Bulletin No. 200 - Maintaining Potato Yields by Hill Selection

George Stewart

D. C. Tingey

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Maintaining Potato Yields
By Hill Selection

GEORGE STEWART and D. C. TINGEY

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*On leave.
Utah's agriculture has passed definitely out of its pioneer period. Single-cropping, whether to wheat, to potatoes, or to sugar-beets, during the past few years has been forced from its last stronghold. The earmarks of mature agriculture are already visible. Of these, there are four important ones: (1) the production of both crops and livestock; (2) careful manuring and irrigation; (3) good crop rotations; and (4) the use of high-grade parental stock, that is, prepotent sires for livestock and strong and healthy seed for crops.

Among our crops, potatoes present perhaps the most serious of all seed problems. The general ravages of mosaic and other diseases of degeneration have not only reduced yields to an extent hitherto undreamed of, but have also led many growers to conclude that the attempt at maintaining seed stocks is hopeless. This, however, is shown to be far from true by the experiment herein reported. On the Central Experiment Station Farm** the yield of hill-selected Rural seed stocks of potatoes has been maintained for eleven years at a standard fully double the state's average.

It is to be understood that the success of this experiment exemplifies a method of field practice rather than proclaims a strain of seed-stock potatoes.

**REVIEW OF LITERATURE**

As early as 1895 Wollny (17) reports an experiment wherein he tested whether it were possible to improve potatoes by select-

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*Approved for publication by Director, 19 April 1927.

**Located at North Logan (Greenville), two miles north of the campus.
ing for high and low specific gravity. There was no effect on yield. He concluded that it was more promising "to improve varieties by developing their individual qualities."

Von Seelhorst (8) found in 1898 and 1899 that he could improve yields by selecting large plants. Some of his seed had been selected from as early as 1892.

Eustace (3) dug 500 hills of potatoes more or less at random. He planted the highest-yielding 125 hills in a test against the lowest-yielding 125 hills and found the yields to be 362 bushels and 339 bushels, respectively. He thought continuous selection would make the gain materially greater.

Greene and Maney (5) of the Iowa Station selected those hills which had an average number of well-formed, medium-sized tubers. The best and the poorest hills, tested for only one year, showed a difference of 50 bushels in favor of the high-yielding hills.

Goff (4) of the Wisconsin Station reports a gain of 180 per cent when the yield of the most productive hills was compared with the yield from the least productive.

Dean (1) of New York State reported in 1913 that he had made considerable gain by hill selection. Since 1904 he has selected by weight high-yielding and low-yielding hills. Potatoes planted from the high-yielding hills produced 350 bushels an acre as opposed to 70 bushels from the low-yielding hills. He also reports small tubers unprofitable for seed.

A report (9) from the Crookston Substation (Minnesota) shows that seed from selected hills gave an average acre-yield of 184.9 bushels as compared with 134 bushels from cellar-selected seed and 64.7 bushels from field-run. In the same experiment the tuber-unit method gave 136.1 bushels.

Waid (14) of the Ohio Station reports a difference of 89 per cent for high-yielding plants over low-yielding and 25 per cent over common stock. His total yields, however, were greater at the beginning than were the 3-year averages, owing probably to the influence of season.

East (2) obtained rather high increases the first year after selection, but afterwards the yields from his check hills were as high or higher than those from the selected hills. He is doubtful, therefore, with respect to the value of selection of this sort. He used stock all grown from a single hill two years previously. This does not represent the sort of seed that farmers are growing, since it is likely that there is a variety of strains in most commercial fields of any considerable size.

Stuart (12) of the U. S. Department of Agriculture, working
at Honeoye, New York, with seed grown at Burlington, Vermont, selected hills and planted each tuber separately. He found that the yield from strong plants was from 5 to 15 times that from the weak plants. He did not report check strains, however, and it is, therefore, uncertain how much better his high-yielding selections were than unselected stock. His data are from the harvests of 1911 and 1912.

Straight hill selections of the Cobbler variety were made in 1911 near Portsmouth, Virginia. The 1912 crop was promising. The selections varied from 2 to 5 hills of seed. The calculated acre-yields varied from 22.2 barrels of culls with no primes to 115.5 barrels of primes and 36.7 barrels of culls. The selections were lost in the spring of 1913 when a severe frost injured the young plants, thereby ruining the stock and causing the experiment to be discontinued. This was unfortunate since it would have been interesting to have found out how the progenies behaved. Stuart concludes that much good may come from hill- and tuber-unit selections, mainly by the elimination of weak or diseased plants.

Zavitz(18) selected seed for 26 years to find out whether home-grown seed could be made to maintain its yield. "No hill selection has taken place in any year in connection with this experiment. The fertility of the soil has probably remained about uniform. . . ." No deterioration took place. He also reports the selection of 241 tubers from a bulk lot. These were planted separately, and one pound from the best hills was used as seed for the next season. The results for the best three strains after four years of selection were 181.4 bushels, 177.3 bushels, and 175.9 bushels, respectively, as against 162.5 bushels for the unselected seed of the variety. Hill selections made for two years in succession and then tested three years in duplicate gave yields of 243.4, 216.3, 190.8, and 136.2 bushels, respectively, as compared with 136.6 bushels for variety tests where no hill selection was used.

Selvig(10) at the Crookston Substation (Minnesota) reports the following results with Early Ohio's for the year 1918:

<table>
<thead>
<tr>
<th>Seed Type</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill-selected</td>
<td>128.6</td>
</tr>
<tr>
<td>Bin-selected</td>
<td>104.1</td>
</tr>
<tr>
<td>Field-run</td>
<td>65.0</td>
</tr>
<tr>
<td>Run-out</td>
<td>58.3</td>
</tr>
</tbody>
</table>

Krantz(6) found no difference in form of tuber nor in yield in lots of Early Ohio potatoes grown by farmers who had practised seed selection for 20 years or more and those by growers practising little or no selection. Later studies(7) showed that
by selecting for variations which occurred in the Ohio variety, such as proportion of width to length, depth of eyes, fissures, knobs, prominence of eyebrow, color of tuber, and haulm character, there appeared to be no hereditary tendencies. These variations he attributes to environment, such as soil heterogeneity, storage, and disease.

