLLECTION, STORAGE, AND EVALUATION FUNCTIONS

Our limited review of germplasm collection, storage, and evaluation functions revealed a number of potentially serious problems. Preliminary information on these problems is discussed below.

1/Seed increases are the periodic growing out of seed needed to replenish existing stock.

Germplasm collection

Since most of the U.S. germplasm needs are from nominative sources, USDA obtains new material from two sources: (1) international exchange, which accounts for about 70 to 80 percent of new germplasm acquisitions, and (2) USDA-funded expeditions to foreign countries, which account for the remainder. Those expeditions which are funded are selected from many proposals submitted to USDA, and priorities are set according to current needs. USDA usually sponsors five or six collection expeditions annually.

USDA does not regularly assess gaps in U.S. germplasm collections or in germplasm losses occurring in storage or in native habitats. As a result, there is no systematic or comprehensive collection strategy. Undoubtedly, plant germplasm is being permanently lost because of this haphazard approach.

Germplasm storage

Germplasm storage problems relate to four factors: (1) curators' objectives, (2) physical quality of storage facilities, (3) NSSL operations, and (4) germplasm replenishment.

Curator's objectives

Each of the 30 (estimated) private germplasm curators is responsible to a different authority with no central control or organization to provide direction. Few curators are responsible to any entity having primary interest in germplasm preservation.

The curators we interviewed said that most of them consider research and plant breeding, not germplasm preservation, their main objective. Most maintain a short-term level of storage to facilitate research and breeding. They direct their own preservation programs and make unilateral decisions on distribution, preservation, and destruction of germplasm. We heard allegations that, as a result of these practices, significant amounts of germplasm have been lost.

Quality of storage facilities

Germplasm stored over a period of time without adequate control of temperature and humidity can suffer irreparable damage or loss. Many of the primary curators are allegedly using minimal or inadequate storage facilities, such as

refrigerators without humidity controls. Such storage facilities could lead to losses of important germplasm stocks.

The small grain cereals storage facility at Beltsville, Maryland--the principal facility for cereal germplasm storage in the United States--is considered totally inadequate by many members of the germplasm community. A task force which examined the facility in May 1979 concluded:

--The small grains and rice collections were too large for the storage and work space available at Beltsville.

--The humidity and temperature control equipment was not only obsolete, but barely operable, seriously jeopardizing the collections. The building itself was not well designed for the needed temperature and humidity control.

--Personnel and funds devoted to the collection were not adequate, particularly for grow-out and evaluation.

The task force concluded that an immediate safety crisis existed at the small grains collection and that it should be moved immediately to a safe storage facility. A representative of the National Program Staff also commented that the Beltsville site was inadequate and that changes were needed. To date, no alterations have been made to the facility although an update of the refrigeration plant will soon be undertaken.

The small grains collection may already be damaged. According to National Program Staff members, germination levels for much of the germplasm at Beltsville may be so low that the seed lines might be lost. Beltsville does not have the capability to test the germination levels. A representative of the facility said that satisfactory growing out of seeds indicated adequate germination levels. However, much of the germplasm at Beltsville has not been grown out recently.

The facility's climate-control practices may also contribute to damage of the collection. Research on storage methods has shown that the total of temperature and humidity should not exceed 100. Although Beltsville does not routinely keep records of its storage temperature and humidity, the limited recordings we found ranged in total from 120 to 130. (Other reports indicate that these levels have reached 170.)

NSSL operations

NSSL is intended to provide long-term storage and emergency backup for other germplasm collections in the event that some calamity eliminates one of these collections. However, for most collections other users have priority before NSSL, and in some cases NSSL does not even receive duplicate seed. The State-Federal plant introduction stations are given no clear directions on when NSSL should be provided duplicate seed.

