A CENTER FOR RESEARCH AND DEVELOPMENT IN HORTICULTURE

THESIS REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF ARCHITECTURE

21 MAY 1956

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21 May 1956

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Dear Sir:

In partial fulfillment of the requirements for the degree of Bachelor of Architecture, I submit this thesis report entitled " A Center for Research and Development in Horticulture. "

Respectfully,

Robert E. Vail

I WISH TO EXPRESS MY SINCERE GRATITUDE TO THE FOLLOWING PEOPLE WHO HAVE AIDED ME IN THE COMPLETION OF THIS THESIS

Department of Horticulture, Michigan State University

Doctor Harold B. Tukey for the inspiration that caused me to undertake this project and guidance throughout.

Doctor Donald P. Watson

Department of Architecture, M. I. T.

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ABSTRACT

The program for the horticultural center can be divided into three parts. The first is a list of building requirements. There is to be one main building to serve the administrative functions, contain a small library and a herbarium, and provide office and laboratory space for six employed horticulturists to do the scientific work on the development of new plant materials. A lecture hall for 250 persons is included as well as extensive greenhouse and propagation facilities.

INTRODUCTION

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" The great need in America today is plant materials which are adapted to the climate of a new country and geared to the temper of a new people. Americans have, for several centuries, been busy in the conquest of a continent, but have now arrived at the stage where they are ready to settle down to real living, with their roots deep in the soil of their new civilization. "

This is an opinion expressed by Dr. Harold Bradford Tukey in an article by him entitled " If I Had Ten Million Dollars " appearing in the December 1955 issue of " Horticulture " magazine. This article is reproduced in its entirety in the appendix.

Dr. Tukey is Head of the Department of Horticulture at Michigan State University. He feels that as a nation becomes less involved in expansion, as populations increase and come to enjoy more settled living, gardening is increasingly important as a creative outlet and a stabilizing force in the society. The expression of man's deep desire to deal with plants and with the soil forms the roots of his security.

Americans have not realized full enjoyment from ornamental plants partly because they have been too busy to take time for such pleasures, but mostly because of a climate of

extremes, which is hard on the material they try to grow. Many of the plants familiar to gardeners have been bred and developed for centuries in the more equable climate of Europe, or have come from other corners of the world with different climates. America has depended too much on species of plants from the great gardening civilizations in the Orient and in Europe which were largely developed and adapted to suit local needs and often do not succeed when subjected to conditions and climate of the New World. In many cases, only when the foreign species are blended with native American sorts is a plant established which will suit the need.

It is Dr. Tukey's hope that an interested benefactor may some day provide funds for the establishment of an institute for the purpose of making a concentrated, systematic effort to develop plants for American gardens, climate and local needs. Much has been done already in this line, but the successes serve mostly to show the possibilities rather than to satisfy the need. It calls for an endowed institution with a long-term program in breeding and selection of locally adapted flowers and ornamental plants. It is toward this end that Dr. Tukey unfolds his ideas for the organization of such an institution.

The program thus outlined by him, coupled with my own interest in horticulture inspired me to undertake this project for my thesis and investigate the problem from an architectural standpoint. Through correspondence with Dr. Tukey, in which he was most co-operative, interested, and helpful;

with Dr. Watson also of the Department of Horticulture at Michigan State University; and consultation with Mr. Seth Kelsey of Kelsey-Highlands Nursery in Massachusetts, the program for a center for research and development in horticulture was evolved. While work of a similar nature has been carried on by other interests, an institution so set-up is apparently unique, giving an experimental character to the project.

PROGRAM

PROGRAM

The functions of the proposed horticultural center can be most readily made understandable when set up in three divisions; one in which the scientific work is done for the origination of plants; a second, where these plants are tested; a third to serve demonstration purposes for the new material. Let us consider first division one.

Division 1 - BUILDINGS

In this category fall all the buildings and structures to be erected in connection with the work on plants.

The first function to be considered is that of administration. Foremost administratively is the director of the institute. He will have a private office and be aided by a small clerical staff in a central office. There will also be an assistant director having an office of his own. A conference room of fair size should be provided where they can consult with advisory committees representing local groups and special plant societies.

Working with these men will be trained horticulturists skilled in plant breeding and the use of the scientific methods and equipment of the modern plant breeder and plantsman. These men should each have office space in close connection with a laboratory space which he would use to perform experiments and keep equipment pertaining to his specialized work. Two or more horticulturists doing work in the

same field might share office and laboratory space. There should be such office-laboratory combinations to accommodate six horticulturists. They will all share a general laboratory containing facilities common to most scientific work in plant breeding.

In connection with laboratory work there should be several spaces provided for work on a larger scale or of longer duration and requiring a more permanent set-up. These are best termed "experimental rooms." Also there must be a small refrigerated space for cold-storage of plants and seeds.

Lounge and toilet facilities should, of course, be provided for the entire staff.

The project is to contain a library and herbarium. In view of the location near an already extensive garden library and herbarium (this is explained more fully in discussion of the site), the library requirement was reduced to include only a small collection of valuable material and a reading area. The herbarium is to concentrate on classes of plants not included in the one nearby.

There is to be a lecture hall with a capacity of 250 persons to serve an outlet to the public and various societies of information in connection with the work at the institute and for related activities. It might be well to have the hall so arranged as to be open to the public without throwing open other facilities.