Whipple (16), working in Montana, concluded that hill selection was not practical in improvement as it brings only temporary improvement in acre-yields and does not isolate high-yielding lines which may be maintained by mass-selection based on tuber characters alone. He goes on to state that vine characteristics are a much more valuable guide and more practical. The work extended over a 3-year period with three varieties, viz., Green Mountain 108, Rural New Yorker 108, and Early Six Weeks.

Hill-selection experiments at the Minnesota Station (15), where potato varieties had been degenerated for many years, failed to isolate strains resistant to disease. High- and low-yielding hills and tubers possessing desirable and undesirable characters followed the same course, low-yielding hills often giving the better results.

Detailed data on hill-selection work at the Utah Station up to 1919 and the acre-yields for 1920 were published in Utah Station Bulletin No. 176 (11). The experimental work, however, continued up to and including 1925. A summary of the data appearing in this earlier bulletin and the data obtained as a result of an additional 5 years of work are herein reported.

**MATERIAL USED**

During the years 1908 to 1911 three varieties of potatoes were grown at the Utah Experiment Station. They went under the varietal names of Majestic, Bangor, and Peerless. When classified according to Stuart’s (13) classification, the Majestic proved to be Rural, the Bangors were Triumphs, and the Peerless strain was a Pearl.

As this was the material from which the selections were

<table>
<thead>
<tr>
<th>Variety</th>
<th>Total Acre-Yield (Bu.)</th>
<th>Average Bu.</th>
<th>Percentage Marketable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1908 1909 1910 1911</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triumph</td>
<td>333.3 351.7 380.8 114.0</td>
<td>294.9</td>
<td>83</td>
</tr>
<tr>
<td>Pearl</td>
<td>280.5 304.6 317.9 334.4</td>
<td>309.3</td>
<td>85</td>
</tr>
<tr>
<td>Rural</td>
<td>453.3 458.3 343.5 85</td>
<td>400.9</td>
<td>85</td>
</tr>
</tbody>
</table>

*Hill selections were first made from the 1911 crop*
made and the data secured that are reported in this bulletin, the yield data for the three varieties from 1908 to 1911 are given in Table 1.

METHODS OF SECURING DATA

Hills Selected.—About 500 hills of each of the three varieties were dug and each left on the ground by itself. Examination of these hills showed some to consist of one or two overgrown tubers, frequently misshapen and hollow near the center. Other hills consisted of one or two large tubers and several small ones. Some hills consisted almost entirely of tubers too small to be marketable. The desirable hills had in them several medium-sized, regular-shaped tubers with few or no small ones. As the experiment progressed, hills of this general nature were chosen.

High-yielding hills were used throughout, but attention was also given to uniformity, to smoothness, and to marketable size of tubers in the hill. Nearly always the seed-stock hills consisted of five to ten uniform marketable tubers, tho occasionally there occurred some hills of more than a dozen desirable tubers. In the Rural variety care was taken to avoid the use of hills in which the tubers showed any marked tendency to be pointed rather than well-rounded and flat-oval.

Plan of Experiment.—The selections that were made from year to year were planted in rows three feet apart with the sets about 14 or 15 inches apart in the rows. Beginning with the 1915 crop, the land was marked out with rows 30 inches and the sets exactly 14 inches apart in the row. The length of row and the number of replications varied, depending on the size of hill and on the number of hills selected. The sets from each hill constituted seed for a short row. With the 1915 crop unselected
Fig. 2.—Three types of poor hills, none of which should be used as seed stock as they show signs of degeneration.

Material was added as a check on selected strains. For the first few years, the check material was planted in full rows throughout the breeding plat, but in the later years the rows were shortened and the number of rows increased, resulting in greater distri-

Fig. 3.—View of the breeding plat. The row on which the kodak case is standing is one of the foliage selections. To the left of it are 3 rows of pedigreed selections and to the right of it is a row of unselected stock.
bution of unselected stock over the breeding plat. Tubers were cut into sets approximately two ounces in size and as uniform as possible by means of hand cutting. Each set contained at least one good eye and usually two. The row thus planted from the sets derived from one hill of the previous year was marked with a numbered peg and regarded as a unit. No effort was made to keep the sets from each tuber separate from those of other tubers in the same hill.

The seedbed was prepared in the usual way. The land usually received a light application of farm manure. Plowing was done in the fall and a fine and moderately firm seedbed prepared in the spring.

The planting was done by hand. A shovel was used in opening a hole into which a set was dropped, covered, and the soil tramped. Irrigation was usually not necessary until the plants were well above the surface of the ground. During this time the soil was cultivated and hoed sufficiently to keep down weeds and to prevent crusting.

As the season advanced water was applied as needed, in furrows to avoid surface flooding. As soon afterward as the soil permitted, the field was cultivated with a one-row horse cultivator.

Harvesting was done in the fall after the vines had died from frost or from maturity when good weather continued well into October. In two or three seasons, oncoming winter forced early harvesting. This was especially true in 1919 which greatly decreased the yield.

Digging was done by hand with a fork or shovel; the tubers of each hill were allowed to dry and were then placed into a separate paper bag, after which all the hills from one progeny row were placed in a burlap sack and properly labeled with the respective pedigree number. During
the fall and early winter, data for the weight of total and marketable tubers and for the number of tubers were taken. The tubers were then returned to the bags and stored until the data were calculated.

From the 1911 crop, high- and low-yielding hills were selected from each of the three varieties listed in Table 1. These hills were labeled and kept in separate paper bags until planting time.

The good hills were to be designated by the small letter "g" and the poor hills by the small letter "p". The hill selections from each variety were given the annotation "T", "P", or "R", according as they were from Triumph, Pearl, or Rural varieties, respectively. "Tg", "Pg", and "Rg" stood for the high-yielding ("good") hills from the respective varieties, and "Tp", "Pp", and "Rp" for the poor or low-yielding hills which were selected for test.

These hills were grown in the breeding plat, as previously described. At harvest time each hill was dug and kept separate by placing it in a paper bag, and then all the hills from one row were placed in a burlap bag, properly labeled, and put into a cellar for storage. During the winter, data were taken on each hill. When the calculations were completed and when the planting season approached, the material was taken from the cellar and planting selections were made. In these "good" selections, only the highest-yielding hills, and in these "poor" selections only the lowest-yielding hills were retained for planting. This sort of selection was carried on for two years with the Triumph and Pearl varieties and for three years for the Rural variety. The data secured for each of the three varieties are given later, in their respective places.