Current capacity at NSSL is for 180,000 cans or 200,000 envelopes for seed storage. At the time of our review, about 110,000 varieties were in storage with another 100,000 samples not yet in containers and in temporary storage. This would indicate that if NSSL were current in storing samples, storage capacity would be exceeded. A proposal by the NSSL director to double NSSL's storage capacity has been prepared, but that would seem to be inadequate based on the number of varieties to be put in containers and the present rate of acquisition. An NPGC subcommittee has been appointed to assess NSSL's future needs.

Germplasm replenishment

Over time, stored germplasm must be replenished. The germination rate--the percentage of seeds that will grow if planted--will decrease in stored germplasm to a point where viability is seriously reduced or even lost. To maintain viability, the seed must be grown out periodically to replace seed in storage. Failure to grow out germplasm when needed can result in either damage to or total loss of seed.

The curators we interviewed said that they are behind in meeting their seed increase needs. They attributed this to lack of funding and insufficient staffing. Also, curators have limited capabilities to determine germination rates. NSSL has received germplasm from other curators with germination rates as low as 5 percent. (NSSL increases seed when it falls below a 60-percent germination rate.)

Germplasm evaluation

Evaluation of plant germplasm to determine morphological and genetic characteristics is limited and sporadic; no information system exists to accumulate and disseminate the results of evaluations that are done. Some portions of most collections have been evaluated, but these evaluations

have not been consistent in the information gathered or in the evaluation methodology. The lack of evaluations and of an information system has had two effects: (1) a researcher or breeder searching for desirable genetic characteristics may have to screen hundreds or thousands of samples because either no evaluations have been made or the results of previous evaluations are not readily available and (2) the germplasm which has been evaluated receives limited use because of the lack of a system to disseminate results.

USDA has recognized the need for germplasm evaluations and an information system. In 1976 the Germplasm Resources Information Project was initiated to evaluate the feasibility of an information system.

One of GRIP's goals is to determine the criteria for evaluations. To identify the criteria, or descriptors, for a germplasm information system, crop advisory committees are being used. These committees, each dealing with one crop, are made up of crop specialists from the private and public sectors. To date, nine advisory committees--for wheat, oats, tomatoes, potatoes, sorghum, alfalfa, beans, peas, and soybeans--have completed their descriptor recommendations. Three advisory committees have been proposed for the corn, cotton, and peanut crops.

While virtually everyone we talked with agreed that setting criteria for evaluation is a necessary first step, some believe that the crop advisory committees are biased toward plant breeders and that the proposed evaluations will be of less use to genetic researchers. Representatives of breeders generally commented that evaluations should be done for general descriptors, such as height and resistance to disease and insects. Researchers commented that evaluations should include identification of the genes responsible for insect and disease resistance. USDA officials estimate that performing these genetic evaluations would cost an additional $25 million to $35 million annually.

NEED TO IMPROVE PLANNING AND BROADEN SYSTEM OBJECTIVES

Although conditions within NPGS indicate problems with control, planning, and coordination of program activities, a more basic concern is the lack of long-range planning and the system's narrow scope.

NPGS is best described as having decentralized planning and decentralized management. Such a system is not really feasible for an organization that lacks a strong

focal point or that requires close coordination to achieve a central or directed objective. If U.S. germplasm needs were truly regional, then the current system could possibly work. We believe, however, that these needs are national.

Planning has been limited

The only central plan for the germplasm program was prepared in 1973 by ARS' National Program Staff in consultation with field staff. This plan has not been functional. It was prepared to meet an ARS requirement that national research programs set 10-year goals, not to provide strategic planning or direction to the germplasm system.

The Director, SEA, told us that strategic planning within USDA (regarding germplasm) was generally not done. He said that planning was done as a "reaction" to events rather than in anticipation of events.

Year-to-year planning is done by the State-Federal plant introduction stations and is discussed at NPGC meetings. However, these plans rarely anticipate future problems or needs of the system.

USDA in commenting on this report disagreed with our characterization of germplasm planning. It stated that planning is done in conjunction with the budget cycle. Again, this is to meet short-term operational needs of the system. No long-term planning exists, and no evaluation is conducted to measure system performance against the 10-year goals established by the National Program Staff.