On the negative side of the program, it is not necessary to include exhibition space within the buildings. At

first thought it might seem that such a project should include considerable exhibition space. However it becomes apparent on reviewing the function of the institute to develop ornamental plants for local outdoor use, that most of the material will be on display out-of-doors in its season and according to its intended use. (See division 3) Should plants be grown out of season they could as well be viewed in the greenhouse where they grow as in an exhibition space, for they will be out of context in either case.

Some parking should be provided for the staff and guests. However it is not thought necessary to provide a full compliment of parking facility for the lecture hall. When a full hall creates a peak load, space could more than likely be borrowed from service roads on the lot, and is always available on the public road (See discussion of the site). In any case a rigid layout of space to serve such a peak is unnecessary, but care should be taken to assure that sufficient space could be made available for such occasions.

A very important function to the project is that of the greenhouse. The purpose of a greenhouse is to enable artificial adjustment of temperature and humidity to suit the growing requirements of plants under cultivation. It is necessary to divide the greenhouse area into four parts in order that four different conditions of temperature and humidity may be maintained. Easy access to the greenhouse from the laboratory functions is desirable. (A discussion

on greenhouses in some length is to be found in a later section).

Accompanying the greenhouse there must be a "headhouse" which contains a work area to service the greenhouse and a place for storage of tools and related equipment. In conjunction with the headhouse there is to be a receiving area for unpacking and packing plants in various materials for shipment over a wide area. Some space should be allowed in the greenhouse function which excludes light, for additional temperature, humidity, and light control experiments. Considerable storage space should be allowed including further cold storage. A locker and shower space should be provided for workmen.

Propagation facilities are to consist of two small pit houses 50' x 12' and 100' - 200' of hotbeds and cold frames. A location near the greenhouse would be convenient.

A lath house for the purpose of providing temporary partial shade for plants outdoors is included with underground and overhead irrigation and is recommended to be made of rot resistant wood, such as cypress, using concrete at points of contact with the ground.

Six small insect and disease houses to be used in testing resistance of plants to various insects and diseases are called for. Each must be completely screened and separated from the other, but they may be adjacent to one another. If there is possibility of a disease becoming air-borne it could be controlled by use of filters and sterilization

equipment in the ventilation system. Such precaution is not usually necessary.

A storage space for various mechanical equipment including several trucks, tractors, cultivators, pruning equipment and numerous other garden tools must be provided.

This concludes a brief description of the building requirements in connection with the administrative and scientific work. A summation and breakdown into approximate area allotments follows.

Division 1 - BUILDINGS

Many of the listed areas are necessarily approximate due to the experimental nature of the project as a whole.

Administration

Director's office	150 sq.ft.
Assistant director	150
Clerical office	300
Conference room	300
Office-lab combinations (6)	360 ea.
General laboratory	500
Experimental rooms (2)	300 ea.
Cold storage	150
Lounge area	500
Library & reading room	600
Herbarium	1200
Lecture hall for 250	

Greenhouse	
Greenhouse units (4)	3,750 ea.
Work area	1,200
Receiving area	600
Light control area	800
Cold storage	200
Locker and washroom	300
Propagation	
Pit houses (2)	600 ea.
Hot beds and cold frames	500-1000
Lath house	2000
Insect and disease houses (6)	400 ea.
Equipment storage	2,500-3000

Division 2 - TRIAL GROUNDS

Considerable ground area will be used for testing plant materials under conditions as nearly like those in which the plant is intended for use as possible and also for further development of new material. The extent of the various areas involved is largely indeterminate for it will depend on the work and experimentation in progress at specific times. A rigid layout of ground areas assigned to certain uses is therefore not possible. A large concentration of work in a particular field or encompassing years of testing would require an amount of land which cannot be predetermined at time of building and need only to be located in the vicinity of the project. However it is desirable to have several acres of land convenient to the greenhouse in which various areas could be adapted to special uses. Besides some general cultivated area, allotments might be made for the following purposes:

1. Plots for lawn grasses
2. Shade and flowering ornamental trees
3. Deciduous shrubs
4. Broad and narrow leaved evergreens
5. Perennial, biennial, and annual flowers
6. Vines and other ground cover materials
7. Areas of special soil type for:
    a. ericaceous and other acid soil plants
    b. alkali soil plants
    c. arid plants

d. aquatic and bog plants

e. alpine plants

It might be well to mention that these grounds are not intended to be designed as a park for leisure or entertainment but are primarily for research work.

