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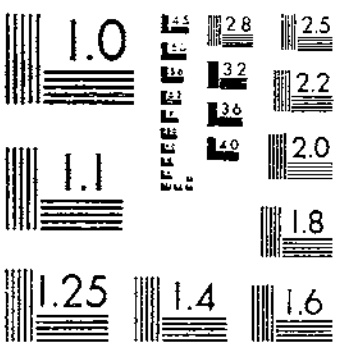

MICROCOPY RESOLUTION TEST CHART
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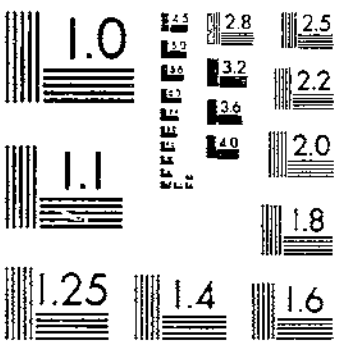

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NATIONAL BUREAU OF STANDARDS-1963-A

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FACTORS INFLUENCING THE YIELD OF APPLES IN THE CUMBERLAND-SHENANDOAH REGION OF PENNSYLVANIA, VIRGINIA, AND WEST VIRGINIA[1]

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IN COOPERATION WITH THE

VIRGINIA AGRICULTURAL AND MECHANICAL COLLEGE AND POLYTECHNIC INSTITUTE; COLLEGE OF AGRICULTURE, WEST VIRGINIA UNIVERSITY; AND SCHOOL OF AGRICULTURE, PENNSYLVANIA STATE COLLEGE

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INTRODUCTION

Fluctuations in the price of apples is caused to a large extent by fluctuations in the total production of apples. There are many causes for annual fluctuations in production, but high or low production over a period of years is the final result of increases or decreases in the planting of trees.

When prices are high over a period of years tree plantings are increased, and when prices are low the planting of trees is slowed up, and many orchards are neglected. A comparison between prices paid to farmers for winter apples and wholesale prices of all commodities shows that with few exceptions the prices of apples have

[1] Acknowledgment is due the following for assistance in collecting and critically examining the data: S. W. Fletcher, R. D. Anthony, F. F. Lininger, and R. H. Sudds, Pennsylvania State College of Agriculture; H. L. Crane, P. A. Eke, E. Angelo, and Allan Tener, West Virginia College of Agriculture; F. J. Schneiderhan, F. W. Hoffman, and H. G. Coville, Temporary Field Agent, Virginia Agricultural Experiment Station, Virginia Polytechnic Institute. Credit is also due to the many apple growers and others who furnished the data.

been lower than the general price level during each of the years from 1914 to 1926, inclusive.

In the Cumberland-Shenandoah region many trees in commercial orchards that were set out years ago have but recently come into full bearing. Commercial apple production has increased considerably in the face of increased production in competing areas.

In late years economic distress among the apples growers of the region has been widespread, and many orchardists have found it difficult to meet operating expenses. In many instances the growers must decide whether it is worth while for them to put into their orchards the time and money which the best practices and methods seem to require or take what they can with the least possible expense. In order to reach an intelligent decision or to avoid similar difficulties in the future, an understanding of the underlying causes of the present economic distress and the future possibilities of the apple industry are essential.

Accordingly, in 1925, officials of the agricultural colleges and experiment stations of Virginia, West Virginia, Pennsylvania, and Maryland and of the United States Department of Agriculture, met at Winchester, Va., to discuss the various problems of the apple growers and to formulate plans for definite research projects that might seem advisable. Need for research in many different technical fields was disclosed, and in order to arrive at definite plans of work, committees were appointed to assemble available data and formulate the cooperative research projects which seemed advisable. A committee was appointed to cover each of the following phases of the subject: (1) Rootstock problems, (2) economics of orcharding, (3) uniform spray service, (4) rosy-apple aphis, and (5) correlation of current research projects.

This bulletin contains the results of a study made in Virginia, West Virginia, and Pennsylvania under the direction of the committee on economics of orcharding. The committee felt that, preliminary to a study of the marketing and production problems of the growers, a survey should be made to determine the extent of crop failures or low apple yields and the reasons. This problem was deemed of first importance because the orcharding of the region has developed rapidly and in comparatively recent years and under widely varying conditions of soil, topography, elevation, and methods of orchard management.

Commercial orcharding in the region has developed almost entirely within the last 30 years. Between the years 1899 and 1919 the railroad shipments of apples increased to six times the size of the 1899 shipment. Prior to taking up the apple enterprise a large percentage of the growers were engaged in grain and livestock farming. The transition to apple production was not in all cases accompanied by a complete understanding on the part of the grower of the requirements necessary to get a crop of apples one year with another. With the exception of a few large commercial concerns, very few growers selected and purchased land which they thought was peculiarly suitable for orchard development. Most growers planted their orchards on the farms they already owned, and since many of the farms did not have the soil and air drainage best suited for apple production many of these orchards were on unsuitable sites.