Objectives need to be broadened

As stated earlier, USDA's objectives for the NPGS are germplasm introduction, maintenance, evaluation, and distribution. We do not dispute the importance of these objectives. They are clearly essential to the system. What the system has not done, however, is to clearly identify the purposes of collecting, what to collect, and how the collection should be used.

We believe that NPGS needs a more basic set of objectives. How much germplasm is needed? What are the Nation's germplasm resources? How vulnerable are they? What needs to be collected (what are the gaps)? How can collections best be used to decrease vulnerability and increase the potential of agricultural crops? What

priorities must be set to meet these concerns with limited available assets? Responding to these questions should be the focal point of an initial long-range plan for NPGS.

USDA disagreed that these questions should be the focal point of NPGS. It stated that germplasm introduction, maintenance, evaluation, and distribution will lead to protection against vulnerability and enhancement of plant crops. We feel that this is a case of putting the cart before the horse. The objectives of any program should be what results one wishes to achieve. In this instance protection against vulnerability and crop enhancement are critical. The four stated objectives are a mechanism to achieve this result. If program objectives are geared to this mechanism, then we feel that the NPGS will be continually short-sighted.

OTA study conclusions

The Office of Technology Assessment has concluded in a concurrent study 1/ that there is insufficient information on genetic diversity on which to base long-term germplasm management decisions. According to OTA, it does not have (1) sufficient knowledge of the extent and value of genetic diversity in the national germplasm system or in other repositories worldwide or (2) an adequate understanding of the rate and degree of genetic erosion in the natural world.

OTA said that it is not known to what extent continued loss will effect genetic resources or the future of agricultural production. It added, however, that because of the extent of vegetation displacement, many decisions concerning germplasm preservation in natural ecosystems--to assure genetic diversity--will need to be made before some information gaps can be filled.

OTA also said that no adequate feasibility study exists to determine which information gaps might be realistically filled to facilitate decisions on how much germplasm should be preserved in situ and how much should be maintained in repositories. Furthermore, OTA said the extent to which new genetic technologies will affect the genetic resource base or crop vulnerability has not been properly assessed.

1/OTA report entitled "Impacts of Applied Genetics - Micro-organisms, Plants, and Animals."

NEED FOR CENTRAL CONTROL

We believe that the immediate needs of planning and coordinating are not well served by the current system. In our opinion, central planning with decentralized operations would be the best means of meeting system needs. Such an arrangement would leave current operating components in place while overall responsibility for developing system objectives and plans to meet them would be placed with a central authority. Without authority to implement or enforce decisions, the coordination function of NPGS has been shown to be generally ineffective in controlling the system. To be effective, the coordinator needs to have power to set priorities, to develop plans and strategy, and most importantly to be able to implement and enforce decisions.

In a report submitted this fall to SEA, NPGC concluded that NPGS' primary weakness was its decentralized organization. The committee made a series of recommendations to centralize authority within the system with the first priority given to developing a long-range plan. SEA's response to NPGC's recommendations has been to assign the germplasm coordinator to the Deputy Administrator's office (National Program Staff) as assistant for germplasm. This action should give greater visibility to germplasm programs, but it will not centralize authority.

We did not thoroughly review the NPGC's proposed reorganization, but we endorse its concern about the need for a strong central organization and for a long-range plan.

CONCLUSIONS

Genetic vulnerability and variability are critical issues that need national attention, but the current germplasm system is inadequate to manage U.S. germplasm resources and to meet research needs. USDA's regionalized approach may or may not be appropriate for other research areas, but it has not added up to an effective national program for germplasm.

Since U.S. crops are genetically vulnerable, USDA is operating from a thin base to deal with that problem. First, some of the critical questions necessary to formulate policy have not been addressed. Second, the current system's organizational structure is not sufficient to answer or respond to these questions. Third, indications are that the existing germplasm collection, storage, and evaluation functions are inadequate. Fourth, a lack of strategic planning exacerbates the system's existing difficulties in coping

with existing problems and increases the system's susceptibility to future problems.