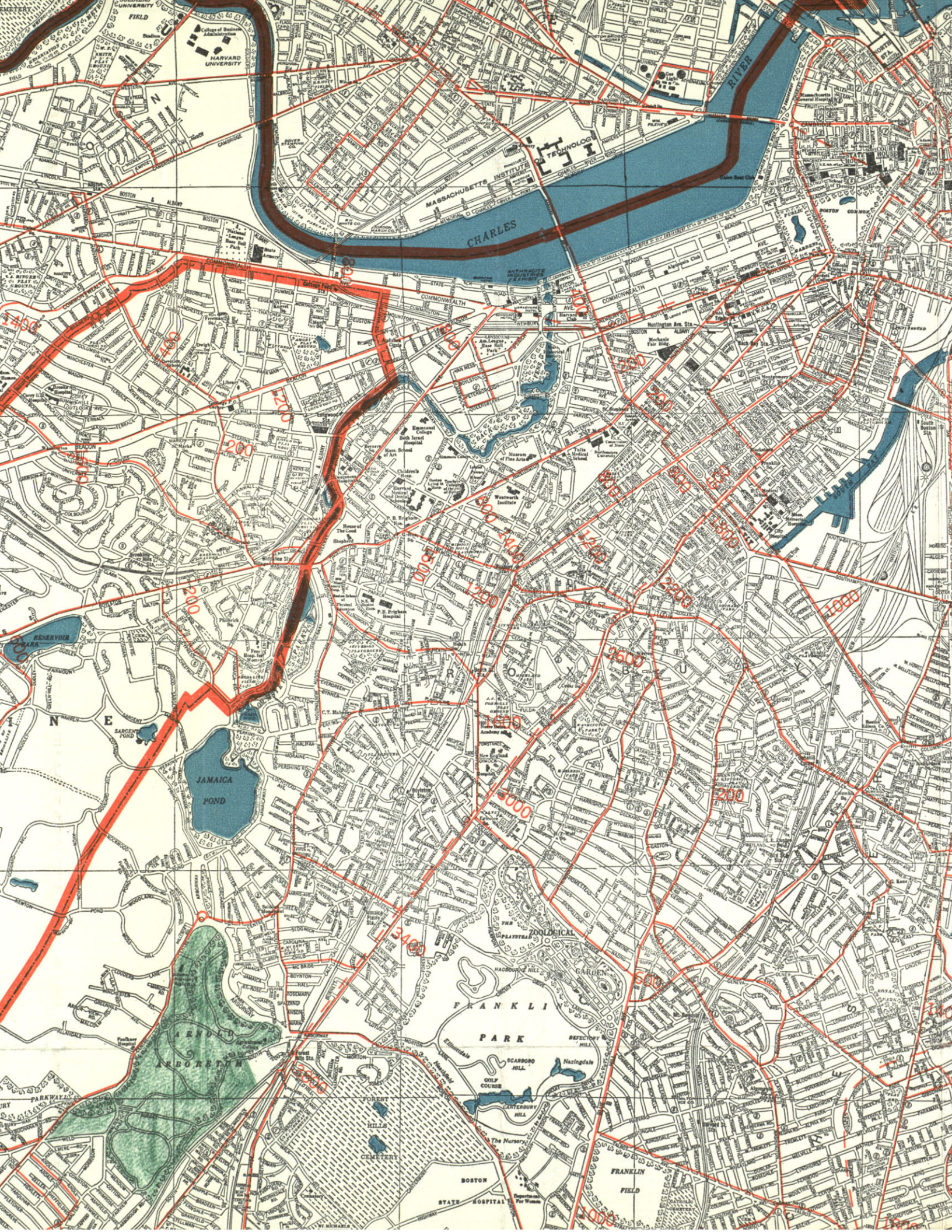
Division 3 - DEMONSTRATION AREA

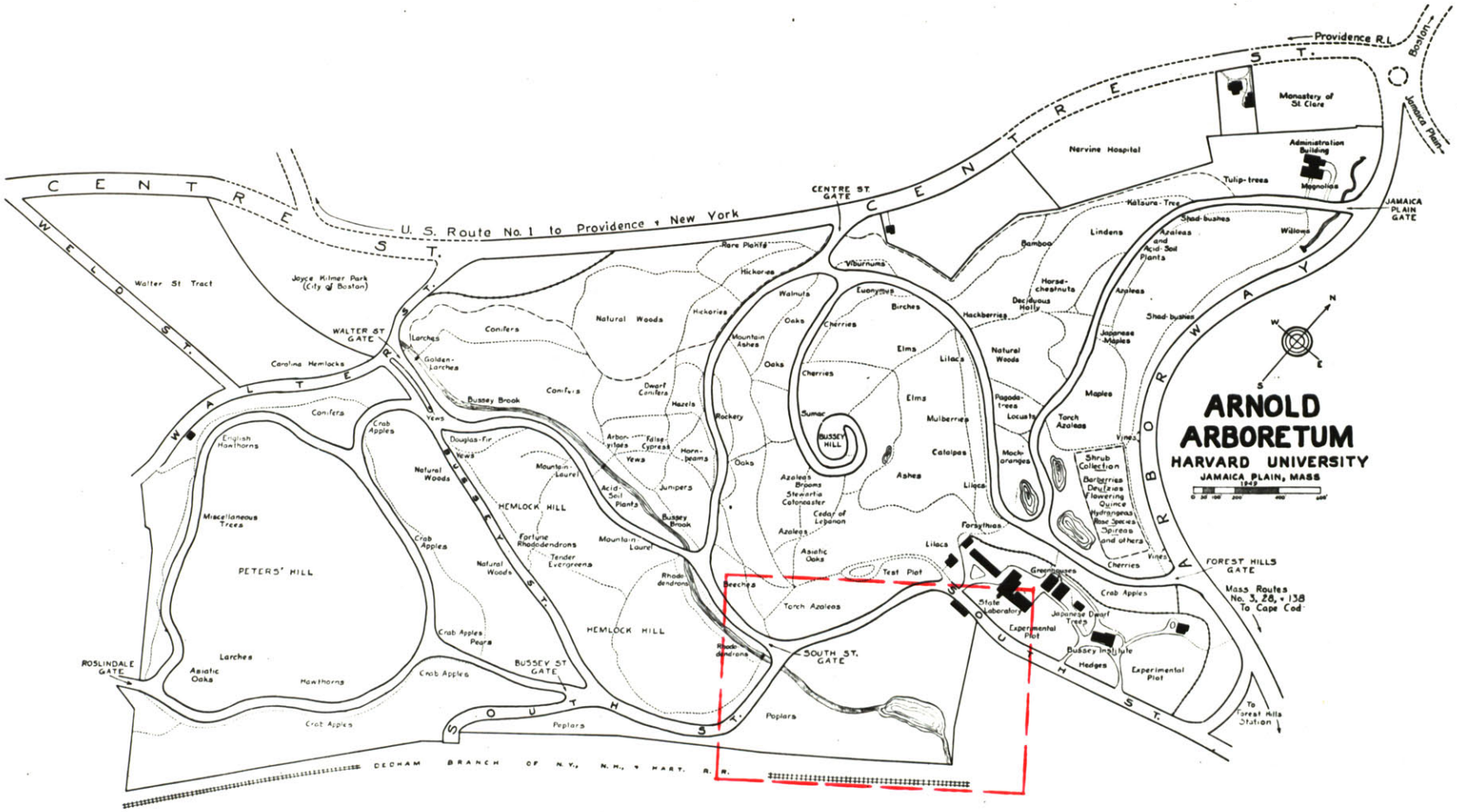
As a part of the institute there is to be a very extensive program for the demonstration of plant material originated there. The plants will be displayed in ways which illustrate the use for which they are intended. In other words they will actually be used in the situations for which they were developed and in this way be made known to the public.

