

ments, and experiment stations, seeds or seedlings of newly developed trees if the Forest Service receives in return property (seed or seedlings, for example) of equal value.

State nurseries, operating under the provisions of the Clarke-McNary Act, undoubtedly will supply most of the new trees for planting on State and private lands in the future. Under the provisions of this act, the Forest Service may provide seed or trees to the nurseries. The ordinary value of the material is credited to the Federal Government's share in operating the nursery. A Clarke-McNary nursery may then sell the trees it grows to forest planters in line with its policy of providing trees at reasonable cost.

The following situation illustrates how this would work out. At the Lake City Research Center in Florida, forest geneticists selected and bred trees that yield twice the average amount of gum for naval stores. They demonstrated that the tendency was an inherited characteristic. Cuttings of these trees may be made available to State nurseries, as in Florida and Georgia, whose foresters would use the cuttings in developing seed orchards. Seed would be produced in about 10 years. This seed would then be sown in the nursery to grow superior gum-yielding pines for tree farmers and forest industries.

The Forest Service produces superior trees in its nurseries for planting in the national forests. In California, hybrid seed of Jeffrey pine (*Pinus jeffreyii*) and Coulter pine (*P. coulteri*) and of knob-cone pine (*P. attenuata*) and Monterey pine (*P. radiata*) have been produced in quantity by controlled pollination. Seed will be sown in the Forest Service nursery near Placerville to produce hybrid trees for planting in the national forests.

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## Introducing New Horticultural Varieties

VICTOR R. BOSWELL

A EUROPEAN visitor to the Plant Industry Station of the Department of Agriculture at Beltsville, Md., once asked us, "When your plant breeders develop a new horticultural variety, do you have any difficulty in getting farmers and gardeners to grow it?"

We replied that the Department has no trouble in obtaining prompt and widespread use of a truly improved sort, but that we do have difficulty of an opposite kind.

It is generally difficult to persuade prospective growers and users of a promising new variety to be patient until we feel sure that the variety merits introduction to the public and to wait until enough seed or other propagating material can be produced.

And thereby hangs this tale, which describes how breeders in this country introduce new horticultural varieties. It is devoted mainly to seed-propagated varieties.

The breeding and evaluation of a superior variety is one problem. Introducing that variety to the public on a large scale for prompt and widespread commercial or amateur planting is another kind of problem.

Solutions of the two problems are interdependent. In practice, the solution of the second overlaps the first; evaluation is still continuing while seedsmen or other propagators are developing the first commercial supplies for planting.

An element of risk exists in the acceptance of any new variety. Why, then, are planters so eager to grow new varieties that are developed by breeders in public and private agencies?

American farmers and gardeners are justifiably optimistic. They have observed the progress in varietal improvement over many years and are confident that it will continue. Furthermore, for economic and esthetic reasons, they need improvements in quality and yield of plant products.

Growers know that many promising varieties fail to live up to their promise. Nevertheless, depending chiefly on the originators' record of successes and failures, American growers often switch to new, improved varieties with amazing speed. Such a switch can be made rapidly and on a large scale only when the originator and the commercial seedsmen or other propagators work together with perfect coordination of evaluations, the making of decisions, the increasing of supplies of seeds, and the timing of appropriate announcements.

Vegetable seedsmen and nurserymen in America are to be commended for the remarkable manner in which they have voluntarily collaborated with each other and with public agencies in developing and operating our current practices for introducing the horticultural varieties that are produced by public agencies.

Systems introducing horticultural varieties differ somewhat among the States. State and Federal agencies and public and private agencies also may follow somewhat different procedures. All, however, are attempting to attain much the same ends by means most advantageous under their respective circumstances.

Before the present system of introducing vegetable varieties by the Department of Agriculture was established in 1944, we had failed to appreciate the necessity of perfect coordination between the Department and the vegetable seed industry in all the details of evaluation, development of commercial supplies, formal introduction, and announcements of a new variety. Wide publicity before ample commercial supplies were available created a demand that the seedsmen could not

meet. By the time supplies were ample, the publicity was forgotten, and there were few orders for the new variety. This kind of error can retard the acceptance of a new variety, however good it may be.