TABLE 2.—Acre-yields from good and from poor selections, Triumph variety, 1912 and 1913, also the number of rows and the range in length of row in feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Acre-yields (Bu.)</th>
<th>Difference in Favor of Good Selection (Bu.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good Selections</td>
<td>Poor Selections</td>
</tr>
<tr>
<td>1912</td>
<td>259.0</td>
<td>58.0</td>
</tr>
<tr>
<td>1913</td>
<td>382.4</td>
<td>22.5</td>
</tr>
<tr>
<td>Average</td>
<td>320.7</td>
<td>40.2</td>
</tr>
<tr>
<td></td>
<td>201.0</td>
<td>359.9</td>
</tr>
<tr>
<td></td>
<td>280.4</td>
<td></td>
</tr>
</tbody>
</table>

Number of Rows and Range in Length of Rows in Feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Good Selections</th>
<th>Poor Selections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Rows</td>
<td>Range in Length of Rows (Ft.)</td>
</tr>
<tr>
<td>1912</td>
<td>27</td>
<td>14 to 74</td>
</tr>
<tr>
<td>1913</td>
<td>10</td>
<td>41 to 68</td>
</tr>
<tr>
<td>Average</td>
<td>18</td>
<td>27 to 71</td>
</tr>
</tbody>
</table>
DATA FOR GOOD AND POOR SELECTIONS

**Triumph.**—The data for the good and the poor selections from the Triumph variety are given in Table 2, which shows that when the high-yielding hills are used as seed stock the acre-yields were high. Low-yielding hills as seed produce low acre-yields. Many of the low-yielding hills failed to produce any progeny at all.

**Pearl.**—The data for the good and for the poor selections from the Pearl variety are given in Table 3.

**Table 3.—Acre-yields for the good and for the poor selections, from the Pearl variety for 1912 and 1913, also the number of rows and the range in length of rows in feet**

<table>
<thead>
<tr>
<th>Year</th>
<th>Good Selections</th>
<th>Poor Selections</th>
<th>Difference in Favor of Good Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1912</td>
<td>426.0</td>
<td>244.0</td>
<td>182.0</td>
</tr>
<tr>
<td>1913</td>
<td>188.7</td>
<td>55.0</td>
<td>135.7</td>
</tr>
<tr>
<td>Average</td>
<td>307.3</td>
<td>148.0</td>
<td>158.9</td>
</tr>
</tbody>
</table>

Table 3 again brings out the great differences in acre-yield when seed taken from high-yielding hills is compared with that from low-yielding hills. In the Pearl variety, as in the Triumph, many of the low-yielding hills failed to reproduce.

**Rural.**—The yield data for the good and for the poor selections from the Rural variety are given in Table 4.

A study of Tables 2, 3, and 4 shows convincingly that some hills used as seed are much more likely to give a high yield than are others. The yields from the good selections are very much higher than from the poor selections. Many of the poor strains had completely degenerated or run out. Possibly due to the presence of disease which resulted in a low yield and due to selecting the low-yielding hills, “running out” was hastened. On the other hand, due to the selection of the high-yielding hills, fewer tubers from diseased hills were represented. It seems also that certain strains in a variety possess hereditary qualities which furnish a tendency toward higher acre-yields.

Poor stands accompany poor selections. In addition, the tubers from the poor selections are on the average much smaller than from the good selections. This results in a low percentage
Fig. 5.—An unusually high-yielding hill of uniform tubers marketable, thus showing an even more striking difference in the acre-yields of marketable tubers, which in the final analysis is the real measure as to the comparative value of the two methods of selections.

Table 4.—Acre-yields for the good and for the poor selections from the Rural variety for the period 1912 to 1914, also the number of rows and the range in length of rows in feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Acre-yields (Bu.)</th>
<th>Difference in Favor of Good Selection (Bu.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good Selections</td>
<td>Poor Selections</td>
</tr>
<tr>
<td>1912</td>
<td>548.0</td>
<td>249.0</td>
</tr>
<tr>
<td>1913</td>
<td>358.7</td>
<td>15.0</td>
</tr>
<tr>
<td>1914</td>
<td>220.4</td>
<td>17.2</td>
</tr>
<tr>
<td>Average</td>
<td>375.7</td>
<td>93.7</td>
</tr>
</tbody>
</table>

Number of Rows and Range in Length of Rows in Feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Good Selections</th>
<th>Poor Selections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Rows</td>
<td>Range in Length of Rows (Ft.)</td>
</tr>
<tr>
<td>1912</td>
<td>29</td>
<td>64 to 120</td>
</tr>
<tr>
<td>1913</td>
<td>28</td>
<td>30 to 153</td>
</tr>
<tr>
<td>1914</td>
<td>78</td>
<td>5 to 92</td>
</tr>
<tr>
<td>Average</td>
<td>45</td>
<td>33 to 122</td>
</tr>
</tbody>
</table>
GOOD AND POOR SELECTIONS VS. NO SELECTION

Both the good and the poor selections from the Triumph and from the Pearl varieties were discarded at the end of the second year. The Rural stock was continued.

Beginning with the crop of 1915, check material was added for the purpose of finding out whether the good selections were better than no selection at all, or whether no selection was worse than the poor selections.

The check, or unselected material as it is called, consisted of tubers of the same original stock as those originally selected for high and low yields. They had not been selected but had been grown at the station each year since the experiment began. Until 1915, this unselected material was not grown adjacent to the selected material; hence, comparative yields were not possible before that date.

Beginning with the 1915 crop unselected stock was planted at intervals throughout the plat as a check on the selections. It might be well to state that with the unselected stock the only selection practiced hereafter consisted of getting tubers large enough to make proper-sized sets for planting. In addition, any tubers showing vascular discoloration were discarded.

For the first time, then, in 1915, a comparison can be made between good and poor selections and between each of these and unselected stock. The data are given in Table 5.