This will require layout of a large area, which may involve buildings of various sorts, since much of the material will be used in connection with structures. The development of an overall plan for this purpose is beyond the scope of this thesis but some provision is made for its fulfillment, as will be explained in more detail in the discussion of the site.

The demonstration area is the only part of the project intended to be wholly open to the public.

S I T E


HARVARD UNIVERSITY
CHARLES RIVER
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
JAMAICA POND
SARGENT POND
RESERVOIR PARK
ARNOLD ARBORETUM
FRANKLIN PARK
ZOOLOGICAL GARDEN
FRANKLIN FIELD
CEMETERY
BOSTON STATE HOSPITAL
COMMONWEALTH AVE
BEACON
BOYLSTON
HUNTINGTON AVE
SOUTH BOSTON
CAMBRIDGE


ARNOLD ARBORETUM
HARVARD UNIVERSITY
JAMAICA PLAIN, MASS
CENTRE ST.
WALTER ST.
WELD ST.
SOUTH ST.
U. S. Route No. 1 to Providence + New York
Providence R.I.
Boston
Jamaica Plain
CENTRE ST. GATE
WALTER ST GATE
ROSLINDALE GATE
BUSSEY ST GATE
SOUTH ST. GATE
JAMAICA PLAIN GATE
FOREST HILLS GATE
Mass Routes No. 3, 28, + 138 To Cape Cod
To Forest Hills Station
DEDHAM BRANCH OF N.Y., N.H. + HART. R.R.
Monastery of St Clare
Nervine Hospital
Administration Building
Magnolias
Tulip-trees
Katsura-Tree
Shad-bushes
Willows
Lindens
Bamboo
Azaleas and Acid-Soil Plants
Horse-chestnuts
Deciduous Holly
Hackberries
Japanese Maples
Natural Woods
Pagoda-trees
Locusts
Torch Azaleas
Maples
Vines
Shrub Collection
Barberries
Deutzias
Flowering Quince
Hydrangeas
Rose Species
Spireas
and others
Cherries
Mock-oranges
Lilacs
Forsythias
Greenhouses
Crab Apples
State Laboratory
Experimental Plot
Japanese Dwarf Trees
Bussey Institute
Hedges
Test Plot
Torch Azaleas
Beeches
Rhododendrons
Asiatic Oaks
Azaleas
Cedar of Lebanon
Stewartia
Catonoaster
Brooms
Azaleas
Ashes
Catalpas
Mulberries
Elms
Sumac
BUSSEY HILL
Rockery
Oaks
Junipers
Acid-Soil Plants
Bussey Brook
Mountain-Laurel
Fortune Rhododendrons
Tender Evergreens
HEMLOCK HILL
Natural Woods
Arbor-vitaes
False Cypress
Yews
Horn-beams
Hazels
Dwarf Conifers
Conifers
Bussey Brook
Douglas-Fir
Yews
Crab Apples
Conifers
English Hawthorns
Miscellaneous Trees
PETERS' HILL
Crab Apples
Natural Woods
Crab Apples
Pears
Larches
Asiatic Oaks
Hawthorns
Crab Apples
Crab Apples
Poplars
Poplars
Rhododendrons
Mountain Ashes
Walnuts
Oaks
Cherries
Elms
Lilacs
Oaks
Cherries
Birches
Euonymus
Viburnums
Rare Plants
Hickories
Natural Woods
Conifers
Golden-Larches
Larches
Carolina Hemlocks
Walter St Tract
Joyce Kilmer Park (City of Boston)