AGENCY COMMENTS

USDA strongly objected to our description of the management of NPGS. It felt we should highlight their October 1980 changes. The major changes are the assignment of the germplasm coordinator to the Deputy Administrator's office (National Program Staff) and the identification of plant germplasm as a high priority thrust area for the fiscal year 1983 budget. Appendix II details changes in system management made in October 1980. To quote SEA-AR's comments on our draft report:

> "The National Program Staff members, including the Assistant to the Deputy Administrator (DA) for Plant Germplasm, have both the authority and responsibility for maintaining communications with all programs related to their area of responsibility. They can and are expected to communicate with anyone in the organization at any time with respect to technical aspects of the program. They are expected to be the key individuals in SEA-AR for program assessment, recommendations for redirection, closeout, expansion or other modifications in national programs. They are the lead persons in budget development and implementation. The Assistant to the Deputy Administrator (DA) for germplasm reports directly to the DA. The DA reports directly to the Administrator. Obviously, the Administrator does have line authority over all programs in SEA-AR. Thus, the recommendation that there be centralized authority for the germplasm programs seems irrelevant in light of the existing organizational structure and strong central authority for germplasm."

USDA, in effect, has made the germplasm program coordinator more visible. These changes do not alter decisionmaking or management authority. While it is true that the Administrator of SEA-AR can exercise authority over the system, this has not occurred on a regular basis. The germplasm system requires daily attention. The SEA-AR Administrator cannot or should not be expected to provide such attention.

USDA feels that to centralize germplasm management would, in effect, create management problems for the other SEA-AR research programs. We do not believe this to be true.

NPGS should be viewed as a service function, assisting all other research areas as appropriate.

SEA-CR personnel feel that the development of a central authority would reduce State willingness to cooperate with Federal research efforts and lead to a reduction of State resources devoted to germplasm. This argument seems to contradict SEA-AR's statement above that a strong central authority was already in existence. It is also debatable that the States would view a centrally managed system as a threat. State representatives were on the NPGC subcommittee which recommended central management.

RECOMMENDATIONS TO THE SECRETARY OF AGRICULTURE

We recommend that the Secretary centralize authority over the Federal portion of the National Plant Germplasm System with that central authority having responsibility for all USDA-funded germplasm activities. We are not recommending that program activities be collapsed, but that management authority for planning, budget, and personnel be centralized, possibly within SEA. Until such action is taken, the major issues of genetic vulnerability and variability cannot be effectively addressed.

We further recommend that the system's first priority be to develop a comprehensive, long-range plan. Such a plan is essential regardless of management structure. This plan should address the following topics:

1. Assess the genetic vulnerability of major crops. Determine what planting or use trends might threaten or make these crops more vulnerable. Provide for monitoring the use of inputs, such as pesticides and fertilizers, to be aware of their potential impact on vulnerability. Provide for keeping closer watch on what varieties of seed are being planted and the research efforts of private seed companies.

2. Determine the gaps in current germplasm collections in terms of availability and evaluation. Develop objectives for collecting or otherwise acquiring needed germplasm.

3. Assure that stored germplasm is available by making sure that the stock is evaluated; that an information system is in place so that the information can be disseminated; and that when necessary, prebreeding is done so that

desirable genetic characteristics from otherwise undesirable types are transferred into a more suitable genetic background.

AGENCY COMMENTS ON RECOMMENDATIONS

USDA disagreed with our recommendation for more central control of the germplasm system for reasons discussed earlier. It did agree with our recommendation for long-range planning, and the Administrator of SEA-AR has stated that such a plan will be developed. (See item 3, app. II.) USDA stated that a lack of resources has prevented the Department from developing and implementing a long range plan in genetic resources. It did not state how much such a program would cost. USDA has recently established a working group to develop specifications for a long-range plan which should address both our criteria for a plan and the cost. This group should have a report completed for review by summer 1981.