TABLE 5.—Average acre-yields of good and of poor selections and of unselected stock for the 1915 crop

<table>
<thead>
<tr>
<th>Average for</th>
<th>No. of Rows</th>
<th>Range in Length of Row (Ft.)</th>
<th>Acre-yield (Bu.)</th>
<th>Relative Yields (Unselected taken as 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unselected</td>
<td>3</td>
<td>103</td>
<td>179.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Good Selections</td>
<td>50</td>
<td>13 to 108</td>
<td>301.0</td>
<td>167.9</td>
</tr>
<tr>
<td>Poor Selections</td>
<td>7</td>
<td>4 to 18</td>
<td>109.9</td>
<td>61.3</td>
</tr>
</tbody>
</table>

Table 5 shows that the use of seed from poor selections decreased the yield 39 per cent below that of the unselected, whereas the use of seed from the good selections increased the yield nearly 68 per cent over no selection. The good selections yielded 173.9 per cent higher than the poor selections. This again emphasizes the importance of selecting the best hills as seed stock.

Another matter of considerable importance is the fact that all the good selections bear the pedigree number Rg-25-1, showing that these are all the progeny of hill No. 25, in the 1911 selections of good hills of the Rural variety.
BEST HILLS FROM POOR SELECTIONS, GOOD SELECTIONS, 
AND UNSELECTED STOCK

When seed for the 1916 crop was planted all the good selections, save those which bore the pedigree Rg-25-1-9, were discarded.

In place of selecting the poorest hills from the poor selections, as had been previously done, this year a few of the best hills from the poor selections were planted. The most degenerate types had completely run out or had been discarded. The data for this year are given in Table 6.

Table 6.—Acre-yields for the good selections, for the best hills from the poor selections, and for unselected stock for 1916 crop

<table>
<thead>
<tr>
<th>Average for</th>
<th>No.</th>
<th>Range in Length of</th>
<th>Acre-Yield</th>
<th>Relative Yields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>of</td>
<td>(Ft.)</td>
<td>(Bu.)</td>
<td>(Unselected)</td>
</tr>
<tr>
<td></td>
<td>Rows</td>
<td></td>
<td></td>
<td>taken as 100</td>
</tr>
<tr>
<td>Unselected</td>
<td>4</td>
<td>100-103</td>
<td>191.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Best Hills from Poor Selections</td>
<td>3</td>
<td>13-23</td>
<td>184.9</td>
<td>96.6</td>
</tr>
<tr>
<td>Good Selections</td>
<td>40</td>
<td>31-67</td>
<td>282.0</td>
<td>147.5</td>
</tr>
</tbody>
</table>

By selecting (Table 6) the better hills from the poor selections, the total acre-yield is approximately as high as that from unselected stock. On the other hand, for the previous year, due to the selection of the poorest hills from the poor selections, the acre-yield was decreased by about 39 per cent. The good selections again yielded much above either the unselected or the good hills from the poor selections.

It is unfortunate that data were not taken on the percentage marketable, as it is evident that the poor selections gave a large percentage of small tubers, as indicated by the average weight to the tuber, which is 91.3 grams (just slightly above the minimum size for good marketable tubers). This would tend to modify the significance of the total acre-yields for the poor selections as the total salable potatoes would be much reduced.

RESULTS OF PEDIGREED SELECTIONS, MIXED, GENERAL, AND UNSELECTED STOCK

Beginning with the 1917 crop and continuing thru 1918 and 1919 some changes were made in the breeding plat. All the poor selections were discarded as well as all other material except that bearing the pedigree Rg-25-1-9-20 and a few of the best hills of the remaining material which were grouped together and called "general". Two selections of the selected material, arising from hills Rg-25-1-9-20-3 and -5, respectively,
FIG. 6.—Graph showing the necessity of continually selecting the best hills as seed stock if yields are to be maintained. Selections of the "mixed" and "general" stock were discontinued. (3-year average) were retained. After selecting the best hills, the remnants were thrown together to form a strain called "mixed". These were retained.

TABLE 7.—Average acre-yields for the 3-year period 1917 to 1919 on two strains of pedigreed selections, on general, on mixed, and on unselected stock, also the number of rows and the range in length of rows in feet

<table>
<thead>
<tr>
<th>Series</th>
<th>Total Acre-Yields (Bu.)</th>
<th>Percentage Marketable</th>
<th>Number of Rows and Range in Length of Rows in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1917</td>
<td>1918</td>
<td>1919</td>
</tr>
<tr>
<td>Rg.-25-1-9-20-3</td>
<td>382.4</td>
<td>257.9</td>
<td>117.4</td>
</tr>
<tr>
<td>Rg.-25-1-9-20-5</td>
<td>311.9</td>
<td>270.2</td>
<td>130.5</td>
</tr>
<tr>
<td>General</td>
<td>259.7</td>
<td>172.3</td>
<td>122.8</td>
</tr>
<tr>
<td>Mixed</td>
<td>277.2</td>
<td>151.4</td>
<td>91.2</td>
</tr>
<tr>
<td>Unselected</td>
<td>269.3</td>
<td>202.4</td>
<td>114.5</td>
</tr>
</tbody>
</table>
grown in the breeding plat, as has been previously described. The data for two selected strains for mixed, for general, and for unselected stock for the 3-year period are given in Table 7.

Table 7 brings out the importance of continued selection for maximum yields. This is evident from a comparison of the selected strains represented by Rg-25-1-9-20-3, by Rg-25-1-9-20-5, and by the mixed material. It is remembered that the “mixed” material resulted from massing the remaining hills out of which the selected material was taken. In other words the “mixed” stock was of the same material as the pedigreed stock up to 1917. After this year the mixed stock was not further selected but the pedigreed stock was. The acre-yields in bushels for the two selected strains were 252.6 and 237.5, respectively, as compared with 184.8 for the mixed stock. The mixed stock after the first year was as low or even lower in yield than the stock which had no selection at all.

The stock marked “general”, which originally came from the same hill when the experiment began and consisted of a number of the best hills of strains other than the two above mentioned, gave a slightly lower yield than the unselected stock.

The yield for the general stock for the 1917 crop is not a fair test as the stand was unaccountably rather poor, which resulted in a lower yield than was normal.