It has taken years of experimental work to determine the most successful present methods of soil and tree management. Since the

orchards were usually introduced as an additional enterprise to an already large number of enterprises existing on the farm it has often been the case that the farmer had too little time and insufficient information, to give proper attention to his orchard.

METHOD OF STUDY

It was generally known before the study was undertaken that several factors were influencing the yields obtained by different growers. Since few growers kept complete records of their business operations it was necessary to prepare a schedule upon which the experiences of a great many growers could be recorded. Careful estimates of yields were obtained over a six-year period and in each case the grower was asked to give the cause of low apple yields and to esti-

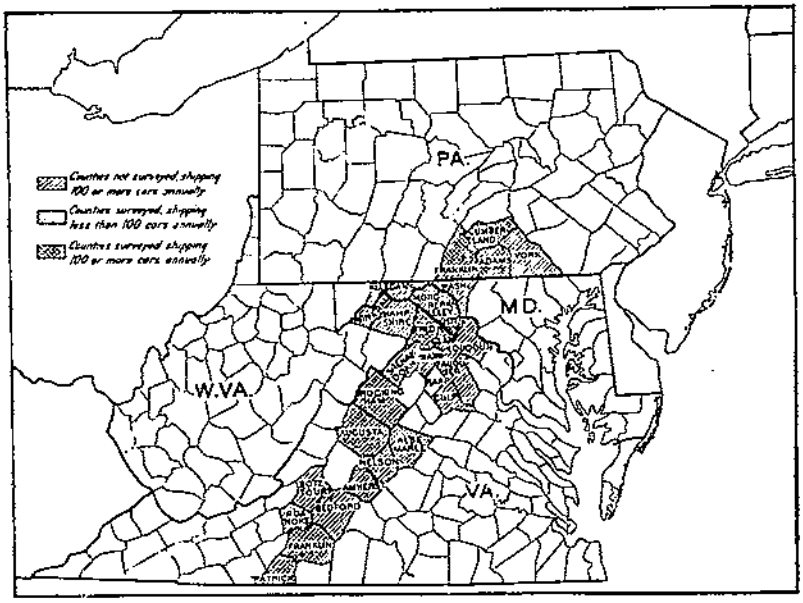

FIG. 1.—PRINCIPAL APPLE-SHIPPING COUNTIES AND COUNTIES IN WHICH SURVEY WAS MADE OF THE CUMBERLAND-SHENANDOAH VALLEY AND PIEDMONT APPLE SECTION FOR THE STATES OF PENNSYLVANIA, MARYLAND, VIRGINIA, AND WEST VIRGINIA

Car-lot shipment data do not indicate any movements of apples from Rappahannock County, but it is included here because many apples are shipped from points outside the county, since no railroad enters the county.

mate the amount of loss due to the various causes. The men who obtained the records were well trained in their respective professions, and each had had considerable experience with orchard and farm problems.

CHARACTERISTICS OF AREA STUDIED

The orchards observed in the summer of 1926 are found in Franklin, Cumberland, and Adams Counties, Pa.; Jefferson and Berkeley Counties, W. Va.; Frederick, Rockingham, and Augusta Counties in the Valley of Virginia; and, Rappahannock, Albemarle, Nelson, Amherst, Franklin, and Patrick Counties in the Piedmont section of Virginia. (Fig. 1.) The four-year average (1922–1925) car-lot shipments of apples for each important apple-producing county in the region is given in Table 1.

TABLE 1.—*Counties in the Cumberland-Shenandoah Valley and Piedmont section having an average annual shipment of 100 or more cars of apples, 1922–1925* [1]

State and county	Average shipments	State and county	Average shipments
Pennsylvania:	*Cars*	Virginia—Continued.	*Cars*
Adams	765	Franklin	132
Cumberland	231	Frederick	2,389
Franklin	924	Loudoun	140
York	151	Nelson	839
Maryland:		Patrick	116
Allegany	114	Roanoke	322
Washington	800	Rockingham	500
Virginia:		Shenandoah	660
Albemarle	985	Warren	548
Amherst	102	West Virginia:	
Augusta	1,051	Berkeley	1,994
Bedford	149	Hampshire	432
Botetourt	263	Jefferson	717
Clarke	240	Mineral	109
Culpeper	199	Morgan	492
Fauquier	104		

[1] The car-lot shipments reported for the different counties were not in all cases indicative of the commercial production. For instance, Rappahannock County, Va., produces many apples but has no car-lot movement from within its borders, as all carloads of apples move from points in other counties.

FIG. 2.—A typical Yellow Newtown (Albemarle Pippin) orchard in a mountain cove of Nelson County, Va. Orchards in the Piedmont section are frequently found on very steep and rugged land, which perhaps accounts for the rather large number of missing trees. The rich dark soil of these coves is particularly well suited to the production of the Yellow Newtown. Air drainage in most orchards that are similarly located is good

Orchards throughout this region are found along the mountain slopes, on the foothills, and on the rolling and level land in the valley. "Apple Pie Ridge" which extends through Frederick County, Va., and Berkeley County, W. Va., is particularly well suited to the growing of apples on account of soil and air drainage. Orchards in this region are found on many different elevations. The

usual elevation is around 600 to 700 feet; other elevations range upward to approximately 1,500 feet. In general it may be said that the valley orchards are on gently rolling land, but outcropping limestone offers some obstruction in the use of tractors, spray, and other machinery. Orchards in the Piedmont section of Virginia, on the whole, are on much more rugged land; some of these orchards are correctly termed "mountain orchards." (Fig. 2.)