FOUR REVIEWS OF PLANT GENETIC VARIABILITY AND/OR VULNERABILITY

NATIONAL ACADEMY OF SCIENCES STUDY

In a study partially sponsored by USDA, NAS took perhaps the first major overview of the genetic vulnerability of U.S. crops. The impetus for its 1972 report, "Genetic Vulnerability of Major Crops," was the 1970 corn blight.

The report stated, "Two points are clear: (a) vulnerability stems from genetic uniformity, and (b) some American crops are on this basis highly vulnerable." The table on page 4 was taken from the NAS report and indicates the degree of uniformity in U.S. crops. NAS made the following "challenges" to NPGS:

--Establish a watchdog system to identify exotic pests and test U.S. plants for susceptibility to those pests.

--Improve and enlarge the agricultural research talent pool committed to germplasm.

--Establish a national monitoring committee to monitor the development of crops and be alert to potential hazards associated with new or widespread agricultural practices.

--Continue development of germplasm resources through plant introduction and storage.

--Develop new plant varieties incorporating beneficial genetic material.

--Collect parasites for research in improving crop resistance.

--Devise a means of mitigating the economic loss from future epidemics.

AGRICULTURAL RESEARCH POLICY
ADVISORY COMMITTEE STUDY

In response to the NAS study, ARPAC established an Ad Hoc Subcommittee on Genetic Vulnerability. Its 1973 report was much more specific than the NAS study in discussing problems with U.S. efforts and in making recommendations. The ARPAC report concluded in part that:

> "There has never been a directed national effort toward the effective utilization of genetic resources. Our collections have never been used as much as they should have been, largely for want of basic research on patterns of variation, on genetic transfer in wide crosses, on components of adaptation, and on cytoplasms available. Most exotic materials are poorly adapted and must be converted to suitable types before the germplasm can be used. Supporting research of this kind has seldom been provided and never on a sustained and systematic basis.
>
> "While a considerable effort has gone into genetic resource management in the U.S., the effort has been too haphazard, unsystematic, and uncoordinated and has never received the high priority it deserves among the many agricultural research programs. The situation is serious, potentially dangerous to the welfare of the Nation, and appears to be getting worse rather than better."

ARPAC made many recommendations for improving the national system. General recommendations were to

- --establish a national plant genetic resources commission,
- --develop a national plan for plant genetic resources, and
- --collaborate in international efforts to conserve world plant genetic resources.

Specific recommendations were related to the management of U.S. plant genetic resources including plant collection, maintenance, and evaluation.

NATIONAL PLANT GENETIC RESOURCES BOARD

In response to the ARPAC recommendations, the Secretary of Agriculture established NPGRB in 1975. It was extended in 1978 and 1980. NPGRB's role is to provide policy guidance to the Secretary on plant genetic resources. Board members are a mixture of private, Federal, and State personnel having a broad interest in plant germplasm.

NPGRB's principal activity has been the publication of "Plant Genetic Resources: Conservation and Use" in 1979. This report was requested and accepted by the Secretary of Agriculture and contained a seven-phase program for genetic improvement of crops.

1. Collecting, maintaining, evaluating, documenting, and distributing plant genetic resources.

2. Understanding the genetic vulnerability and geographical distribution of cultivated species and their taxonomic and cytological relationships with closely related species.

3. Screening plant genetic resources for specific, desirable characteristics.

4. Studying the genetic mechanisms controlling the inheritance of desirable characteristics. Such knowledge is required for determining breeding objectives, selecting parental materials, and choosing appropriate breeding methods.

5. Combining genes from diverse sources into improved strains more useful to plant breeders. Genes for desirable characteristics are often found in stocks inferior to cultivated ones; they are seldom found within the same stock.