![Fig. 7](image-url)

**Fig. 7.—Selecting seed stock from plants with off-type foliage characters resulted in low yields with running-out of many of the strains**

**FOLIAGE SELECTIONS, HILL SELECTIONS, AND NO SELECTIONS**

In the 1917 crop there appeared in the pedigreed stock a number of hills which showed variations in the character of
vine. The vines of the pedigreed stock as a whole are semi-erect with medium coarse stems and leaves of a uniformly dark-green color. One progeny row had a large, coarse stalk and another row dwarfed but leafy vines; three others showed a marked tendency to chlorosis in the leaves. Selections were made from all of these in the fall of 1917 and were continued up to 1922. Each year, the highest-yielding hills were taken for seed. The yield data for the foliage selections, for the hill selections, and for the unselected stock for a 5-year period are given in Table 8.

Table 8.—Acre-yields for hill selections, for foliage selections, and for unselected stock from the Rural variety, for 1918 to 1922, also the number of rows and the range in length of rows in feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Acre-yields (Bu.)</th>
<th>Percentage Marketable</th>
<th>Number of Rows and Range in Length of Rows in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hill Selections</td>
<td>Selections for Foliage</td>
<td>Unselected</td>
</tr>
<tr>
<td>1918</td>
<td>250.2</td>
<td>192.6</td>
<td>202.4</td>
</tr>
<tr>
<td>1919</td>
<td>117.4</td>
<td>72.6</td>
<td>114.5</td>
</tr>
<tr>
<td>1920</td>
<td>241.6</td>
<td>101.6</td>
<td>157.6</td>
</tr>
<tr>
<td>1921</td>
<td>275.1</td>
<td>151.8</td>
<td>159.7</td>
</tr>
<tr>
<td>1922</td>
<td>591.3</td>
<td>284.1</td>
<td>285.9</td>
</tr>
<tr>
<td>Average</td>
<td>295.1</td>
<td>160.5</td>
<td>184.0</td>
</tr>
</tbody>
</table>

As a 5-year average (Table 8) only two of the foliage-selected strains yielded just slightly higher than did the unselected stock. Of the other five strains, three yielded very much lower than the unselected material. The yield selections, on the other hand, gave much higher yields than did either the unselected or any of the foliage selections. This emphasizes the
fact that in selecting potatoes for seed, only tubers from hills with vines characteristic of the variety and with a healthy green appearance should be chosen.

Each of the foliage selections bred true for the peculiar vine character. Thus, it was either a case of degenerate mutation or disease which was carried over from year to year by the tuber. In regard to disease, it might be stated that during 1920, Shapavolov* examined these strains for disease. Certain of them had virus diseases; others seemed to have hereditary albinism, on which no known disease was recognized.

![Graph](image)

**Fig. 8.**—The yield data for the first year the type selections were in the test and for the 8-year period after they had been subjected to hill selection as compared to hill selections and unselected stock

**COMPARISON OF TYPE SELECTIONS (CORNELL), HILL SELECTIONS (UTAH), AND NO SELECTION**

To the breeding plat in 1918 were also added 20 hill selections from several varieties brought from Cornell University. These were designated as "type selections" and were labeled T-1, T-2, etc., up to T-20. The yields the first year ranged from 32.9 up to 356 bushels an acre for the various selections. All but three of the selections (T-2, T-11, T-15) were discarded because of low yields or because of poorly shaped tubers. After the second year, T-2 and T-15 were discarded, and T-11 which was a Rural New Yorker was retained, and selections from it were continued to the end of this experiment. Thus, after the third year all this progeny is traceable back to one hill. Inas-

*Pathologist, Bureau Plant Industry, U. S. Department of Agriculture
much as these type selections were grown in the same breeding plat as the unselected and the good selections from the Rural variety, it is possible to make a comparison of the data secured. These data are given in Table 9.

Table 9.—Acre-yields and percentages marketable for two selected strains of the Rural variety and unselected stock for 1918 to 1925, also the number of rows and range in length of rows in feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Acre-yields (Bu.)</th>
<th>Percentage Marketable</th>
<th>Number of Rows and Range in Length of Rows in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hill Selections Rg. 25-1-9-20</td>
<td>Type Selections (Cornell)</td>
<td>Unselected (Utah Sta.)</td>
</tr>
<tr>
<td></td>
<td>250.2</td>
<td>190.6</td>
<td>202.4</td>
</tr>
<tr>
<td></td>
<td>117.4</td>
<td>172.4</td>
<td>114.5</td>
</tr>
<tr>
<td></td>
<td>241.6</td>
<td>286.3</td>
<td>157.6</td>
</tr>
<tr>
<td></td>
<td>275.1</td>
<td>262.1</td>
<td>159.7</td>
</tr>
<tr>
<td></td>
<td>591.3</td>
<td>638.8</td>
<td>255.9</td>
</tr>
<tr>
<td></td>
<td>469.2</td>
<td>481.7</td>
<td>250.4</td>
</tr>
<tr>
<td></td>
<td>449.7</td>
<td>439.6</td>
<td>227.8</td>
</tr>
<tr>
<td></td>
<td>569.0</td>
<td>559.4</td>
<td>291.6</td>
</tr>
<tr>
<td>Average</td>
<td>370.4</td>
<td>378.9</td>
<td>211.2</td>
</tr>
</tbody>
</table>

As a 7-year average the hill selections from the Rural variety which began back in 1911 gave about the same total yield and percentage marketable as did hill selections of the Rural potatoes brought from Cornell in 1918. In the case of unselected, the yield is much less than either of the hill-selected
strains. The percentage marketable, on the other hand, was practically as high for the unselected as for either of the hill selections.

During the harvest season of 1918, W. W. Owens, at that time County Agricultural Agent Leader for Southern Utah, selected ten hills from each of the two varieties, Burbank and Rural, from fields in Sevier County. These hills were grown in the breeding plat. Hills from the Burbank variety were designated as B-1, B-2, etc., up to B-10, and those of the Rural variety were designated as R-11, R-12, etc., up to R-20. The progeny of each hill was harvested separately and the data recorded. For each year the best hills were selected for planting. This was continued until 1922.

The acre-yields for the first-year progenies from the individual hills of the Burbank variety ranged from 62.8 to 375.7 bushels. After the first year the progenies from only four hills out of the ten were retained for further testing. By 1922 the progeny of one other hill was dropped out, leaving the progeny of B-4, B-6, and B-10. These were the three highest-yielding hills the first year.

The acre-yields of the progenies from the hills selected from the Rural variety varied from 150 to 339 bushels. The second year the progenies of only four of the hills were retained, and by 1922 all had been discarded except the progeny of one hill, R-18.