The number of orchard blocks observed in the above-named States are as follows: Pennsylvania, 101; West Virginia, 114; Virginia, 279; or a total of 494 orchard blocks. The total acreage of all orchard blocks studied was 14,735 and the total number of trees 561,680. (Table 2.)

TABLE 2.—*Orchard blocks included in the survey, by States and sections, 1926*

State and section	Blocks	Acres	Trees	Varieties
	Number	*Number*	*Number*	*Number*
Virginia:				
Valley	124	4,159	157,577	33
Piedmont	155	4,317	153,601	28
Total	279	8,476	311,178	
West Virginia:				
Berkeley County	68	2,190	95,750	20
Jefferson County	46	1,548	60,175	19
Total	114	3,738	155,925	
Pennsylvania:				
North Mountain	14	152	5,532	15
Greencastle	9	413	10,516	11
Waynesboro	10	593	22,837	12
Fairfield	10	349	9,819	15
Biglersville	28	639	21,053	15
York Springs	6	96	3,741	10
Cumberland County	8	279	12,079	10
Total	101	2,521	94,577	
Total, all States	494	14,735	561,680	

BLOCKS OF TREES STUDIED

All trees of one or more varieties set in a particular unit were considered as constituting an "orchard block." If an orchard block contained more than one variety, each variety was known as a "varietal block." The survey included only blocks of trees which were 15 years of age or older in 1926. The data were obtained for one to three blocks of trees on each farm visited, depending on the location and variety of the trees and the amount of time the grower could give the enumerator. The distribution of blocks by sizes, as shown in Table 3, merely indicates the number of blocks of various sizes and not the frequency with which orchards of the different sizes occur in the region. Only those orchardists who had been in the region for a number of years and who knew the details of their business, were interviewed.

TABLE 3.—*Number and size of blocks of trees studied by sections, 1926*

Size of blocks in acres	Blocks studied					
	All sections	Virginia		West Virginia		Pennsylvania
		Valley section	Piedmont section	Berkeley County	Jefferson County	All sections
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
10 or less	142	23	49	21	6	44
11 to 20	115	28	43	10	13	24
21 to 30	69	23	23	9	5	8
31 to 40	60	15	14	12	8	11
41 to 50	31	15	7	3	2	4
51 to 60	22	5	5	6	4	2
61 to 70	19	6	6	2	4	1
71 to 80	4		1		2	1
81 to 90	6	2	1		2	1
91 to 100	5	3		1		1
More than 100	18	4	6	4		4
Total	494	124	155	68	46	101

AGE OF APPLE TREES

Of the eight leading varieties in the blocks of trees surveyed, the York Imperial and the Yellow Newtown were well represented in the old-age groups. The York Imperial has held its place in recent years but the Yellow Newtown appears to have lost some of its popularity; only a few trees were found that were between 15 and 19 years old. The Winesap and Ben Davis have been grown in quantities for many years. Stayman Winesap and Delicious, relatively new varieties, are now well represented in the region. Few Stayman trees were found that were more than 25 years old and no Delicious trees that were over 20 years old. Relatively few Grimes Golden of 25 years of age and older were reported, and few of the Arkansas (Mammoth Black Twig) variety of trees were over 35 years of age. (Table 4.) These figures do not represent the recent trend in the development of specific varieties in the region, but they indicate the relative proportion of trees of the eight leading varieties that were over 15 years old and whether the variety is of long standing in the region or of more recent introduction.

TABLE 4.—*Trees of eight leading varieties of the orchard blocks studied in Virginia and West Virginia, 1926, classified by age* [1]

Variety	Trees reported by age				
	15 to 19 years	20 to 24 years	25 to 29 years	30 to 34 years	35 years and over
	Number	*Number*	*Number*	*Number*	*Number*
York Imperial	55,484	46,853	38,869	17,118	8,028
Winesap	23,317	11,742	25,426	8,547	1,290
Ben Davis	10,851	21,029	15,169	4,384	1,848
Stayman Winesap	41,597	2,225	39		
Yellow Newtown (Albemarle Pippin)	445	2,337	9,116	8,213	8,231
Grimes Golden	14,304	5,450	1,092	235	45
Arkansas (Mammoth Black Twig)	6,931	2,832	1,695	1,895	79
Delicious	5,785				

[1] A small percentage of the trees in the orchard blocks studied is not included because the age of the trees was not reported.

