# SELECTION OF SUGAR MAPLES FOR HIGH SUGAR CONTENT IN SAP--DEVELOPMENT OF PROCEDURES

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This is a report on the procedures used in making phenotypic selections among sugar maples for high sap sugar, and a discussion of the philosophy underlying those procedures.

Geneticists working toward the improvement of an organism through breeding ordinarily choose as parental stocks the best phenotypes that are available for their purposes. In sugar maple, I am not sure what constitutes the best parental stock for breeding for high sap sugar, I do know that the sap of the average tree in Vermont and New York contains about 2.5 percent sugar, but whether I would settle for 12 percent trees as parental stock I don't know at this time, But I do feel that our present survey and selection techniques may lead us to an answer to this question,

The job of developing a suitable selection technique was started in 1962 and continued in 1963. The work in 1962 was done in sugar bushes in Chittenden and Bennington Counties in Vermont, Through the sponsorship of NEFTIC, selection crews operated in Maine, Vermont, New Hampshire, and New York during the 1963 sugaring season., using the same techniques as in 1962.

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By this time it was obvious that the field procedures should be modified. We were fortunate to receive constructive suggestions from several of the state cooperators. These suggestions were incorporated in the revised procedures described later.

Phenotypic expressions are the sum totals of the interaction between genotypes and environmental factors. Usually, certain characters are found to be under strong genetic control. Here environment plays only a small part in the differences between individuals. Conversely, with respect to characters that are under only loose genetic control, environmental factors exert considerable influence on the phenotype.

A basic premise in our program is one that is common to all selection work: selections are effective only when based on differences that are heritable. In as - much as we know little of the role that heredity plays in sap sugar production, our procedures must take account of environmental factors. Unfortunately, we are equally in the dark about the effects of the environmental factors on the characters for which we are selecting. Thus our selection technique must minimize the effect of environment with respect to the phenotypic differences observed.

The selection technique should also give the geneticist some idea of the range in variation of the character in which he is interested. For a widely distributed species, such as sugar maple, it would be beneficial to learn whether certain areas of the species' range show greater variation than others. If this were so, we should concentrate much of our selection work in those areas.

Summing up, our selection procedures must (1) minimize the influence of environmental factors and (2) provide a survey of the variability within stands and within areas.

## ORIGINAL PROCEDURE-- 1962-63

The first step in the procedure was to obtain a list of sugar producers from the State Extension Foresters and County Agents. The producers usually were contacted a day or two in advance of work on their land to make any necessary arrangements and to verify that, the trees had been tapped.

Originally the survey was divided into two parts: (1) a systematic sample of 10 trees to establish an average for a relatively narrow strip through the bush along one contour; and (2) a larger systematic sample of 100 trees taken to check the reliability of the preliminary 10-tree sample, and to serve as a basis for estimating between-tree variation within the bush.

Information obtained from the owner about the size and shape of his bush was used to determine (1) the starting point of the sample, (2) the direction the sampling line would follow, and (3) the approximate spacing to allow between trees to be tested.

Sap sugar in each tree was determined by a refractometer. Results were recorded on two special forms: one for documenting any individual trees that gave sugar readings appreciably higher or lower than average, and the second for recording the general survey data. As a tentative selection criterion, all trees in the 100-tree sample that were found to be at least 50 percent above or below the 10-tree average were marked for future reference,. In 1962 we located 35 trees that met this criterion.

During the 1963 sugaring season, it soon became apparent that our initial methodology did not satisfactorily meet our requirements. Several faults showed up: (1) environmental effects were not minimized, and consequently the 35 trees from the previous year did not stand up very well under screening; (2) potential selection candidates were being passed up because they occurred in local areas of the sample where the sugar concentrations were considerably below the calculated overall average; and (3) we had no way of compensating for changes in density, size, or age classes of trees as they occurred in the course of taking the 100-tree samples.

## REVISED PROCEDURE-- 1963

The new tachnique that was developed, which we call progressive sampling, changes the old procedures in these respects: the 10-tree sample, the predetermined average, and the old selection criterion of a minimum of 50 percent above or below average were abandoned. Instead, only one sample--preferably of 100 trees--is run. However, the size of this sample now is flexible; it may be as few as 50 trees or as many as 150 trees.