Table 10 gives the yield data for the hill selections from the Burbank variety from Sevier County; for three hill-selected strains of Rurals—one from Sevier County, one from Cornell University (Ithaca, New York), and one from the Utah Station; and for unselected stock of the Rural variety.

Table 10 shows very little difference in the acre-yields for the four strains of hill-selected stock from the two different varieties. The hill-selected stock, however, gave much higher yields every year than did the unselected stock. In only one year (1919) did the unselected stock approach the hill-selected in size of yield. This year was by all odds the most unfavorable year for potatoes during the entire period of the experiment. The stand in some parts of the field was much poorer than in other parts. This was apparently due to mere chance, as similar stock in different parts of the field showed great variations in stand. In other words, no particular strain showed any more marked tendency to produce poor stands than did others. The acre-yields were determined largely by the particular location in the field. The breeding plat was not injured any more seriously than were the commercial fields in the same
MAINTAINING POTATO YIELDS BY HILL SELECTION

Table 10.—Acre-yields for hill-selected Burbanks, three strains of hill-selected Rurals and unselected stock for 1919 to 1922, also the number of rows and range in length of rows in feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Acre-yields (Bu.)</th>
<th>Rural Unselected (Utah Sta.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Rural Selections (Cornell)</td>
</tr>
<tr>
<td></td>
<td>Burbank (Sevier)</td>
<td>Rural (Sevier)</td>
</tr>
<tr>
<td>1919</td>
<td>250.3</td>
<td>242.7</td>
</tr>
<tr>
<td>1920</td>
<td>220.8</td>
<td>201.7</td>
</tr>
<tr>
<td>1921</td>
<td>203.9</td>
<td>230.0</td>
</tr>
<tr>
<td>1922</td>
<td>560.1</td>
<td>506.2</td>
</tr>
<tr>
<td>Average</td>
<td>308.8</td>
<td>295.1</td>
</tr>
</tbody>
</table>

Percentages Marketable

<table>
<thead>
<tr>
<th>Year</th>
<th>Hill Selected</th>
<th>Rural Unselected (Utah Sta.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Rural Selections (Cornell)</td>
</tr>
<tr>
<td>1919</td>
<td>90.9</td>
<td>87.6</td>
</tr>
<tr>
<td>1920</td>
<td>89.0</td>
<td>89.6</td>
</tr>
<tr>
<td>1921</td>
<td>79.4</td>
<td>75.6</td>
</tr>
<tr>
<td>1922</td>
<td>93.6</td>
<td>92.4</td>
</tr>
<tr>
<td>Average</td>
<td>88.2</td>
<td>86.3</td>
</tr>
</tbody>
</table>

Number of Rows

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Rural Selections (Cornell)</th>
<th>Rural Selections (Utah Sta.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1920</td>
<td>24</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>1921</td>
<td>32</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>1922</td>
<td>7</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>Average</td>
<td>18</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

Range in Length of Rows in Feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Rural Selections (Cornell)</th>
<th>Rural Selections (Utah Sta.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>27 to 50</td>
<td>7 to 35</td>
<td>10 to 44</td>
</tr>
<tr>
<td>1920</td>
<td>26 to 60</td>
<td>18 to 63</td>
<td>24 to 36</td>
</tr>
<tr>
<td>1921</td>
<td>20 to 45</td>
<td>20 to 44</td>
<td>26 to 37</td>
</tr>
<tr>
<td>1922</td>
<td>15 to 30</td>
<td>17 to 28</td>
<td>11 to 29</td>
</tr>
<tr>
<td>Average</td>
<td>22 to 46</td>
<td>15 to 42</td>
<td>18 to 36</td>
</tr>
</tbody>
</table>

vicinity, all of which showed great variations in stand even tho planted with one stock of seed.

With such an unfavorable season and with a crop like potatoes, which under the best conditions shows great variation in yield, the data for 1919 are of little value. Averages tend to overcome part but not all such great variations.
The percentages marketable were higher for the "T" stock and pedigreed Rurals (Utah Station) than for the Burbank or for Rural stock from Sevier County. The difference was from 6 to 9 per cent. The unselected stock, on the other hand, gave about the same percentage marketable as the better pedigreed selections.

By 1923 some of the strains from Sevier County showed signs of degeneration and all were discarded at digging time in order to keep down the size of the breeding plat.

HILL-SELECTED vs. UNSELECTED STOCK OF THE RURAL VARIETY

For the period from 1915 to 1925, hill-selected and unselected stocks originally of the same lot of material were grown and tested in the breeding plat. The acre-yields, the percentages of difference in favor of selection, and the percentages of marketable tubers are given for each year, with an average for the 11-year period, during which checks of unselected stock were included.

TABLE 11.—Average acre-yields and percentages marketable for hill-selected and for unselected stock, both originally from the same lot of the Rural variety, 1915 to 1925

<table>
<thead>
<tr>
<th>Year</th>
<th>Acre-yields (Bu.)</th>
<th>Percentages Marketable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hill Selections</td>
<td>Unselected</td>
</tr>
<tr>
<td>1915</td>
<td>301.0</td>
<td>179.3</td>
</tr>
<tr>
<td>1916</td>
<td>282.0</td>
<td>191.2</td>
</tr>
<tr>
<td>1917</td>
<td>347.1</td>
<td>269.3</td>
</tr>
<tr>
<td>1918</td>
<td>250.2</td>
<td>202.4</td>
</tr>
<tr>
<td>1919</td>
<td>117.4</td>
<td>114.5</td>
</tr>
<tr>
<td>1920</td>
<td>241.6</td>
<td>157.6</td>
</tr>
<tr>
<td>1921</td>
<td>275.1</td>
<td>159.7</td>
</tr>
<tr>
<td>1922</td>
<td>591.3</td>
<td>285.9</td>
</tr>
<tr>
<td>1923</td>
<td>469.2</td>
<td>250.4</td>
</tr>
<tr>
<td>1924</td>
<td>449.7</td>
<td>227.8</td>
</tr>
<tr>
<td>1925</td>
<td>569.0</td>
<td>291.6</td>
</tr>
<tr>
<td>Average</td>
<td>354.0</td>
<td>211.8</td>
</tr>
</tbody>
</table>

Table 11 shows the added increase in acre-yield due to selection. This increase ranged from 2.5 per cent in 1919 to 106.8 per cent in 1922, with an average of 62.1 per cent for the entire period. The percentage marketable was 3.5 per cent greater for the hill-selected stock.