LOOKING UP SOUTH STREET

VIEW FROM GATEWAY TO ARBORETUM

VIEW FROM SOUTH ST. OPPOSITE GATE

LOOKING TOWARD GATEWAY TO ARBORETUM

LOOKING SOUTH FROM POSITION 100'
INSIDE SITE OPPOSITE SOUTH ST. GATE

LOOKING SOUTHEAST FROM POSITION 100'
INSIDE SITE OPPOSITE SOUTH ST. GATE

THE SITE

The location of this horticultural center might be anywhere in the United States. Its purpose is to develop plants to fill local needs, and benefit would be gained from its services in whatever corner of the country it is situated. The only criterion is that it be located near one of the great centers of population, where the plants which are developed would be adapted and useful to millions of people in the immediate vicinity. New England could benefit greatly from such an institute, and a site in the vicinity of Boston, Massachusetts would be ideal.

The combination of horticulture and Boston immediately brings to mind the Arnold Arboretum located in that city, which has gained world fame for its plant collections and contributions to horticulture under the direction of Harvard University. Its work was cited by Dr. Tukey as a good example of what has already been done to advance horticulture in this country. If the facilities of the proposed institution could be so located as to supplement the work of the Arboretum, the combination would produce an outstanding horticultural center unmatched anywhere in the country.

With this in view, a search was made of the land in the vicinity of the Arboretum to determine if a suitable site for the project was available. A lot of about fifteen acres on the southeast side was selected which seems very well suited to the purpose. The land was acquired by the Arbor-

etum some years ago, but has never been developed. It lies on the opposite side of a small public road named South St. from the main body of the Arboretum, at the South St. Gate entrance. It is set apart from the Arboretum by this road which forms its northern and western boundary.

Access to the lot is via South St. which connects with the Arborway a few hundred yards to the east almost at the Forest Hills rapid transit station on Washington St. The Arborway and Washington St. both lead directly into Boston. No vehicles are allowed in the Arboretum except by special permit so no traffic flows through the South St. Gate.

The site is bounded on the southeast by the Dedham Branch of the New York, New Haven, and Hartford Railroad. This is a single track commuter line with heaviest traffic in the mornings and evenings and light service during the day. The lot is terminated on the east by an extremely steep rise of the land.

The site sports a small stream which flows in under South St. at the South St. Gate and empties into a small seasonal pond which in turn drains through a culvert under the railroad track. Where it enters, the stream flows swiftly and picturesquely over the rocks, but fans out to an indefinite pattern as it nears the pond. The pond itself has an indefinite border subject to seasonal variation. The greater part of the land is nearly level, but rises sharply along the north and northwest sides. There is a small rectangular,

two story, Colonial brick building at South St. on the north which is on ground high above the main body of the site but which is scarcely seen from below because of the trees which abound on the hillside. Owing to the steepness of the slope the lot is effectively terminated, however, before the building is reached. The hilly region along South St. is covered with growth and a few trees are spotted randomly throughout the rest of the site, but all are small and no really big trees can be found on the lot.

The wide variance in the terrain makes it excellent for the proposed trial grounds. There is flat land available for cultivation and those test plots requiring level ground; there are steep rocky slopes for those plants requiring alpine conditions; there is a gentle, sandy rise in ground to the east which is excellent for plants requiring good drainage; and lastly there is the pond for aquatic plants and its indefinite bank made to order for bog plants. It would be extremely difficult to find a lot which encompassed more of the desired variation in conditions in such a close relationship with one another.

THE EFFECT OF LOCATION OF THE SITE ON THE PROGRAM

The Arnold Arboretum maintains a complete garden library in the Administration Building located at the Jamaica Plain Gate. Its proximity to site of the project makes duplication of the facility unnecessary. Therefore the proposed library will consist only of a small collection necessary to the scientific work and of special interest to members of the institute. The maintenance of a complete and extensive library will be left to Harvard University and the Arboretum. From time to time the institute will undoubtedly put forth literary work to contribute to that and other libraries as well as to its own.

The Administration Building of the Arboretum also contains an extensive if not complete herbarium. The proposed herbarium will serve to supplement the other concentrating on classes of plants not included in their files.

The group of buildings on the opposite side of South St. to the north of the site are used as biological laboratories by the State with exception of two greenhouses which the Arboretum maintains.

It would seem that the Arboretum might be an excellent place for the demonstration of at least some and probably many of the plants originated by the institute. For years its function has been to display plants and their uses and it could continue to serve this function with the new ma-

terial. Both the Arboretum and the institute stand to gain much by close co-operation in this matter of demonstration of the newly developed plants as well as in the scientific and literary fields. It is with this thought in mind that the demonstration division of the program is laid aside for the purposes of this thesis.

S O L U T I O N

THE SOLUTION

Primarily the buildings of the horticultural center constitute a place in which to do work. But it must also be considered as having an institutional character. For this reason a solution was sought which would provide a central building of some distinction, but without any great formality or monumentality. Into this structure would go the administrative functions, the library and herbarium, and the main laboratory spaces. There was strong feeling that the whole project would maintain unity if these functions were tied together in close relation to one another.