In progressive sampling, the fieldman begins with no preconceived or rigid sap-sugar level that a tree must meet in order to be selected. As in the original method, he starts sampling along a predetermined cruise line that follows a contour, As he progresses with the sample, he notes any trees that show substantially higher sugar than others along the line. Should he encounter such a tree, he then takes sugar readings from other immediately adjacent trees, which are used as standards for comparison. Four or five standard trees that are relatively uniform in size and shape are sufficient for determining an average (figure 1).

In order to be considered for selection, a tree must exceed the sweetest of the standards by a minimum of 0.5 percent sap sugar and be at least 30 percent above the average of the standards.

Each unusually sweet tree and its surrounding standards are marked for reidentification with colored plastic engineering tape and plastic tags, and the group is treated as a unite All trees in a unit are tested for sap sugar within the same hour to minimize the variations associated with time of day.

The selected trees and standards are tested twice more during the current sugaring season at spaced intervals, and twice in the following season. The last reading will be made in conjunction with a final screening. At that time the effects of such environmental factors as soil and topography will be assessed. Details on the final screening have not been completed to date, mainly because we know so little about the influence of the environmental factors on sugar production.

However, the ability of the selected tree to consistently maintain its superior position, relative to its standards, will be of prime importance in determining whether it makes our catalogue of superior trees.

Samples of our revised forms for recording data for sweet trees and their standards (form #1) and for the 100-tree samples (form #2) are shown in figure 2.

Figure 1.--The superior sugar producing phenotype in the rear-center is 70% sweeter than the nearest 4 trees adjacent to it.

Tree Number *

Do not write in this space

#1

INDIVIDUAL TREE RECORD FORM

SUGAR MAPLES SELECTED FOR HIGH SUGAR CONCENTRATION

Name of Owner: _____
Last Name Initial First Name

Address: _____

_____

Location of tree if different from owner's address _____

_____

SELECTED TREE VS STANDARDS

| Date of Test | Percent Sugar: Selected Tree | Standards 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Sugar Tests Made By:

☐ Refractometer ☐ Hydrometer

By_____ Title_____

* If more than one tree is selected in the same bush, use a separate form 1 for each tree but number them consecutively.

8-63

Sugar Bush Number

#2

Do not write in this space

SURVEY RECORD FORM

☐ SUGAR BUSH ☐ ROADSIDE OR FENCELINE TREES

Name of Owner: _____
Last Name Initial First Name

Address: _____

_____

Location of Bush if different from owner's address: _____

_____

100-Tree Sample

| Tree No. | % | Tree No. | % | Tree No. | % | Tree No. | % | Tree No. | % |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | 21. | | 41. | | 61. | | 81. | |
| 2. | | 22. | | 42. | | 62. | | 82. | |
| 3. | | 23. | | 43. | | 63. | | 83. | |
| 4. | | 24. | | 44. | | 64. | | 84. | |
| 5. | | 25. | | 45. | | 65. | | 85. | |
| 6. | | 26. | | 46. | | 66. | | 86. | |
| 7. | | 27. | | 47. | | 67. | | 87. | |
| 8. | | 28. | | 48. | | 68. | | 88. | |
| 9. | | 29. | | 49. | | 69. | | 89. | |
| 10. | | 30. | | 50. | | 70. | | 90. | |
| 11. | | 31. | | 51. | | 71. | | 91. | |
| 12. | | 32. | | 52. | | 72. | | 92. | |
| 13. | | 33. | | 53. | | 73. | | 93. | |
| 14. | | 34. | | 54. | | 74. | | 94. | |
| 15. | | 35. | | 55. | | 75. | | 95. | |
| 16. | | 36. | | 56. | | 76. | | 96. | |
| 17. | | 37. | | 57. | | 77. | | 97. | |
| 18. | | 38. | | 58. | | 78. | | 98. | |
| 19. | | 39. | | 59. | | 79. | | 99. | |
| 20. | | 40. | | 60. | | 80. | | 100. | |

Date: _____ Time Started: _____ Time Completed: _____

Sugar Tests Made By: ☐ Refractometer ☐ Hydrometer

By_____ Title _____

Remarks:

Figure 2.--Forms for recording data for sweet trees and their standards (#1) and for the 100-tree samples (#2).