VARIETIES OF APPLES

Apple trees of 48 varieties were found in the orchards studied in Virginia and West Virginia. Similar data are not available for the Pennsylvania orchards studied. Of these, seven varieties—York

Imperial, Winesap, Ben Davis, Stayman Winesap, Yellow Newtown, Grimes Golden, and Arkansas made up more than 90 per cent of all the trees included in the survey. The York Imperial is an important variety in all districts studied; the Winesap is of particular importance in the Piedmont section of Virginia; the Ben Davis, Stayman Winesap, Grimes Golden, and Arkansas are rather generally grown in the region, and the Yellow Newtown is found almost exclusively in Virginia, particularly in the Piedmont section. The Gano, Jonathan, and Delicious are grown on a number of farms in both sections of Virginia and in West Virginia. The Bonum is rather important in the upper Piedmont of Virginia; King David is of importance in the Valley of Virginia, and Yellow Transparent is found in goodly numbers in Berkeley County, W. Va. (Table 5.)

TABLE 5.—*Original number of trees planted by varieties in the orchard blocks studied in Virginia and West Virginia*

Variety	Total trees	Virginia		West Virginia	
		Valley section [1]	Piedmont section	Berkeley County [2]	Jefferson County
	Number	*Number*	*Number*	*Number*	*Number*
York Imperial	199,920	94,490	34,589	47,843	23,004
Winesap	81,830	5,220	73,667	365	2,569
Ben Davis	63,007	19,143	5,275	22,597	16,052
Stayman Winesap	47,897	21,122	11,028	10,124	5,623
Yellow Newtown (Albemarle Pippin)	36,001	1,750	34,081	80	90
Grimes Golden	25,847	5,610	1,215	12,427	6,595
Arkansas (Mammoth Black Twig)	14,884	4,360	2,478	2,677	5,369
Delicious	6,780	4,805	695	200	1,080
Bonum	6,700		6,700		
Gano	6,347	3,007	1,250	250	1,750
Jonathan	5,892	2,125	1,105	620	2,042
Northwestern Greening	3,703	845		2,856	62
Yellow Transparent	2,448	530		1,418	500
Black Ben	1,885	1,735	150		
King David	1,690	1,340	30		320
Royal Limbertwig	1,321		1,321		
Rome Beauty	1,001	110	441	250	200
Beach (Apple of Commerce)	875	250	425		200
Collins (Champion)	705	355	250		100
July (Fourth of July)	600			600	
Lowry	560	400	160		
Early Ripe	400	250		150	
Rambo	400	300		100	
Maiden Blush	385			385	
Akin	350			350	
Gravenstein	300	300			
Lowell	300			300	
Wealthy	300	300			
Stark	270	50		150	70
Baldwin	260	225			35
Arkansas Black	257		100		157
Henry Clay	250	250			
Lawver	200	200			
Red Astrachan	185			185	
Buckingham	155		155		
Kinnard	112	100	12		
Oliver Red (Senator)	100				100
Jefferis	92		92		
Milam	85	85			
Ralls (Rawles Genet) (Neverfail)	85	85			
Missouri Pippin	55		55		
Winter Paradise (Paradise Winter Sweet)	55		55		
Domine	50		50		
Rhode Island Greening	50	50			
Fall Cheese	40	40			
Virginia Beauty	35	35			
Robinson	30		30		
Northern Spy	12	12			
Total	514,832	169,548	175,409	103,957	65,918

[1] Does not include the number of trees planted in 1 orchard block in Augusta County.
[2] 800 trees of unknown varieties are not included.

YIELDS OF APPLES

The five-year average yield for 441 orchard blocks studied was 1.2 barrels per tree. About 11 per cent of the blocks of trees yielded one-half barrel or less per tree, and nearly 40 per cent produced 1 barrel or less per tree annually. Only 6 per cent had yields of more than 3 barrels per tree, and slightly more than half of the blocks yielded 1.1 to 3 barrels per tree. (Fig. 3 and Table 6.) Undoubtedly a part of these variations in tree yields are caused by variations in the ages of the trees. Yields of one-half to 1 barrel per tree are lower than should reasonably be expected if the trees are properly located and tended, even for the youngest trees included in the survey.

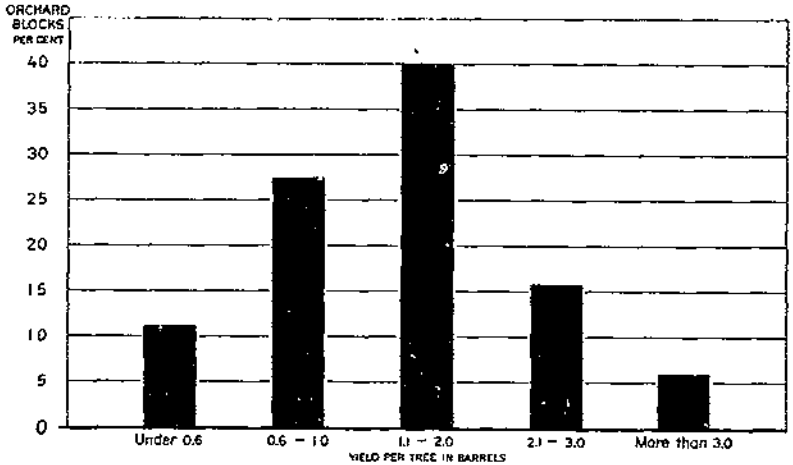

FIG. 3.—ORCHARD BLOCKS CLASSIFIED BY YIELDS, AVERAGE, 1922-1926

Approximately two-thirds of the orchard blocks studied in Pennsylvania, Virginia, and West Virginia had average yields of 0.6 to 2 barrels per tree for the period 1922–1926. Only 6 per cent had average yields of more than 3 barrels, and 11 per cent had average yields of one-half barrel or less per tree.