6. Breeding, releasing, and maintaining breeder seed of varieties and stocks of improved germplasm.

7. Producing high-quality planting seed and distributing it to farmers. This is the ultimate objective of all the preceding phases because it makes available seeds with the inherent capability for efficient production of high-quality crops, well

adapted to our environment and cultural practices, and with as much "built in" protection as possible from pests and environmental stresses.

Although NPGRB did not specify what the division of labor should be between private interests and the Government in carrying out these phases, members of the Board indicated that Government should be responsible for phases 1 through 5 and private industry responsible for phases 6 and 7.

NPGRB also made the following recommendations to USDA.

--Improve the U.S. National Plant Germplasm System by recognizing the importance of genetic research; continuing support for collection, maintenance, and distribution of germplasm; and supporting ongoing work on an information system.

--Reestablish U.S. crop authorities to monitor plant breeding, recommend collections and maintenance, and periodically report on crop productivity.

--Improve genetic traits of cultivated crops through developmental breeding programs and crop improvement teams.

--Continue to support NPGRB.

--Continue liaison among other organizations interested in genetic resources.

Although the seven phases of genetic work have been widely accepted within USDA, little has been done to implement the recommendations. NPGRB is an advisory body with no authority. The Board has provided a valuable service in providing USDA with a proposed genetic agenda and in offering continued support for genetic improvement of U.S. crops. The Board has done very little in formally assessing the adequacy of USDA and State efforts to manage the germplasm system or in critiquing the direction of those operations.

THE SECOND NAS STUDY

In 1978 NAS released "Conservation of Germplasm Resources: An Imperative." This study reviewed the conservation of all germplasm resources, including plants and animals. Like the other studies, this report stressed the importance of genetic diversity. The report recognized USDA's role in protecting genetic resources for U.S. crops but indicated that the following matters needed early attention.

--Establishment of repositories for clonally propagated materials.

--Establishment of a tropical facility.

--Funding of additional curators outside the system.

--Identification of gaps in the collections.

--Computerization of information.

--Additional research on germplasm maintenance.

SUMMARY OF INFORMATION PRESENTED TO THE NATIONAL PLANT GENETIC RESOURCES BOARD BY T. B. KINNEY, JR., ON OCTOBER 22, 1980 1/

The information was presented from notes related to the planned actions of SEA-AR in order to give high visibility to the germplasm program. The points made were essentially identical to those made in a memorandum of October 9 from T. B. Kinney, Jr., to Anson R. Bertrand. The specific points made at the October 22 meeting are:

1. Assign coordinator to Dr. Army's office as Assistant to the Deputy Administrator for national germplasm programs.

2. Reassign the narcotics research program to another person.

3. Conduct an AR review of national plant germplasm research programs and, in consultation with the States and the private sector, develop a long-range plan for plant germplasm programs in AR.

4. Develop a clear statement on the mission and function of the national plant germplasm program.

5. Issue instructions on the need to improve communication with SEA-AR line and staff and cooperators on matters relating to plant germplasm. Dr. Army will make sure that this is accomplished.

6. Modify the nonfunctional SEA-AR Plant Germplasm Coordinating Committee to a Federal working group with representatives from regions, areas, NPS, CR, APHIS, and SCS. This Federal working group would have the responsibility of making recommendations to the national germplasm coordinator and assuring that programs are effective and coordinated.