If the seedsman is to be able to meet a demand created for a new variety, he must first be familiar with that variety and all the facts concerning the preparation for its introduction.

THE PRESENT SYSTEM of introducing new varieties of seed-propagated vegetables bred by the Department and jointly by the Department and State agricultural experiment stations is simple in principle.

It was developed by the Department and the Garden Seed Research Committee of the American Seed Trade Association. It is designed to accomplish three major objectives: Insure adequate evaluation of a new variety before a decision is reached to increase seed supplies for introduction to the public; insure rapid, equable, and technically sound procedures for developing large supplies of commercial seed to meet initial public demands; provide for simultaneous and adequate publicity and catalog listing and other advertising by the respective agencies as soon as there is enough seed for general sale.

As soon as the plant breeder selects a line that appears significantly superior, he must provide enough seeds of it to permit its evaluation by cooperating agencies under a wide range of conditions. Workers at experiment stations, seedsmen, farmers, shippers, food processors, and consumers all usually take part ultimately in these evaluations.

If it is feasible, the breeder produces seed of high quality for the required commercial tests. Usually, however, we find it better to make a contract with one or two seedsmen to produce the necessary seed under carefully controlled conditions. This seed, called the initial increase, is the property of the Government, and it is all delivered to

us in accord with the terms of the contract.

Next, we supply without charge a small amount of the initial increase to each of numerous cooperators for observation and evaluation of the variety. The cooperators agree to refrain from increasing the seed or selling it or giving it away without specific permission. The variety is still the property of the Government and has not been released.

If the prospective new variety passes its examinations, we then release breeder seed to bona fide seed producers, "for increase only." This is a decisive step toward introduction but not the final one.

Before we release seed "for increase only," we offer a share of the breeder seed to all bona fide, primary seed producers and State foundation seed organizations in the country that are known to us. We then supply seed to each one who asks for it and who agrees to certain well-established mutual arrangements.

Receivers agree to increase the seed for commercial use but to refrain from advertising it, listing it in a catalog, or selling it to the public until the public introduction date, which is announced by the Department. This date is determined by consultation between the Department and the seedsmen.

The seedsman also agrees to report to the Department each autumn how much seed of the new item he has produced and how much he plans to plant for further increase the next year. The Department agrees to report the total amount reported by the several seedsmen to all seedsmen who are increasing the variety so that all can see how the total supply is developing.

As soon as it appears that the industry has enough seed on hand to meet the initial public demand for the new variety, the Department (independently or jointly with States) names it, announces its availability to the public, and publishes appropriate information about it. At the same time, the seedsmen list the variety in their cata-

logs and otherwise advertise it and offer it for sale.

Some nice judgments are involved in these procedures. Seed of some vegetables can be increased very fast, the quantity required to plant an acre is very small, and a certain new variety may appear promising for only limited areas or uses. It is feasible in such instances to announce a future date for introduction to the public at the time breeder seed is supplied to seedsmen for growing foundation stock and for commercial increase. Occasionally the date of sale is unrestricted.

The required initial commercial supplies of such seeds as tomato and lettuce can be produced quickly; usually only a year is needed after deciding that a variety merits introduction to the public. Obtaining enough seeds of beans and of peas takes 3 or 4 years and sometimes longer.

This system usually works without any serious hitch.

One should remember, however, that during the period when initial commercial seed supplies are being increased and before introduction to the public, extensive and rigorous evaluations are continuing in commercial-scale tests.

These tests sometimes reveal weaknesses that escaped earlier detection. They may disclose no serious weakness in the new sort but only a lack of any overall superiority. In a few instances the Department has decided during the stage of commercial increase to "kill" a potential variety because it lacked the superiority that would justify introduction.

THE COMMERCIAL VEGETABLE seedsmen of the United States deserve the greatest share of the credit for this system of increase, evaluation, and introduction. It could not have become possible without their thorough understanding and approval of the Department's points of view; without their knowledge and judgment regarding technical and operating problems; and without their wise devotion to the

common good. The system has been invaluable to the vegetable, seed, and vegetable-processing industries, and to the general public.