TABLE 6.—*Number of orchard blocks with specified yields per tree, 1922–1926*

Yield per tree in barrels [1]	Blocks of trees				Percentage of total number of blocks			
	Pennsylvania	Virginia	West Virginia	Total	Pennsylvania	Virginia	West Virginia	Total
	Number	*Number*	*Number*	*Number*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
0.5 and fewer	5	30	14	49	9.4	10.7	12.9	11.1
0.6 to 1	7	90	24	121	13.2	32.3	22.0	27.4
1.1 to 2	23	111	42	176	43.4	39.8	38.5	39.9
2.1 to 3	11	35	23	69	20.8	12.5	21.1	15.7
More than 3	7	13	6	26	13.2	4.7	5.5	5.9

[1] 5-year average, 1922–1926, all varieties. Data on yields in each of the 5 years were obtained for only 441 blocks.

A classification of orchard blocks by yields per tree for each of the six years, 1921–1926, shows considerable variation from year to year in the number of orchards in the different yield classes, but it likewise shows that during each of the past six years (1921–1926) only relatively few blocks of trees yielded more than 2 barrels per

tree. (Table 7.) The heavier-yielding orchards of to-day probably have a relatively large proportion of the York Imperial, Yellow Newtown (Albemarle Pippin), Ben Davis, or Grimes Golden. The Delicious, Stayman Winesap, and to a less extent, the Arkansas (Mammoth Black Twig), and the Grimes Golden are among the more recent plantings in this region, and many trees of these varieties may not yet have attained the full bearing age. It has not been possible to determine exactly the influence of variety on yield per tree, but the data indicate that the York Imperial yields relatively well in all sections studied; the Yellow Newtown yields well in the Piedmont section of Virginia; and the Ben Davis yields well in this entire region when given proper care. Varieties of the Winesap family appear to produce relatively low yields, often because of the poor pollination facilities.

TABLE 7.—*Number of orchard blocks with specified yields per tree, 1921–1926*

Yield per tree in barrels [1]	Orchard blocks					
	1921	1922	1923	1924	1925	1926
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
0.5 and fewer	381	166	116	89	135	39
0.6 to 1	26	101	94	106	102	102
1.1 to 2	22	108	125	137	126	156
2.1 to 3	13	47	53	66	45	89
More than 3	4	22	62	54	45	63

[1] All varieties.

In the Cumberland-Shenandoah region the orchards varied in size from a few acres to more than 1,000 acres. With the low yields obtained by many, an orchard of less than 20 acres does not assure the owner of more than a moderate gross income at best, and in times when prices of apples are low the net income is small. It is possible to make a small orchard that is well located and well tended an important source of income in connection with other farming operations, but a practice of neglecting their trees seems to be rather prevalent among small orchardists, and under such conditions the orchard is often a liability instead of an asset. The large orchards are usually operated in a more businesslike way, and when prices are favorable, returns from them are relatively good. When prices are low the difficulty of paying expenses is increased in comparison with the small orchard because of the large cash expenditures for labor. Any orchard must be properly located with respect to elevation, soil, and shipping facilities and must be handled according to the best known methods if it is to return a fair reward for the capital invested.

CAUSES OF LOW YIELDS

The variation in the yield from year to year in different orchards is caused by a great many factors, in addition to age and variety. Low yields are usually attributed by growers to the following factors: Frost, offyear, failure of fruit to set, hail, diseases, insects, and drought. When orchards are located in frost pockets, or in poor or shallow soil, good yields in all years are not possible. Further, low

yields may be the direct effect of poor and indifferent management either of the trees or of the soil. The opinions of the orchardists interviewed in Virginia and West Virginia as to the relative importance of the various causes of low yields are shown in Figure 4 and for the four principal varieties of apples in Table 8.

