IN CONTRAST with the comparatively small number of different species of important extensive farm crops—a half dozen cereals, two fiber crops, two sugar crops, and perhaps a dozen forage crops—literally scores of common vegetable-crop species are widely grown over this country. The scientific basis for orderly and efficient breeding of most vegetables is much less highly developed than in the cereal and sugar crops, for example, and therefore less can be said concerning the genetics of most individual vegetable-crop species. Even so, the large number of crops to be considered compels drastic limitation of subject matter and scope of the articles that follow.

FEW FOREIGN VARIETIES ADOPTED IN THE UNITED STATES

The excellent and comprehensive treatments of wheat, corn, and certain other crops in the 1936 Yearbook of Agriculture include much data upon foreign varieties, breeding, and improvement; but for many of our vegetable crops such information either is not available or is of such limited interest in the United States that its compilation and publication are hardly practicable. In the main, foreign varieties of vegetables either do not appeal to our tastes or are not well adapted to the environment and the methods of handling in the United States. There are noteworthy exceptions, of course, for there is some international agreement in consumers' tastes and a few crops show wide ranges of adaptability. But the activities of foreign workers have thus far remained to a large extent of academic interest to us, except insofar as they dealt with basic problems of genetics or plant culture. A few examples will explain our limited use of foreign productions.

England stands preeminent in the improvement of the garden pea. More of our pea varieties (or their parent varieties) originated there than in all other countries combined. The English climate is quite cool and moist, ideally adapted to the garden pea, which is sometimes called the English pea. Even though many of our varieties are readily traceable to English work, they constitute only a fraction of the number that have been produced and are still grown in that country. Most of the English varieties are not at all adapted to our more extreme and changeable climate. Most of our own varieties of peas are inferior in quality to the English varieties as these are grown in England.

Tomatoes are grown in England almost exclusively in greenhouses. None of our important commercial sorts will bear satisfactorily out
of doors in England, because the climate is too cool; neither are they adapted to the English hothouse industry. On the other hand, English varieties of tomatoes have never become popular in the United States, because they are too small to suit our growers and consumers, even for production under glass.

Our growers envy the Italians their ability to produce tomatoes of such high color and high content of solids and have repeatedly attempted to adapt Italian varieties to this country, but without success. Italian tomatoes are not adapted to our climate and soils, and furthermore, the small size of some of the best makes them expensive to harvest. Americans demand bigness, not only for appearance but to facilitate handling and to reduce production costs. World-wide collections of tomato varieties grown in this country have revealed none that we can afford to adopt as they are.

The huge Telegraph type of cucumber grown in English greenhouses has contributed to the development of some of our own varieties, but Americans will not buy the enormous English sorts. Likewise our ideas of a good cucumber are unacceptable to the English; our varieties would be considered as nubbins. Again, our varieties for outdoor culture are of no interest in England, where cucumbers must be grown under glass.

As we owe a debt to England for fine peas, so we are indebted to the Netherlands, Germany, and Denmark for our principal varieties of cabbage and spinach. The leafy crops reach perfection in those cool north European countries. Although we adopted their productions as the best immediately available, they were developed under environments so different from our own that they are really well adapted to very few localities in the United States. A Danish seedsman who supplies large quantities of cabbage and other seeds for our growers once said in effect with reference to this fact: "I have never seen a crop of cabbage in the United States that would be considered good in Denmark."

We have adopted a few varieties of vegetables from France, but only a few—lettuce and celery in particular. Again, French requirements and American requirements are so different that one country rarely seems to be able to make use of the varieties considered good by the other.

In some countries other than those mentioned there are highly developed and carefully controlled stocks that are all important to the respective regions. But in much of the world vegetable breeding and improvement remains as a quite local enterprise in the hands of unskilled and untrained workers, or is indeed nonexistent. Imported or adopted varieties that were once acceptable here, when we had no others and before growers were beset with so many problems, are now considered inadequate. Increasing severity of insect and disease attacks, new techniques of production, handling, and processing, and ever-changing requirements for market and culinary quality, all combine to make new variety problems and to make them rather peculiarly our own.

In general, vegetable-crop species do not have the world-wide importance possessed by the cereals, sugar plants, fiber plants, and tobacco. Tomatoes, peppers, sweet corn, squash, and pumpkin are
all believed to be of New World origin and do not have the long cultural history of certain staple crops; they are comparatively unknown in large parts of the Far East. Until a scant hundred years ago the tomato was thought to be deadly poisonous even in America, and most Europeans still think corn is unfit for human consumption. In our turn we are entirely unacquainted with scores of Asiatic vegetables, some of which might well be consumed in this country.

This "local" or national interest in varieties and species does not mean that we minimize the value of foreign sorts as possible parents in breeding and improvement work in the United States. Some of the most significant improvements ever effected have been through using certain commercially worthless and practically inedible forms for hybridizing with commercially desirable varieties to obtain new disease-resistant sorts.

PRIVATE AND PUBLIC IMPROVEMENT AGENCIES

In an appraisal of vegetable-variety improvement up to about 1925, primary recognition must be given to private growers, seedsmen, and amateurs. It is only in the last 10 or 15 years that research institutions in this country or abroad have been much of a factor in the breeding and selection of new and improved varieties of vegetables. Prior to that time most of the advancements in yield, appearance, and quality had been brought about by private workers, mainly through mass selection. Some very productive hybridizing was purposefully done, and approximate pure-line selection methods were applied to closely self-fertilized crops like peas and beans.