This system, as followed by the Department of Agriculture and vegetable seed producers, is now largely taken for granted in the United States, but it is not clear to others why competing American seedsmen voluntarily and apparently at their own risk produce hundreds of thousands of pounds of a new variety of bean, for example, that has not yet been introduced to the public by the breeder. Neither is it clear why we, in public agencies, do not hesitate to furnish our breeding lines and potential varieties, years in advance of introduction, to private seedsmen for study and evaluation. This unforced, voluntary collaboration between industry and public agencies and within the industry is built solidly on mutual confidence and enlightened self-interest.

Any unauthorized use or sale of any of our material is so exceptional that we do not consider it a hazard. Apparently, a system like this is now used nowhere but in America. We salute our collaborators in private industry! The system I have described for vegetable seeds has not been used with flower seeds by the Department of Agriculture because the Department is not developing seed-propagated types of flowers. We see no reason, however, why the procedure should be any less successful with flower seeds than with vegetable seeds.

ONCE THE DEPARTMENT of Agriculture has distributed breeder seed of a vegetable variety to a seed producer, we do not resupply him with seed. From the initial distribution onward, each firm that produces a particular variety maintains its own foundation seed (usually called "stock seed" in the vegetable seed industry).

If a seedsmen loses his stock seed or lets it deviate from type or become mixed to an objectionable degree, he is in trouble. He must buy good stock

seed from a competitor (that may be difficult) or make a new start with his stock or with commercial seed, and select a new stock having acceptable conformity to the original.

Most American vegetable seedsmen do a good job of maintaining stock seeds of varieties. To those who are doing a good job, it therefore seems unfair for the Department to bail out the careless vegetable seedsmen by resupplying him with stock seed. Each vegetable seedsmen has a responsibility to maintain what public research has supplied to him or to regain its equivalent at his own expense. Vegetable breeders in the Department thus are relieved of the responsibility of maintaining stock seed at public cost.

THE RELEASE, or introduction, of inbreds by public agencies for the production of hybrid vegetable seed involves some considerations not encountered in the introduction of conventional varieties.

Inbreds generally are introduced for their value as parents, either in producing hybrids or in genetic and breeding work. They are rarely planted for the production of commercial vegetables or in home gardens. They therefore do not normally enter retail trade channels as such.

Recently, however, after we had introduced a certain inbred for the usual purposes, different seed firms judged it to be an attractive variety in its own right. Each wanted to name it, describe it in its catalog, and promote it as a conventional variety. Who should name it? Who should "introduce" it as a conventional variety? As this is written, these questions have not been completely resolved.

Comparatively few producers of vegetable seeds are involved with commercial production of hybrids, except those of sweet corn and onions. The distribution of breeder seed therefore is easy. Because of the way inbreds are used incidental to the development of commercial hybrids, only very small lots of inbred seed need to be furnished

each seedsman to meet his initial requirements. This, too, simplifies the distribution.

Inbreds are "introduced" to seedsmen and breeders with far less publicity than conventional varieties are introduced to the public and with no problem of coordinating commercial supplies and publicity.

If a seedsman or other breeder introduces a hybrid (or a conventional variety) of which a public-produced inbred is a parent, his acknowledging the use of the public inbred and crediting its originator appears definitely to be in the public interest.

Combinations of inbreds that produce superior hybrids are "introduced" after extensive commercial evaluations of the hybrids themselves and with much the same fanfare that a conventional variety is introduced. In a way, however, "introduction of a hybrid" might be considered as a misstatement.

When a public agency "introduces a hybrid," it actually introduces no hybrid seed. It publishes information on how to produce the hybrid and on the properties and performance of the hybrid and its inbred parents. It releases—introduces—seed of the inbreds to the few producers of hybrid seed. Sometimes the inbreds already have been released for another purpose or purposes when an especially attractive hybrid involving them is first announced.

When a private firm introduces a hybrid that it has developed from its own privately developed inbreds, the firm does not ordinarily reveal the identity of the inbreds. Neither does a private firm share with others the seed of the inbreds it has developed.

If a publicly developed inbred parent or both parents should be involved in a privately developed and introduced hybrid, the agency originating the inbreds believes that it is entitled to know that and to know the identity of the inbred. This information constitutes evidence of the value and use of a research product of a public research agency.