TABLE 8.—*Number of varietal blocks in Virginia and West Virginia, the owners of which reported reduced yields due to frost, offyear, failure of fruit to set, drought, hail, wet weather, and other causes, 1922–1925*

Variety	Frost				Offyear				Failure of fruit to set			
	1922	1923	1924	1925	1922	1923	1924	1925	1922	1923	1924	1925
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Ben Davis	55	18	22	35	23	23	46	20	3	4	6	9
Yellow Newtown (Albemarle Pippin)	13	17	8	0	24	37	15	33	7	7	8	6
Winesap	61	60	24	49	13	22	17	22	48	60	51	51
York Imperial	124	57	50	86	42	75	85	108	11	13	13	10

Variety	Insects and diseases				Drought, hail, wet weather, and other causes			
	1922	1923	1924	1925	1922	1923	1924	1925
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Ben Davis	14	19	20	23	21	27	41	59
Yellow Newtown (Albemarle Pippin)	10	10	12	8	9	8	8	25
Winesap	20	16	46	14	28	34	31	84
York Imperial	61	61	58	53	35	55	60	112

Growers attributed more losses to frosts and freezes than to any other single cause. Many orchards are damaged by frost or freeze every year, and in some years the damage is particularly great. In 1921 frost or freeze caused an almost total loss of crop throughout the region. It was again particularly severe in the northern portion of this region in 1922. In 1923 a frost hit the southern end of the region, and in 1925 frost again hit the northern sections very severely. It will be noted from Figure 4, however, that, in the opinion of the growers interviewed, other causes in the aggregate were more important than frost in the lowering of yields. Next in importance to frost is what is termed "offyear." A considerable reduction in yield was attributed to failure of fruit to set. Insects and diseases, drought, hail, and unknown factors were given as the causes of a considerable proportion of the losses.

FROST

The upper part of the Shenandoah Valley suffered greater damage in 1922 than did the lower section of the valley or the Piedmont section; in 1923 the conditions in this respect were reversed, according to the growers' reports of damage. In the upper part of the Shenandoah Valley and in Pennsylvania the three years 1922, 1925, and 1924, in the order given, were severe for the growers whose orchards were on poor sites. In 1923, 1922, and 1926 frost was severe in Albemarle, Nelson, and Franklin Counties, Va. In 1923 and 1925 the frost damage was outstanding in Augusta, Amherst, and Rappa-

hannock Counties. The freeze in 1921 was very destructive to the apple crop in all sections except for a few isolated cases. (Table 9.)

In this region the average date of blooming and of the last killing frost in the spring are very nearly the same. The low temperature danger point for fruit blossoms, or for fruit just set, ranges in most cases from 27° to 29° F.[2] Buds will withstand somewhat lower temperatures than blossoms.

In most of the years when frost damage was heavy the apple trees bloomed earlier than usual. There is a great deal of variation in spring temperatures from year to year and, since for most plants the temperature at which vegetative functions begin may be taken at 43° F.,[3] there is a great deal of variation in dates of blooming.

Orchardists are often inclined to overestimate the damage to their crop of a frost at blossom time, for there are usually many more blossoms on a tree than are required to set a full crop, and a frost that leaves a fair percentage of blossoms unharmed may cause no serious reduction of the crop.

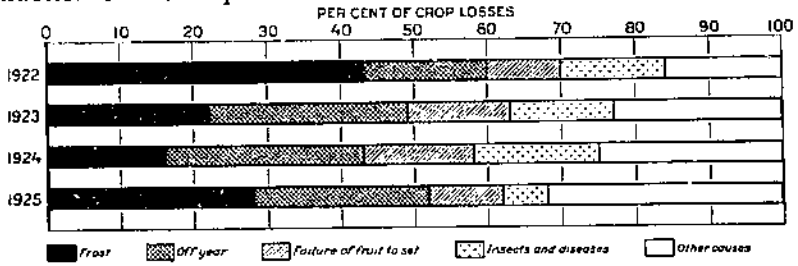

FIG. 4.—CROP LOSSES ATTRIBUTED TO DIFFERENT FACTORS BY GROWERS, 1922-1925

Frost is less responsible for losses to the apple crops of the region than is generally thought. On the farms studied, offyear, failure of fruit to set, insects and diseases, and miscellaneous causes are responsible for from one-half to more than three-fourths of the total losses during the various years 1922 to 1925. Data for 1921 are not included because of the severe freeze. Data for 1926 are not included on account of the unusually favorable growing season.

TABLE 9.—*Percentage of orchard blocks the owners of which reported frost damage, 1921–1926*

State and county	Orchard blocks	1921	1922	1923	1924	1925	1926
	Number	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Virginia:							
Augusta	41	98	26	48	7	43	29
Rockingham	44	100	5	14	5	14	20
Frederick	39	97	56	31	41	51	(a)
Albemarle	47	100	57	64	19	28	36
Rappahannock	38	90	13	13	11	26	5
Amherst	19	100	42	58	21	42	37
Nelson	23	100	35	43	9	22	43
Franklin	14	100	21	21	14	14	14
Patrick	14	100	7	14	7	7	0
West Virginia:							
Berkeley	68	84	53	6	18	26	3
Jefferson	46	100	96	4	28	78	7
Pennsylvania:							
Sections—							
North Mountain	14	57	50	0	7	29	0
Greencastle	9	78	78	0	11	22	0
Waynesboro	19	74	47	0	0	36	0
Fairfield	19	70	37	5	21	11	5
York Springs	6	83	67	0	0	0	0
Cumberland County	8	50	37	12	12	25	12
Biglersville	26	57	42	4	16	8	8

(a) No data.

[2] Smith, J. W., Agricultural Meteorology, 1920, p. 139.

[3] Ibid., p. 67.