To accomplish these ends a roof system was devised which would bespeak this unity of purpose and at the same time provide gayety and interest. This roof system becomes the focal point of the entire design. Though fanciful in aspect, it serves the function of admitting luxurious amounts of daylight to interior spaces allowing compact planning. Care is taken in the layout of functions under the roof not to destroy its unity or violate its organization by allowing interior partitions to intersect it in peculiar positions.

The end of the building accessible by the main entrance is devoted to the library and herbarium. Adjacent to this area are the administrative offices. The other half of the building consists of the laboratory functions. Continuous flow of space under a single roof system was an objective, however a feeling of separation between the different func-

tions at either end of the building was sought by the arrangement of partitions. A certain continuity of the whole is preserved by the repetitious nature of the forms. Full height partitions are used only where sound insulation is necessary.

The form of the lecture hall is derived from the modular pattern of the main building. The area is a multiple of the units in that structure, and the roof preserves the same slope. This shape has inherently good properties for speech reinforcement when properly used. Only minor adjustments and addition of some absorption are necessary to provide good hearing conditions.

The lecture hall is arranged so that it may be opened to the public without opening the rest of the institute.

The roof of both structures is to be made of reinforced concrete. In the main building the weight of the slab is carried to edge beams and thence transferred to columns poured integrally with the whole and terminating in footings. Each section of the roof is supported on four columns, one in each corner, the upper sections having columns in common with the lower. The upper weather surface of the concrete will be given an acrylic plastic coating incorporating a white aggregate.

The floors in these two buildings will be concrete slab on grade. The outside walls are to be framed with wood studs and faced with vertical board and batten employing 10" boards with 2" battens. This will articulate the siding and give it scale.

The large clerestory windows are protected somewhat from direct sunlight by a wide overhang of the roof, but further control is to be provided by vertical louvres inside the glass operating much on the principle of a Venetian blind on its side.

The preceeding discussion was intended to briefly point out some of the more important considerations in the design of the main buildings. It was in these structures that the greatest freedom of expression was sought. The remaining structures are laid out on a more purely functional basis.

ABOUT GREENHOUSES

Not content with any preconceived notion of how a greenhouse should look or be constructed I set about to learn in what ways its requirements might be fulfilled.

The purpose of a greenhouse is simply this: to provide artificial control of temperature and humidity in such a way as to promote optimum growing conditions for plants.

Material

The insulating material used to create artificial conditions must be able to transmit light from the sun. Sometimes it is desirable to diminish the intensity of the sun's rays in which case a translucent material may be used. However it is often important that as little reduction in light intensity as possible be obtained for proper growing conditions. It is an easy matter to reduce light transmission by applying some other material over a highly transparent one. It is not so easy to make a translucent material transparent and therefore it follows that a greenhouse should be made of material with a high degree of transparency.

Some plastic films are highly transparent, but they are not permanent enough to be practical. The only plastic which can compete with glass in both durability and transparency is the acrylic. Unless formability is desirable the only advantage it has over glass is its light weight. Its heat transfer for comparable thickness does not differ greatly from that of glass and it is more expensive and more subject

to surface scratching. So the most practicle material to use for a greenhouse seems to be glass.

Temperature control

Artificial temperature control is obtained in winter by heating the greenhouse by any one of several conventional methods: the piping of hot water, steam, or flue gases through the house or by electric coils imbedded in the soil. During the day the heating system is greatly aided by the sun.

It is never necessary to lower the humidity, but it can be easily raised by turning on fine mist sprays.

It is much more difficult to cool a greenhouse in warm weather. Huge quantities of solar energy pour in through the glass and convert to heat. To lower the temperature by a refrigeration process would require equipment of great capacity. It is not practicle at present to cool greenhouses in this way, but sometimes such provision can be made in a small space for experimental work.

This means that ventilation is of great importance. As long as the greenhouse remains closed, solar energy continues to pour in raising the temperature. If adequate ventilation is provided it can at least be held to nearly the temperature of the outside air.

The greenhouse can be covered with a material which will block some of the energy from the sun and thus reduce temperature rise, but the subdued light may be sometimes undesirable for the plants.

An inexpensive way to cool a stream of air is by al-

lowing it to pass through a mist of water, the evaporation process serving to draw out the heat. Very often this method is used to cool the incoming air in greenhouses. It is the only practicle way of cooling a large quantity of changing air. It also serves to increase the humidity, and high humidity is usually desirable.

The number of degrees the air can be cooled by this method is, however, sharply dependent on the relative humidity of the air to be cooled. Air at a relative humidity of 100 per cent regardless of its temperature, cannot be cooled at all by this method. The following chart shows how much cooling by evaporation is dependent on relative humidity:*

per cent humidity	degrees cooler by evaporation at 110 F.	100F.	90 F.	80 F.
100	0	0	0	0
90	3	3	3	2
80	7	6	5	5
70	11	9	8	7
60	15	13	11	10
50	19	17	15	13
40	24	21	19	16
30	29	26	23	20
20	35	31	27	23
10	40	35	31	27

Evaporation of moisture outside the greenhouse does not directly effect the temperature of the air inside nor block entrance of solar energy and therefore provides no benefit.