The privately developed inbred parents of any privately introduced hybrid are looked upon as strictly private property. Even the identity of such parents of privately developed hybrids is the confidential knowledge of the owner. Thus the private breeder has a way to maintain sole control of his varietal introduction when it is a so-called "closed-formula" hybrid.

STATE BREEDING agencies often are in a somewhat less favorable position than the Department of Agriculture for conducting widespread and extensive evaluations of their potential new horticultural varieties and for stimulating the rapid buildup of large initial commercial stocks.

State agencies are less free to engage in operations of national and inter-regional scope than are Federal agencies. With more restricted objectives and areas of operation, it is often less easy to attract the widest commercial interest in the exhaustive testing and expansion of use of new horticultural sorts.

There is, of course, no reason why a State-produced new variety cannot attain as widespread and great use as one produced, tested, and introduced by the Department or in cooperation with the Department. In fact, some State introductions, such as Rutgers tomato, have attained top rank.

State agencies therefore generally handle their own vegetable introductions a little differently.

Some States have foundation seed organizations that receive their breeder seed and produce original foundation stock (stock seed) for sale to vegetable seedsmen. A few such organizations also continue to produce and maintain foundation seed of a limited number of items for sale to growers of certified seed.

Little certified true seed of vegetables is produced in this country. Keen competition in the vegetable seed industry, the pressing demands of critical customers, and the limited number of

producers of seeds of any one vegetable have combined to keep the general level of excellence of commercial stocks high enough that certified seed has not gained any great use.

Foundation seed organizations were established within individual States largely to do with certain "farm seeds" what the vegetable seedsmen are doing with vegetable seeds. The volume of farm seed required and numbers of seedgrowers to produce and distribute it are enormously greater than for vegetable seeds. The problems of management and quality control consequently are far greater.

For the production of a few vegetable seeds officially certified by State agencies, seedgrowers are required to return periodically to an official source of foundation seed. There is virtually no other continuing function for a foundation seed organization to perform with seeds that are generally produced on a large scale by well-established vegetable seedsmen.

Foundation seed organizations, however, do perform a vital continuing function in maintaining disease-free stocks of potatoes on a large scale for the production of certified seed potatoes. Potatoes and sweetpotatoes for planting purposes are not produced by vegetable seedsmen.

Sometimes a State agency will organize a small association for producing stock seed of one or a few items to meet difficult and exacting standards, and for producing limited quantities of vegetable seed for commercial planting. This is unusual, but it is sometimes necessary with a special item of critical importance to a limited area and number of growers.

Disease-resistant celery for a single area is an example. The volume of seed business with such items may be too small for any one of them and the production problems too great to justify production by vegetable seedsmen generally. A foundation seed association could perform this function when necessary.

Occasionally a State agency and one

private seed firm will enter into a cooperative plant-breeding arrangement that grants the firm an exclusive right to propagate and sell seeds of a new jointly produced variety for a limited time before the seeds are available to other seedsmen. Such arrangements are uncommon and are unlikely to become popular.

The prevailing policy among public agricultural research agencies is to grant no exclusive rights to any product of research that is developed wholly or partly with public funds.

The procedures for increase and introduction of vegetable seeds in most States are basically similar to those I have described for the Department of Agriculture.

There may be some differences: Commercial evaluation tests are less widespread and there is less general prerelease knowledge of and interest in the prospective variety. Breeder seed is not always offered initially to all who are bona fide producers of the kind of seed involved. Seedsmen sometimes pay for breeder seed. States generally will resupply foundation seed, especially of varieties of limited use. Often there is less formality concerning public release dates.

It may never be feasible or necessary for most State agencies to engage in commercial evaluations quite as widely as the Department is obligated to do. It seems, however, that more widespread commercial evaluations of State and Federal productions before release would be helpful to all agencies and growers concerned.

Private seed producers feel strongly that they all should have the opportunity to accept or decline a share of original breeder seed from any public agency when it is available to a competitor.

IN INTRODUCING a new variety, the private breeders-seedsmen face many of the problems that public agencies do, but the seedsmen solve the problems differently. Business rivalries and competition lead private firms to de-

velop and evaluate their introductions as quietly as possible.