There is a very close inverse relationship between the mean spring temperature and the production of apples. The period during which temperatures apparently have greatest influence in determining the blossoming date is that from February 7 to March 21. The correlation coefficient between mean temperature for this period and the percentage of average apple yield in Virginia is −0.79. The data are shown in Table 10. The relationship is illustrated in Figure 5. Analysis of spring temperatures at official stations of the Weather Bureau, and total production of apples in Virginia for the years 1906–1925, indicate that if the temperature for the period February 7 to March 21 is above the normal it may usually be expected that blossoming will be early, that many orchards will be damaged by frost, and that yields will be low. Conversely, if the mean temperature for this period is below normal, blossoming will be delayed, and yields will usually be good. In 1921, for example, the season was unusually early, apple trees bloomed about three weeks earlier than usual, and a freeze killed most of the crop in the entire region. On the other hand, 1926 spring temperatures were below normal, blossoming was delayed in many places, there was little frost damage, and one of the largest crops on record was produced.

TABLE 10.—*Relation of average temperatures, February 7 to March 21, to apple production, Virginia, 1906–1925*

Year	Average temperature[1] Feb. 7 to Mar. 21	Total apple production	Year	Average temperature[1] Feb. 7 to Mar. 21	Total apple production
	° F.	*1,000 bushels*		*° F.*	*1,000 bushels*
1906	36	5,500	1916	37	13,209
1907	38	5,200	1917	37	11,778
1908	37	8,900	1918	43	10,068
1909	41	6,107	1919	41	8,943
1910	39	12,100	1920	35	13,744
1911	39	7,200	1921	46	570
1912	34	15,000	1922	41	8,960
1913	41	5,200	1923	39	10,000
1914	32	15,300	1924	36	14,500
1915	39	13,176	1925	45	7,844

[1] At six official stations of the U. S. Weather Bureau located in the apple-producing section of Virginia.

Some orchards seem to be so located that they are troubled with frost almost every year. Practically all orchards were frozen in 1921, with the result that there was practically no crop in the region. A more normal trend of yields is represented in the period from 1922 to 1925. The numbers of growers reporting damage or no damage from frost during the years 1922–1925 and the average yields per tree are shown in Table 11. In general, average yields for the four-year period were lower in the orchards which had frost damage three or four times in the period than in the orchards which had no damage or which were damaged in only one or two years. It is evident, however, that frequency of frost damage alone does not account for all the variations in yields.

TABLE 11.—*Frequency of frost damage and average yield per tree, by varieties, for the four-year period, 1922–1925* [1]

Variety	No frost		Frost once		Frost twice		Frost 3 times		Frost 4 times	
	Varietal blocks	Average yield per tree	Varietal blocks	Average yield per tree	Varietal blocks	Average yield per tree	Varietal blocks	Average yield per tree	Varietal blocks	Average yield per tree
	Number	*Barrels*	*Number*	*Barrels*	*Number*	*Barrels*	*Number*	*Barrels*	*Number*	*Barrels*
York Imperial	85	1.23	73	1.53	50	1.50	32	1.10	9	0.90
Ben Davis	41	1.30	33	1.46	23	1.48	17	1.03	None.	None.
Winesap	58	1.19	32	.73	31	.70	15	.85	11	.20
Stayman Winesap	25	1.02	22	.80	24	.74	8	.40	8	.37
Grimes Golden	13	1.12	10	1.29	10	1.16	5	.90	2	.45
Yellow Newtown (Albemarle Pippin.)	36	1.40	12	1.53	5	1.69	6	1.28	1	.29
Arkansas (Mammoth Black Twig)	27	.84	18	.56	13	.50	7	.69	2	1.15
Delicious	10	1.36	8	.72	4	.25	1	.24	2	.64

[1] Data for 1921 not included on account of the destructive freeze. Data for 1926 not included because of the almost complete freedom from frost damage.

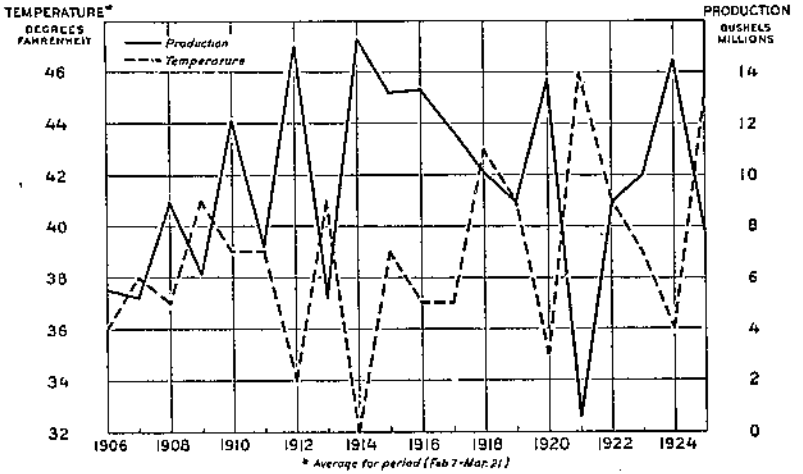

FIG. 5.—RELATION OF TEMPERATURE, FEBRUARY 7–MARCH 21, TO APPLE PRODUCTION

An analysis of temperature data for the years 1906 to 1925 from six official stations of the United States Weather Bureau located in the apple-producing section of Virginia shows that the period during which temperatures have the greatest influence on the blossoming date of apples is February 7 to March 21. Temperature above normal for this period usually indicates early blossoming and reduced yields from frost, and temperature below normal delays blossoming, a condition favorable to good yields.