Form of the greenhouse

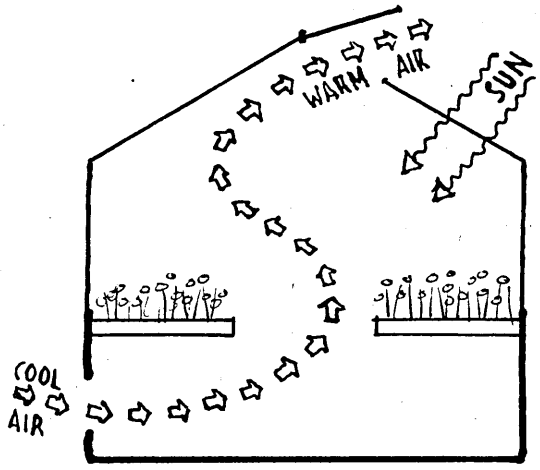
In view of the importance of ventilation it would seem almost mandatory to have an outlet for warm air at the top

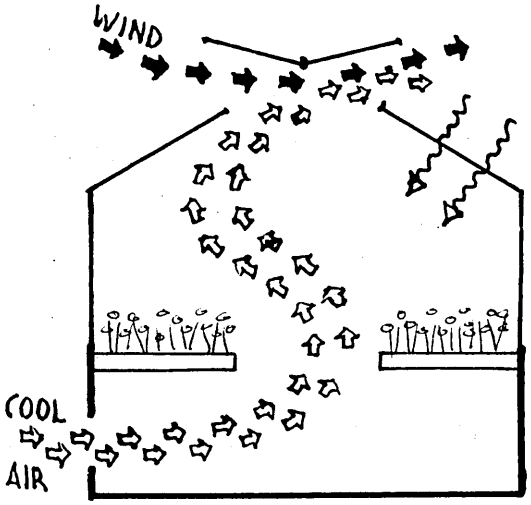
* "Sunset Ideas for Building Plant Shelters"

SCHEMATIC DIAGRAMS OF .

VENTILATION IN GREENHOUSES

Circulation of air

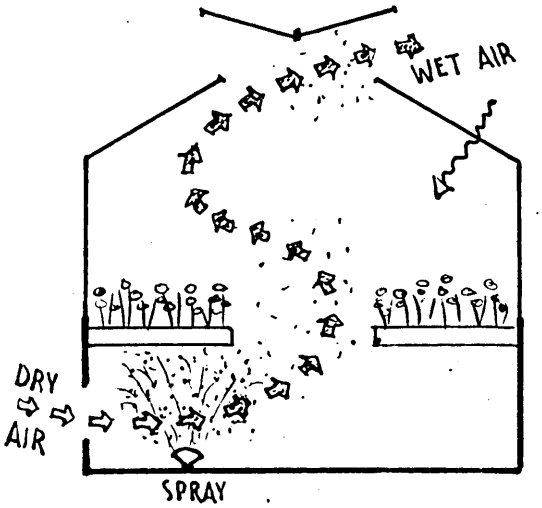




Taking advantage of wind

Evaporative cooling

using spray



of the greenhouse and an inlet for cool air near the bottom. Further in order to assure as little accumulation as possible of dirt and debris on the surface of the glass, it is better that it have a sloping surface. This suggests a number of shapes: domes, vaults, and various pitched roofs.

In this project four units are required for four different control conditions. Domes do not lend themselves to division and are inconvenient to service upon multiplication. Vaults have no advantage over pitched roofs. Probably the most pleasing shape, and the one which would be most in accord with the design of the other buildings, is that of a long rectangular greenhouse with low straight sides and a simple pitched roof. This is the form which was selected and curiously enough is the form which has evolved for most greenhouses over many decades.

The size can be large or small and units can be placed adjacent to one another to form a "ridge and furrow" greenhouse. Because of the requirement for four different temperatures it is necessary to have four separately enclosed units. It was my feeling that they might as well be separated a short distance from one another to take advantage of the opportunity for cool air intakes near the ground. To keep the scale and height of the units down, I planned to have dual units for each of the four temperatures. It would be possible to obtain good air circulation and cooling by alternating the intakes from one side to the other.

Because of high humidities coupled with high tempera-

tures in this part of the country, evaporative cooling is not always effective and the experimental nature of these greenhouses may call for installation of refrigeration in one of the units.

APPENDIX

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IF I HAD TEN MILLION DOLLARS

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If I had 10 million dollars I would establish the "Harold Bradford Tukey Institute" for the development of ornamental plants through plant breeding. Since I do not have the 10 million dollars, I can only tell my story in the hope that it may reach someone who may be able to establish such an institute in his own name. This I do with firm belief that such a benefactor and such an institute would make a great contribution to society - much greater over a period of years than many larger sums now being spent for other purposes.

The great need in America today is plant materials which are adapted to the climate of a new country and geared to the temper of a new people. Americans have, for several centuries, been busy in the conquest of a continent, but have now arrived at the stage where they are ready to settle down to real living, with their roots deep in the soil of their new civilization.

Evidence of this trend is the 20 million Victory gardens of World War II, the 50-million-dollar small garden tractor sales of a year ago, the billion-and-a-half dollar horticultural specialties (flowers, bulbs, nursery stock and greenhouse crops) of the last census and the fact that gardening in one form or another is by all odds the principal avocation of Americans. As a country gets older, as populations increase, as the need for privacy and a creative outlet grows,

so people down through the ages have turned to plants and gardening.