It is difficult for the private breeders to obtain the widespread commercial evaluations that they need without revealing their progress to competitors. By working through their own laboratories and field stations and their trusted associates and the customers, though, seedsmen can evaluate their productions and make their independent decisions as to whether to introduce specific varieties.

As the seedsman increases the seed of a new variety preparatory to introduction, he supplies substantial quantities to selected customers for final trial. If all goes well, the seedsman names the variety and introduces it by means of catalog listing and description, advertising, and personal salesmanship.

Private firms have no problems of joint decisions or coordination of plans and actions with other agencies. At the same time, it is a hard problem to coordinate testing and evaluation, seed production, publicity, and sales among different departments in a large firm with farflung operations.

The seedsman often takes greater financial risks on his own introductions than on public introductions. He may not have opportunity for adequate evaluation. He does not have, at introduction, the extension and publicity services that are available to public agencies for announcing a new sort.

Even so, the private breeders-seedsmen have done very well in this country. They have produced and introduced the greater proportion of the varieties of vegetables grown today and have made their work profitable. In this country, the private breeders have no control over seeds of the "open-pollinated" varieties they introduce, once the seed is sold to the public. Their superior introductions, however, gain prestige and attract increased volumes of business for their respective firms. That is how private vegetable breeding can be profitable in this country.

There is no doubt in our minds that unrestricted sale of seed of new vegetable varieties in this country has been a boon to vegetable growers, food processors, and consumers. It appears, also, that under the policies and practices of the American seed trade, the aggressive breeder-seedsman is no less prosperous than his fellow seedsman abroad who has the protection of "breeder's rights."

THE "INTRODUCTION" of a new variety of seed-propagated vegetable is but a landmark in its early history. It marks the end of its developmental phase but only the beginning of an arduous maintenance history.

Seedsmen face difficult problems in maintaining foundation or stock seed of a vegetable variety, true to its original characteristics, performance, and uniformity.

The seedsman must guard against seedborne diseases, mixture with seeds of other varieties, and cross-pollination with other varieties. These are largely mechanical problems. They generally are not too difficult to handle, but they require vigilance and scrupulous care.

It is harder to control a variety's inherent tendency to vary and to change as a result of natural selection or of the seedsman's selection. Minimizing the effects of variability is difficult enough in relatively stable lines of self-pollinated species, but it is especially difficult in the less stable, cross-pollinated kinds.

No variety is absolutely uniform and fixed. Although the plants from seeds of a variety may appear as alike as peas in a pod at the time of introduction, they are not all exactly alike genetically. As numbers of plants increase in succeeding generations, after repeated shuffling of countless genes, characteristics emerge that did not have the mathematical opportunity to appear earlier.

These offtype plants must be removed—rogued—from a stock before they bloom, lest they cross with the

others and cause an increase in frequency of occurrence of offtypes in successive generations. Seeds of offtype plants must not be allowed to develop and become mixed among the seeds of typical plants. The undesired variants often are more prolific producers of seeds than plants of the desired type and so in time tend to predominate unless they are kept out.

Offtype plants can also arise by mutation and perpetuate their characteristics by seeds.

Notable deviations from good type can appear suddenly in a supposedly well-fixed stock of an inherently variable species at any time that it is grown in a markedly different environment. The cabbage family clearly exhibits this tendency.

A stock of cabbage may appear uniform and true to variety when the plants are grown in an environment like the one in which it was selected.

Other plants grown from the same package of seed, but under a different pattern of temperature, are likely to be rather highly variable. Some of them may be extremely offtype. The variety has not broken down. It has not reverted. It was like that from the start. It simply has been grown in the "wrong" environment.

We need to remember that the detailed features of a plant are the result of neither its hereditary makeup alone nor of its environment alone. They are the result of the interplay between its hereditary entities (its genes) and its environment. And we need to remember that no seed-propagated variety or stock is absolutely uniform in its hereditary makeup. Some are less variable than others, but they all vary.

The plant breeder or seed producer selects and reselects successive generations of a stock to make it or keep it as uniform and true to the ideal as he can. He faces a basic problem, however, for which we have no complete practical solution.