7. Develop closer working relations with OICD on matters relating to international germplasm programs.

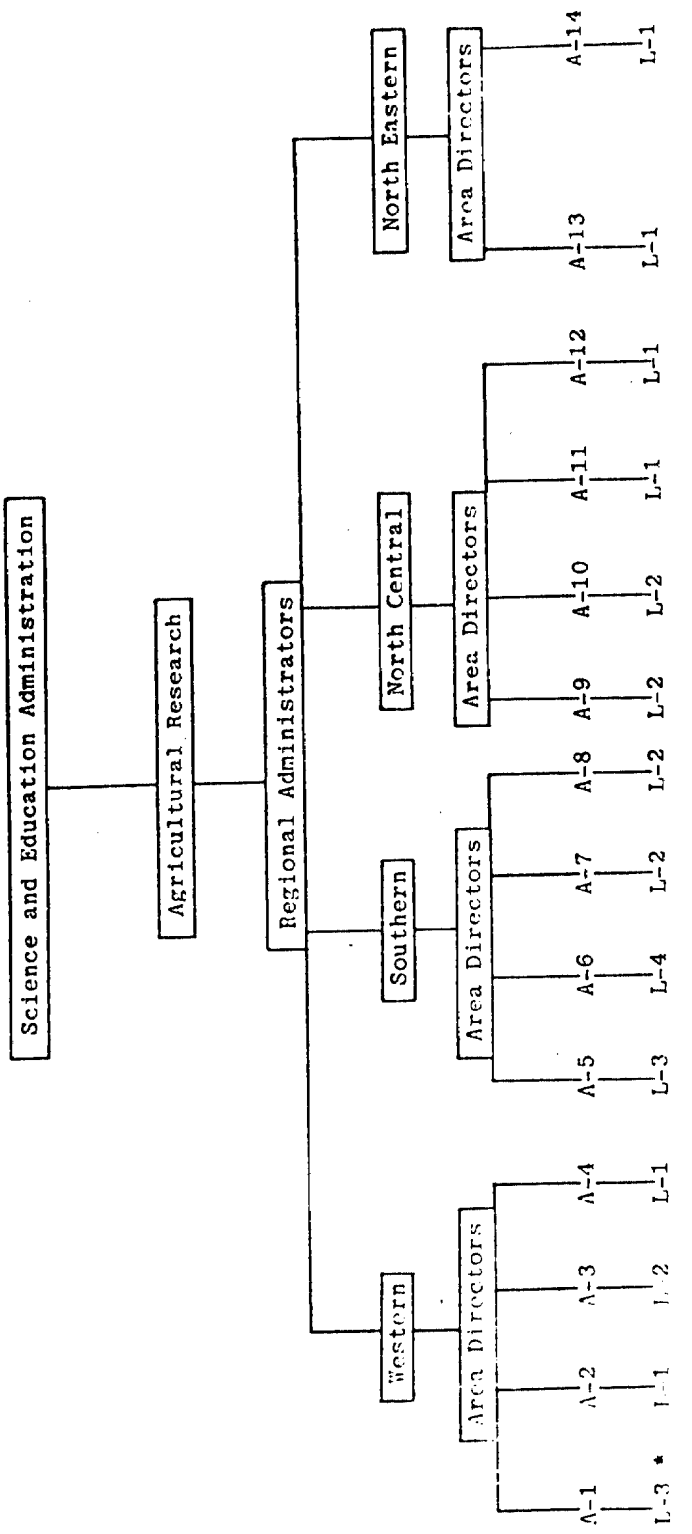
1/This appendix is supplied by USDA in response to a draft of this report.

8. Commit SEA-AR to strengthened cooperative relationships with the States and industry, national leadership, and excellence of administrative management of the national germplasm program.

9. Identify plant germplasm as a high priority thrust area in the FY 83 budget. We need the support of the National Plant Genetics Resources Board in "budget making." The Red Book is not enough--we need personal participation.

APPENDIX III

NPGS - PRESENT ORGANIZATION
OF FEDERALLY MANAGED UNITS



KEY

A-1	Pullman, WA	A-8	College Station, TX
A-2	Fort Collins, CO	A-9	Columbia, MO
A-3	Fresno, CA	A-10	Lafayette, IN
A-4	Logan, UT	A-11	St. Paul, MI
A-5	Tifton, GA	A-12	Fargo, SD
A-6	Gainesville, FL	A-13	Ithaca, NY
A-7	Stoneville, MS	A-14	Beltsville, MD

*Number of Locations in Area

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