The following questions naturally arise: Have the acre-yields for the hill-selected stock increased or decreased over a period of years? Will the acre-yields be maintained with no
selection over a period of years, or will they decrease? That is, will the seed "run out"?

The data at hand are not sufficient to establish conclusively that either is the case, but when the data found in Table 11 are grouped into three periods—the first two periods of three years each and the last period of four years—and when consideration is given to the average data for the period, it is possible to make a comparison of the trends of yields in the hill-selected and in the unselected stock. The reason for taking this particular grouping is because the yield data tended to group naturally into these periods, that is, the acre-yields for each of the years in a period were not extremely variable from other years in the same period. Because of the unfavorable conditions of 1919, it was deemed advisable to omit the data for this particular year. Thus, the first period was for 1915, 1916, and 1917; the second period for 1918, 1920, and 1921; and the third period for 1922, 1923, 1924, and 1925. The average acre-yields for each of the periods, with the percentages increase or decrease from one period to another for the hill-selected and for the unselected stock, are given in Table 12.

Figure 10 and Table 12 show that both the hill-selected and the unselected stock gave a decrease in acre-yield from the first period to the second, this being 21.2 per cent for selected and 23.2 per cent for unselected. From the second period to the third the hill-selected stock increased 103 per cent in acre-yield,
whereas the increase of unselected was 52 per cent, that is, only about half. The increase for the hill-selected from the first period to the last was three times that of the unselected.

Because of the nature of some of the potato diseases, especially the virus diseases such as mosaic, it might naturally be expected that in the end the stock would completely "run out". The unselected stock being infected with rugose mosaic and being grown alongside the hill-selected gave ample opportunity for this disease to spread. The disease apparently did spread, as there was disease in the hill-selected stock, but the selection of the high-yielding hills eliminated much of the disease each year. However, even then it seems reasonable to expect that if mosaic does give very reduced yields, which it

**Table 12.—Comparative increase or decrease in acre-yields for hill-selected and for unselected stock when the data shown in Table 10 are grouped into 3 periods (1919 is omitted): two 3-year periods and one 4-year period as indicated**

<table>
<thead>
<tr>
<th>Period</th>
<th>Year</th>
<th>Average-Acre-yield for each of the Periods</th>
<th>Percentage Increase or Decrease from one Period to Another</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hill Selected</td>
<td>Unselected</td>
</tr>
<tr>
<td>1</td>
<td>1915 to 1917</td>
<td>310.0</td>
<td>213.3</td>
</tr>
<tr>
<td>2</td>
<td>1918 to 1921</td>
<td>255.6</td>
<td>173.2</td>
</tr>
<tr>
<td>3</td>
<td>1922 to 1925</td>
<td>519.8</td>
<td>263.9</td>
</tr>
</tbody>
</table>
does in advanced stages and in some forms more than in others it does appear, that with this variety the complete effect of disease is slow and long-drawn-out, causing an appreciable decreased yield but not causing the variety completely to run out.

The data in Table 13 show that from the first to the last period both the unselected and the hill-selected stock gave a material increase in acre-yield. Much of this increase without doubt was due to better environment. However, even if it is all due to environment, it shows that the stock (even the unselected) has not entirely run out. In fact, it is doubtful whether the yield of unselected stock decreased during this period.

It must be remembered that this stock was of the Rural variety which is considered by some to be somewhat resistant to mosaic.

DISCUSSION OF RESULTS

Farmers are constantly finding it more difficult to produce high yields of potatoes. The problem centers largely around that of good seed. Any economic method, therefore, which would produce or assist in producing more desirable seed is of great value to the potato grower. The data reported in this bulletin suggest a method of maintaining high acre-yields without the usual introduction of new seed each year.

For the past 15 years selecting seed from the high-yielding hills of the Rural variety has given very satisfactory results in Logan (Utah). Such a period of time is fully sufficient to test the value of selection. With the results so much in favor of hill selection as compared with no selection for the last 11 years, during which time they were grown side by side, it seems evident that hill selection should be given more consideration in the production of good seed stock. It is likely that any condition which interferes with the natural development of the plant will probably reflect itself in the lower yield of tubers.

Potatoes are subject to the attacks of many diseases and especially to the ravages of virus, or degeneration diseases, as they are sometimes called. These, no doubt, interfere with the normal functioning of the potato plant, which condition results in lower acre-yields. Mosaic, especially the rugose type, is considered to manifest itself in a rapid reduction in yield. The unselected stock especially, as well as some of the hill-selected material from which the data herein reported were obtained, was heavily infested with rugose mosaic. By the constant yearly selection of seed from the highest-yielding hills of more uniform shape, the yields were maintained over the 15-year period. In fact, the yields appeared to be increasing. On the
other hand, unselected stock grown as check rows beside the selected stock was badly infested with mosaic of the rugose type and with leafroll. This resulted in low acre-yields over the entire period but did not cause complete running out. In fact, it appeared that these diseases cut the yield immediately to about one-half that of selected seed stock, after which no further reduction resulted. This indicates that with this variety under these conditions, rugose mosaic and leafroll do not cause complete running out. By selecting the high-yielding hills, those which are badly affected are mostly discarded because of their inability to yield.

It is important that hill selection be continued year after year if maximum results are to be realized. The data indicate that it is impossible to select high-yielding strains which will continue to produce high-yielding progeny unless selection is continued. This would likely be possible were it not for the fact that disease is an important factor in decreasing yields, thus obliterating any genetic differences which might be present insofar as yield is concerned.

The fact that hill selection must be continued year after year should not discourage any one interested in better seed, for all other proposed methods of producing good seed potatoes involve constant effort. Probably one of the most widely advo-
icated methods of producing good seed is that of rogueing, which consists of the removal of the disease-growing plants from the field. The removal of diseased plants from the field reduces the exposure of the healthy ones to infection.

It should not be lost sight of, however, that rigorous hill selection is in reality an indirect method of rogueing in which the progenies of about 95 to 98 per cent of the weakest plants are discarded. This is accomplished by selecting directly the best few hills as seed stock. Some rogueing to remove occasional diseased plants early in the season would be a desirable supplement to hill selection as here practised.