The selector can discard or retain genes in a stock only as they happen to react with the environment in which

he is doing the selecting and in such a way as to produce some observable effect. All he can do is select plants carrying collections of genes that happen to produce uniformly desirable plants in that particular environment.

In some of those plants that look alike, there are genes that will react with another environment in a manner unlike that shown by other plants in the stock, or to a different degree. There is no way in any environment to determine how any of the plants or the entire stock will behave in another environment. That is why breeders must test and evaluate potential varieties in several environments.

Not all crop varieties are so varied in their hereditary makeup as cabbage or so variable within varieties in their reactions to environment. It is highly important, however, to remember that these variabilities of hereditary makeup and of response to environment are universal. They must never be ignored in the maintenance of stocks.

Lots of stock seed of a variety often are maintained in one or more environments notably different from the one where the original stock was selected for conformity to type. Each different environment tends to increase variability of appearance or behavior among plants within the stock. Certain gene differences among plants that were not expressed in the original location are variously expressed in the new locations.

The seedsman does his best to remove from a stock in a new location any plants that appear different from the original standard. In a few generations, he may select the stock so that in that new location it looks uniformly like the original in the original place.

It may seem that by all that careful work the seedsman has done a commendable job. But, alas, customers in the region where the stock originated may complain that plants from the reselected stock are not quite like the original stock. The seedsman looks into the complaint. He may note that the



plants are different from the original stock and different from those of the same stock growing in his seed field far away. The interplay of genes and environment is the reason.

Many seedsmen are well aware of the hazard involved in stock selection in an environment widely different from that where the commercial seed is to be used.

Suppose a seedsman decides that he must maintain his stock seed in an environment quite different from the one where his stock was originated and selected. Then suppose he decides to refrain completely from any roguing or selection in an effort to avoid interfering with the composition of the original stock. Unfortunately, sooner or later, he finds that the stock has drifted off to some degree, although he has not tinkered with it in the least.

What happens?

Again, the interplay of genes and environment tends to upset the seed-cart. Natural selection and selection by man bring about a shift in the collection of variable living things that make up a stock. In the different environment, some of the variants that appear produce more seeds or fewer seeds than other plants in the stock. In time, the stock contains a large proportion of plants having hereditary makeups that are somewhat different from those of most of the plants of the original stock.

Inbreds, which have been very closely bred and selected for a low degree of variation in hereditary makeup, also tend to drift, especially when they are maintained in an environment quite different from their original one. Inbreds, too, respond to the forces of selection—natural or artificial—that inevitably bear upon differences in properties induced by the interaction of genes and environment.

Inbreds generally tend to drift less rapidly than open-pollinated stocks, because they are less variable in makeup at the start. But they are variable and fluid to some degree.

We think we want commercial va-

rieties that are absolutely uniform and genetically stable and that behave the same in one place as in any other where they will grow. There is no such thing and probably never will be. We can only settle for the best compromise that is feasible. What we are willing to accept—what we can afford to hold out for—depends on a welter of economic considerations and what is biologically possible. Satisfactory compromises are attainable.

Biological research and experience in plant breeding and seed production are making those compromises more favorable. Many of our present varieties behave with satisfactory constancy under a relatively wide range of growing conditions. Breeders now make special efforts to insure that a variety has such a genetic makeup that it can perform rather consistently in different places and seasons. There is a limit, though.

Seedsmen more and more maintain seed stock operations in regions where the commercial seeds from those stocks are to be used. They help thereby to retain the genes in a stock that are essential for the expression of the desired properties and performance in those regions. Through the continuing evaluation of the performance of their commercial stocks, seedsmen get information to help in making sound judgments in the difficult task of control of seed stock.

MOST OF THE breeding of potatoes and sweetpotatoes in the United States is done cooperatively by the Department of Agriculture and the State agricultural experiment stations.

Original potato seedlings of controlled parentage are first propagated on isolated "seed" farms, on which no field-grown tubers from other fields are planted. Only original greenhouse-grown seedlings and local propagations of those seedlings are grown on the isolation farms. The farms are kept scrupulously isolated and free of virus diseases, so that stock of any seedling later found worthy of intro-

duction can be distributed to foundation stock growers in a virus-free condition. Virus infection at this stage might make a potential new variety worthless.