This desire to deal with plants and with the soil is deeply instilled in the human race. Plants anchor society. Better than standing armies and organized work programs is the outlet that comes from plants and the garden. Gardening is the safety valve of society. One can garden as extensively and as expensively as he desires. He can also garden as intensively and as inexpensively as he desires. He can make his activity strenuous or subdued. He can garden out-of-doors on large acres, indoors in a window box, in a basement with artificial light or in a delightful, small greenhouse. The opportunities are limited only by imagination, not by budget, energy or time.

Americans have never been privileged to enjoy plants with the same freedom and ease that Europeans have experienced. This comes about not alone because Americans have been too busy to take time for such pleasures, but because they do not have the extra hands of helpers. It comes about mostly because of a climate of extremes, which is hard on plants, and because many of the plants which Americans try to grow have been bred and developed for centuries in the more equable climate of Europe. Or they have come from other corners of the world with different climates.

From Old World gardens have come pansies, bellflowers, English daises, primroses, roses, foxglove, stock, wallflower, sweet scabiosa, crocus, snowdrop, hyacinth, grape hyacinth,

star-of-Bethlehem, oleander, snapdragon, candytuft and tulips. Africa has given us geraniums and gladiolus. Oriental contributions include lotus, hibiscus, regal lily, peony, abelia, weigela, camellia, hollyhock, China aster, chrysanthemum, clematis and forsythia. Fuchsia, petunia, verbena, morning glory, nasturtium and canna came from South America and cosmos, zinnia and marigold from Mexico.

It is natural that America should depend upon foreign species and varieties of flowers and ornamental plants. The great gardening civilizations have been in the Orient and in Europe, where countless centuries of natural breeding and man-made selections have given us most of our garden plants. Further, really good plant adaptation is rather local. Each European center has developed varieties especially suited to its needs.

The fruit industry of America gives a good example of the need for varieties adapted to American conditions and how this need has been met by the fruit industry. Thus, America had no native peach, pear, plum, grape, cherry, apple or small fruits worthy of the name. So, the best varieties of Europe were imported for planting by early settlers. There seemed no reason why these varieties would not be at home and establish flourishing new enterprises. Most of them, however, failed in the new climate, surrounded as they were by new pests to which they not infrequently succumbed. Only when the European red raspberry was hybridized with the native sorts, was the American red raspberry put on a firm foundation.

This, therefore, is our problem: to make a concentrated, systematic effort to develop plants for American gardens, climate and local needs. Anyone who has been delighted with tulips, which are in bloom for three to four weeks in moderate spring temperatures of Europe, and has seen his own carefully nurtured tulips open on a Saturday afternoon and drop their flowers Sunday afternoon in a short, hot American spring, knows exactly what is meant. Anyone will also understand who has seen his stately tree roses killed by winter cold or his proud perennial border wilt and burn in midsummer heat of over a hundred degrees.

Add to this an impatient national temperament that is interested only in what succeeds, and the combination is one of frustration and disappointment for many amateur gardeners. That gardening is the great avocation of America is more an indication of desires and perseverance than of satisfaction which one rightfully deserves from his efforts.

The question is naturally asked whether we have not already done something of this kind, and the answer is that we have done much. The plant importations by the Arnold Arboretum, the U. S. Department of Agriculture, David Fairchild, Charles Sprague Sargent, Ernest Wilson and many others have been blessings. Further, the breeding of plants by amateurs, seed houses, nurserymen, botanic gardens and State and Federal research stations has added to all of this. These successes serve mostly to show the possibilities rather than to satisfy the need.

For example, great success has attended the breeding of hardy chrysanthemums, petunias, zinnias, marigolds, gladiolus, dahlias, azaleas, rhododendrons, lilies and roses. Just as great success awaits other genera and species. What of wall flowers, godetias, primroses and corn flower? What of woody ornamentals, dwarf evergreens, ground covers and climbing vines? The tax supported institutions are doing their share, though these groups and organizations are drastically affected by the economic level. They reach high levels of activity one decade and all but disappear the next.

The opportunity, of course, is here. It calls for the establishment of an endowed institution with a long-time program in breeding and selection of locally adapted flowers and ornamental plants. This institution should be located near one of the great centers of population, where the plants which are developed would be adapted and useful to millions of people in the immediate vicinty. The director of the institute should be an individual with a real love of plants, plus a natural desire to serve his fellow man. He should be able to talk the language of the average man. He should know plant materials - what is worthwhile and what is not - and should have an appreciation of world geography and sources of plant materials.

This director should furthermore surround himself with plant breeders, technicians and gardeners who first of all love plants, but who also use the scientific methods and equipment of the modern plant breeder and plantsman. He should

work at the job of finding out what his "customers" most desire in the way of plant materials and then work to satisfy those desires. To aid him should be advisory committees representing local groups and special plant societies.

The grounds need not be large, but they should be attractive and well kept. There should be carefully kept trial grounds, all properly labelled, and new night lighting would add both charm and usefulness. There should be sufficient greenhouse and propagation facilities, nursery storage, modest laboratories, a library, a lecture hall and meeting rooms.

Eventually there might be need for a popular garden library and an extension lecture and discussion program. Plant doctor clinics might be a natural outgrowth and the institute might become a garden center of great social significance in the community. Indeed, if I had 10 million dollars, it would be to establish the "Harold Bradford Tukey Institute" along the lines suggested, and I would rest happy in the realization of the great good that would come from my dream.