Other varieties such as Triumph, Green Mountain, and Peerless are thought to be more susceptible to mosaic degeneration than are Rurals. It is also generally thought that there are more favorable seed-growing conditions for potatoes in certain valleys of Utah, and of the northern Rocky Mountain region in general, than is Cache Valley (1) (Utah). The writers, after more than ten years of successful seed-production and observations are convinced that, if attempted on a community basis, highly satisfactory seed of the Rural variety could be maintained by the hill-selection method. In other words, it seems possible for the grower to keep at least one step ahead of mosaic and of other similar diseases. Fifteen years of successful maintenance of yields of one strain of the Rural variety when completely infected stock was grown immediately adjacent to the selected stock for the last eleven years is strong evidence. Moreover, this is fortified by a 9-year repetition with another strain. The Cache Valley is not especially favorable, no effort is here made to extend the applicability of these results to regions unfavorable for the production of seed-potatoes.

Hill selection need not carry the entire burden itself, as certain other methods may be used to assist. Tuber-indexing is available for seed plat work. Rogueing is an established method of field practice among the best growers of potato-seed stock. With these two well-known practices properly used as a supplement to hill selection, there seems to be no good reason why the production of seed potatoes should not develop into an industry of at least sufficient magnitude to care for local needs.

(1) The Central Experiment Station Farm (Greenville) is located about 112° West longitude and 41° 45' North latitude. The altitude is 4600 feet and the rainfall about 17 inches, being somewhat heavier from March to May and almost lacking from June to September, making irrigation necessary. The average frost-free season extends from May 15 to October 6 (144 days). The absolute maximum temperature is 101° F. and the average maximum 95° F. The average minimum temperature is -11° F. and the absolute minimum -52° F. The mean annual temperature is 47.4° F., with a mean daily range of 21.9° F. The July mean is 71.7° F.
No attempt is here made to outline a commercial project, but the agronomic basis for one with Rural potatoes under conditions as favorable as those of the Central Experiment Station Farm is fully established. Organization of a commercial or of a community project is an extension rather than an experimental project and not, therefore, within the scope of this publication.

SUMMARY

Studies in hill selection as a means of maintaining the yields of potatoes were carried on from 1911 to 1925, and careful comparisons of these were made with unselected stock from 1915 to 1925, inclusive, a period of eleven years.

The selection of high- and of low-yielding hills as seed from the Triumph, the Pearl, and the Rural varieties has given results much in favor of the use of high-yielding hills.

The repeated selection of low-yielding hills as seed stock greatly hastened "running out". Diseases, especially rugose mosaic and leafroll, are at least partly (and probably largely) responsible for the reduced yields.

With the Rural variety, the selection of high-yielding hills of a uniform type as seed stock eliminated much of the disease and made possible the maintenance of high acre-yields.

When yields from the high-yielding hills were compared with yields from the low-yielding hills and with yields from ordinary unselected stock, relative results were 167.9, 100, and 61.3, respectively.

Selection of the poorest hills for seed for four years followed by selection of the highest-yielding hills gave yields about equal to those from unselected seed stock.

Selection of the highest-yielding and most uniform hills as seed for six years, after which selection was discontinued, gave greatly reduced yields as compared with continued selection, thus showing that constant selection is necessary if high yields are to be maintained.

Tubers from hills with abnormal foliage characters when used for seed in most cases bred true for such abnormalities. Yield tests showed these abnormalities to be associated with degeneracy, perhaps in most cases from disease, but possibly from other sources, among which was albinism.

Rural stock obtained from Cornell University in 1918 gave yields during the first year slightly less than in unselected Rurals which had been on the Experiment Farm since 1908. In succeeding years, by selecting the high-yielding, most uniform hills for seed, the yields equaled those of stock of the same variety which had been hill-selected previously for seven years.
During an 8-year period, the yields for the two hill-selected strains were about equal, and both were about double the yield of the unselected stock. The percentage marketable remained about the same in each case.

One strain of Burbanks and one of Rurals were introduced from Sevier County. During the fifth year a part of these degenerated. All of the two strains were dropped from the seed plat at the end of the fifth year in order to keep the size of the plat from being too great.

A 4-year yield test on one strain of hill-selected Burbanks, three strains of hill-selected Rurals, and unselected Rurals gave the following results as an average for the period:

<table>
<thead>
<tr>
<th></th>
<th>Acre-yield (bu.)</th>
<th>Marketable(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burbanks (Sevier County)</td>
<td>308.8</td>
<td>88.2</td>
</tr>
<tr>
<td>Rurals (Cornell stock)</td>
<td>339.9</td>
<td>95.3</td>
</tr>
<tr>
<td>Rurals (Utah Station)</td>
<td>306.3</td>
<td>94.2</td>
</tr>
<tr>
<td>Rurals (Sevier County)</td>
<td>295.1</td>
<td>86.3</td>
</tr>
<tr>
<td>Rurals (unselected)</td>
<td>179.4</td>
<td>95.7</td>
</tr>
</tbody>
</table>

During the 11-year period from 1915 to 1925, yields from high-yielding hills of uniform tubers when grown immediately beside unselected stock, both originally of the same lot, gave the following average acre-yields:

<table>
<thead>
<tr>
<th></th>
<th>Acre-yield (bu.)</th>
<th>Marketable(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rurals (hill-selected)</td>
<td>354.0</td>
<td>92.1</td>
</tr>
<tr>
<td>Rurals (unselected)</td>
<td>211.8</td>
<td>88.6</td>
</tr>
</tbody>
</table>

The yield data for the 11-year period for the hill-selected and for the unselected stock were grouped into three periods for comparison. The first period was from 1915 to 1917, the second from 1918 to 1921 (with 1919 omitted), and the third from 1922 to 1925. The first two periods consisted of three years each and the last of four years. The 1919 data were omitted because of the very poor stands obtained that year, thus making the data unreliable. By comparing the average yield for the first period with the second, the yields decreased 21.2 per cent for the hill-selected and 23.2 per cent for the unselected stock. From the second period to the third, the yields increased 103.3 per cent for the hill-selected stock and 52.4 per cent for the unselected. When the first period is compared with the third, the hill-selected stock increased 67.7 per cent and the unselected 23.7 per cent, indicating a much higher relative increase in yield for the hill-selected seed.
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