Seedlings and stocks of sweetpotatoes propagated from them have not been produced under the rigid control that is practiced with potatoes. With increasing troubles from virus diseases in the sweetpotato, however, there is need for similar control.

In supplying propagating material of potatoes and sweetpotatoes to co-operators for evaluation of new seedlings, the breeder usually sends a few tubers (or roots of sweetpotato) to each from his own initial increase plots.

The cooperator easily produces enough stock for further tests while he grows these new items for his first observations. In the South, however, where it is not feasible to produce good seed potatoes, investigators must get their planting stock from favorable locations in the mountains or in the North.

Sometimes the breeder furnishes enough stock for immediate sizable tests (as for southern locations), but he tries to avoid it because of the great bulk and the costs of shipping seed potatoes.

Cooperative evaluations of potatoes and sweetpotatoes are conducted in essentially the same way as seed-propagated plants are.

When cooperating public agencies decide to introduce a variety of potato, one of the agencies furnishes virus-free stock to the foundation seed organizations of the States participating in the introduction of the variety.

These organizations increase the stock under rigid disease control and sell foundation "seed" to the producers of certified seed potatoes. These growers, in turn, produce seed potatoes under official supervision, which is then sold to the commercial growers of potatoes for food. Most of the commercial potatoes in this country are grown from certified seed.

The public agencies introducing a

new variety of potato make a joint announcement naming, describing, and "introducing" the variety as soon as modest supplies of stock are available from a few producers of foundation seed. This announcement is directed mainly to seedgrowers and public agencies rather than to the general public and tells where foundation stock is available. Further publicity is released later as seed supplies become more widely available.

Growers of foundation seed and certified seed potatoes are the counterpart of the producer of vegetable seeds. There are hundreds of such growers in the Northern and Western States.

Fewer than a half dozen of them are breeders, whose objectives and methods differ greatly. Some freely exchange their potential varieties, under agreement, very much as public agencies do, and introduce varieties in about the same way. Others operate more nearly as the private breeder-seedsman does.

When the Department of Agriculture introduces a variety of sweetpotato, it usually acts jointly with one or more States. Introduction consists of a joint announcement naming the variety, describing it, and stating where propagating stock is available. In the absence of a well-established seed sweetpotato "industry," initial stock is furnished to a few selected growers who can meet initial demands.

Some State agencies produce and introduce new varieties of sweetpotato independently in a similar fashion, after evaluating them for their own conditions. In a few States, foundation seed organizations or similar groups grow the foundation stock of sweetpotatoes for producers of seed sweetpotatoes.

PUBLIC AGENCIES often introduce new varieties of tree fruits and nuts, grapes, berries, and vegetatively propagated ornamentals through limited numbers of nurserymen or special propagating agencies, from whom other nurserymen purchase their initial foundation stocks. Practices vary so much among

agencies and among crops both within and among agencies, however, that it is hardly feasible to speak of any general pattern.

Breeders in public agencies generally propagate promising new fruits and ornamentals themselves for further test and evaluation, but there are exceptions. Most of these breeders also directly supply stock to whatever agencies undertake the propagation of foundation stock.

The Department of Agriculture and some State agencies make no charge for breeder stock supplied to propagators of foundation stock. Other State agencies sell breeder stock.

Rarely does a State agency place breeder stock in the hands of but a single private propagator. The Department of Agriculture never does. Stock of State origin often is furnished to all within a State (usually a small number) who request stock and who qualify as dependable, competent, bona fide propagators of the plant. In a few States, the breeders furnish stock exclusively to State-operated foundation stock enterprises, which sell their product to commercial propagators.

Federal and State agencies commonly establish a formal public introduction date, after which stock of a new sort may be sold to the public. The date is set after consultation with propagators to coincide with the availability of a fair supply of commercial stock.

A few States have organizations of growers and nurserymen or other crop specialists who arrange for effective and fair propagation and distribution of foundation stocks of new varieties. As examples:

The New Jersey Peach Council, Inc., cooperates with the State experiment station on evaluation, is consulted about introduction, and propagates and sells the initial supplies of certified stock.