In recent catalogs of two of the larger and more progressive seed firms, approximately 675 and 500 vegetable varieties are listed, respectively. Of these numbers, approximately 6.5 and 5.5 percent, respectively, represent varieties originated and introduced to the trade by State and Federal research agencies, the remainder being the results of private enterprise. It must not be concluded, however, that these percentages represent the proportions of total acreage and production of varieties bred by State and Federal workers. In certain areas and for certain crops a very large share of the total consists of new disease-resistant varieties. Furthermore, hundreds of varieties listed are of quite minor value. Ten years ago probably not over 1 or 2 percent of the varieties listed were the result of work by public investigators; and it is predicted that 10 years hence the proportion will have increased much more.

Until the last few years private growers and seedsmen were able to effect improvements of such character and at such a rate that the requirements of the industry were reasonably met. With increased knowledge of breeding technique as demonstrated by research workers, the seedsmen can do and are doing better work than in the past; but the increasing complexity and magnitude of numerous problems are demanding that public agencies provide solutions to them. With public agencies searching out genes for superior characteristics and introducing them into new varieties, private interests will extend the distribution of those genes into many more varieties and strains.

It should not be supposed that two catalog lists of new varieties bred, named, and introduced by public agencies represent their entire
contribution to vegetable improvement. As has been pointed out for other kinds of crops, they have devised shorter and more effective methods of improvement that are gradually coming into general use by commercial agencies. The Federal and State workers have also accomplished incalculable benefits by the simple procedure of developing superior stocks of old varieties by selection, freeing stocks of mixture and disease, and releasing the resulting material into trade channels. Some of the best and latest productions will not be generally offered for sale for another year or so.

NEW INFLUENCES IN VEGETABLE IMPROVEMENT

ALTHOUGH the avoidance of contamination with disease is perhaps the foremost consideration in seed certification by several States, certification also relates to trueness to varietal type and freedom from rogues and mixtures. This certification does not involve original breeding or improvement but does compel the application of up-to-date methods of maintaining advances that have been made by breeders. Certification, therefore, deserves mention as a public service closely allied with improvement. From a practical standpoint it has resulted in very substantially raising the standards of performances of tens of thousands of acres of vegetable crops.

Under authority of the Bankhead-Jones Act, passed in 1935, the Division of Fruit and Vegetable Crops and Diseases is developing near Charleston, S. C., a well-equipped vegetable breeding laboratory for the study of fundamental breeding problems that are basic to the production of new and improved varieties for the South and Southeast. Solutions to these problems of national and world interest will of course be forthcoming. Rapid progress is being made in providing facilities for research, and a small but able and active staff has been at work since the spring of 1936. The establishment of this station, the only one in this country devoted exclusively to vegetable breeding, is a particularly significant step, but is only one of the signs of the times. The study and application of genetics are certain to solve an increasing number of our problems and contribute greatly to the general welfare.

Another station in the United States that may well be expected to make unusual contributions is the Great Plains Horticultural Field Station, of the Division of Fruit and Vegetable Crops and Diseases, at Cheyenne, Wyo. A most extensive collection of thousands of domestic and foreign varieties, strains, and stocks of vegetables has been acquired by that station in the quest for characteristics of earliness, drought resistance, and cold resistance. Vast stretches of our western United States have such a short growing season by reason of high latitude or altitude, and such extremes of temperature, with low humidity, drying winds, and short water supply, that only a very meager list of vegetable varieties can be grown. There is pressing need for either introducing or breeding varieties of nearly all crops for home and local market use by people living in those areas. The staff of the station at Cheyenne includes men highly trained in horticulture, genetics, cytology, and physiology. The joint efforts of all are directed to the examination of promising material and the execution of a breeding program designed to meet the requirements of the region.
The Division of Plant Exploration and Introduction of the Bureau of Plant Industry plays an important part in the breeding programs, not only of Federal agencies but of all the State experiment stations that call upon that Division for help. Their information upon the geography of plants, their constant close contacts with investigators and dealers all over the world, their exploring expeditions into obscure places, combine to make available to plant breeders in this country a wealth of the world's plant materials that is remarkable. And naturally the Division assists foreign investigators by supplying in exchange considerable quantities of material from American collections. The world's supply of plant materials is becoming diffused into all countries for anyone to use who will.

PRESENTATION OF SUBJECT MATTER

A few words are in order with reference to the organization of subject matter in the articles on vegetable breeding. It is obviously impracticable to treat each crop extensively, therefore crops have been grouped for treatment. Groups are based on botanical and structural similarities in most cases, but a few on the basis of similarity of use or purpose for which they are grown. This grouping has been adopted purely as a matter of convenience in compiling the information or for presenting together crops of related interest regardless of botanical relations. It is not to be considered as a scientific classification. In most cases the authors of the respective articles are now conducting breeding or genetic investigations or have had special breeding experience with the crops under discussion.

It will be noted that the appendix to this group of articles (p. 340) contains data on a number of unclassified crops not discussed in detail in the articles, such as peanuts, sweetpotatoes, and others. Definite information on the breeding, improvement, and genetics of these crops is indeed meager despite the great economic importance of some of them. There is practically no exact knowledge about inheritance in the sweetpotato, and even the origin of surprisingly few sorts is known. The peanut until quite recently has been almost ignored by scientific breeders and students of genetics, but it is due for increasing attention.