The New York State Fruit Testing Cooperative Association helps evaluate new varieties bred by State agencies, propagates those specified for propagation, and sells foundation

stock of introduced varieties to nurseries and the public.

Oklahoma Foundation Seed Stocks, Inc., receives breeder stock, produces foundation stock of peaches and other fruits for sale to nurseries, and handles foundation seed.

Many serious virus diseases are transmitted by vegetative propagation. Some viruses have been eliminated from some kinds of plants by heat treatment or other means, but generally an infected stock remains so.

Infection of an original stock may render it worthless. Careful controls over the production of original plants and foundation stock of vegetatively propagated varieties are necessary.

As an example of this control, the Foundation Plant Materials Service of the University of California tests both old and new varieties of several fruits, including stone fruits, pears, and grapes, for virus infection. It may take up to 6 years to be sure a stock is free of virus. If the service certifies a stock of a variety to be free of virus, the stock is placed under the supervision of the State department of agriculture, which authorizes nurseries to propagate it. The nurseries then sell propagating material or trees to growers within the State and later to growers elsewhere. The foundation trees are continually tested to assure that they remain free of virus.

After preliminary evaluation of potential varieties of strawberries bred by the Department of Agriculture and cooperating States, virus-free plants are furnished to selected nurseries.

These firms are certified by their respective State control agencies as qualified to propagate stocks under conditions that will keep them virus free.

After 1 to 5 years of evaluation and propagation in these nurseries, a variety may be introduced. The nurseries then supply virus-free stock of it to specified "first-year virus-free stock growers" in various States. These stock growers are certified by their respective State inspection services as

qualified to produce foundation stock; they produce commercial plants for sale to strawberry growers.

In breeding blueberries, the Department of Agriculture produces tens of thousands of seeds of controlled parentage each year. The task of growing, propagating, and evaluating seedlings from those seeds is formidable for one agency. The Department therefore enters into cooperative agreements with State experiment stations and with able and interested commercial growers who help do this job.

The Department selects a few of the best seedlings each year for further evaluation. The cooperating growers may propagate and sell a few plants for evaluation studies to cooperating experiment stations and others. By the time any superior seedling is ready for naming and introduction, the original grower of it and a few cooperating fellow-growers will have developed small supplies of propagating material that can be sold to nurserymen and others.

Each kind of fruit crop has its own peculiar problems of propagation, evaluation, and introduction. There are many modifications of the several basic plans described for various fruits to suit specific crops and also sets of circumstances.

THE DEPARTMENT of Agriculture breeds and introduces many varieties of asexually propagated ornamentals, such as lilies, chrysanthemums, and azaleas. When evaluation indicates that a variety merits introduction, it is named and described. An appropriate announcement is sent to commercial propagators.

Upon introduction, a small amount of breeder stock of a variety is furnished to each of a number of nurserymen from a selected list designated by the American Association of Nurserymen, Inc. These selected firms propagate the breeder stock and sell foundation stock to other nurserymen, in accord with an agreement between the Department and the association, which

represents the nursery industry in these matters.

Horticultural varieties of fruits and ornamentals that must be propagated vegetatively can be patented in this country. Many of those introduced by private breeders are patented, but public agencies generally do not patent their introductions.

As with seed-propagated varieties, private breeders of vegetatively propagated varieties generally conduct their work in as inconspicuous a manner as possible and retain strict control of their materials. They introduce their new vegetatively propagated varieties in essentially the same way as seed-propagated varieties, except that the former may be patented before it is introduced publicly and offered for sale.

IT IS EASY to state the objective and principles of orderly, effective, and equitable introduction of a new variety by a public agency, but it is quite another matter to get the job done.

Together with the numerous segments of the industries involved, we all are continuing to develop procedures and facilities for introducing a very wide range of crop species in progressively better and more mutually satisfying ways.

Scientific and technical competence in crop improvement has been progressing in the vegetable seed industry at the same time as in public research agencies. Some of us believe that henceforth private enterprise can and will conduct a still larger share of the "applied research and development" in producing new, improved varieties of vegetables. This is desirable because it will permit public agencies to give more attention to important basic problems in genetics, pathology, and physiology that must be solved to afford a basis for further progress.

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