This investigation brought out the fact that the air drainage afforded by the elevation of an orchard site above the immediately surrounding land is a very large factor in the elimination of frost damage. Orchards on elevated sites gave better average yields for the period 1921–1926, and there was also less variation in annual yields for such orchards in comparison with yields for orchards with little or no elevation above surrounding land.

Each orchard block investigated was classified by the observer as having either good, fair, or poor air drainage. Yields per tree for the period 1921–1926, in orchards classified as having good air drainage, averaged about one-third more than in those orchards where air drainage was poor. (Table 12.)

TABLE 12.—*Relation of air drainage to yield per tree, Virginia and West Virginia average, 1921–1926*

Variety	Good air drainage		Poor air drainage	
	Varietal blocks	Yield per tree	Varietal blocks	Yield per tree
	Number	*Barrels*	*Number*	*Barrels*
Ben Davis	124	1.1	18	0.8
Grimes Golden	62	1.0	11	.7
Yellow Newtown (Albemarle Pippin)	66	1.2	6	1.2
York Imperial	249	1.3	46	1.0

There is a considerable variation between sections in the percentage of the orchard acreage having poor air drainage. (Table 13.) The acreage of the orchard blocks with poor air drainage varies from almost none in Rockingham and Patrick Counties to 39 per cent in Frederick County, Va. Evidently this factor was not given the consideration it should have had when the sites for many of the present orchards were selected.

TABLE 13.—*Percentage of area of the orchard blocks studied that had poor air drainage*

State, section, and county	Acreage of orchards studied		State, section, and county	Acreage of orchards studied	
	Total	Percentage of total having poor air drainage		Total	Percentage of total having poor air drainage
Virginia:			West Virginia:		
Valley—	*Acres*	*Per cent*	Berkeley	*Acres* 2,190	*Per cent* 15
Augusta	1,287	3	Jefferson	1,548	11
Frederick	1,749	39	Pennsylvania:		
Rockingham	1,123		North Mountain	152	1
Piedmont—			Greencastle	413	27
Albemarle	1,023	4	Waynesboro	593	1
Amherst	387	19	Fairfield	349	3
Franklin	391	7	Biglersville	630	10
Nelson	524	37	York Springs	96	21
Patrick	252		Cumberland	279	26
Rappahannock	840	15			

In each section there are many orchards on sites that have good air drainage, and there are many good sites still available for orchard planting on which it is to be expected that frost damage would be low.

Great advantage may be had in selecting a location for an orchard where the local surface is uneven, if only the higher elevations are taken. (Fig. 6.) Pockets from which cold air will not drain are particularly to be avoided. The importance of this matter was repeatedly pointed out by different growers. Orchard surveys by the Weather Bureau in the Western States show that on a frosty morning a rise of 50 feet on a slope will sometimes cause the thermometer to register a temperature 10° to 20° F. higher than that at the base of the hill. In the East temperature variations as a rule are not so pronounced as in the drier western sections, but there is often sufficient difference to protect fruit on the higher grounds.

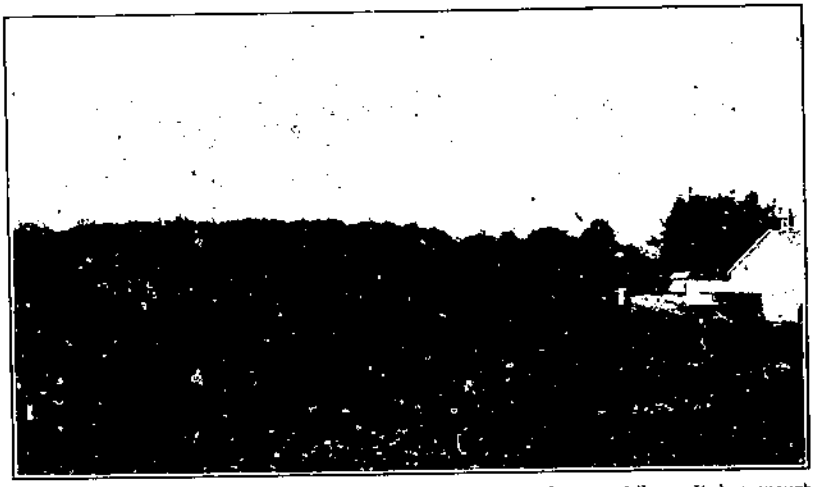

FIG. 6.—The orchard shown in the background has never had a crop failure. It has enough elevation (about 30 feet) and a wide drainage basin, which insure it against frost damage

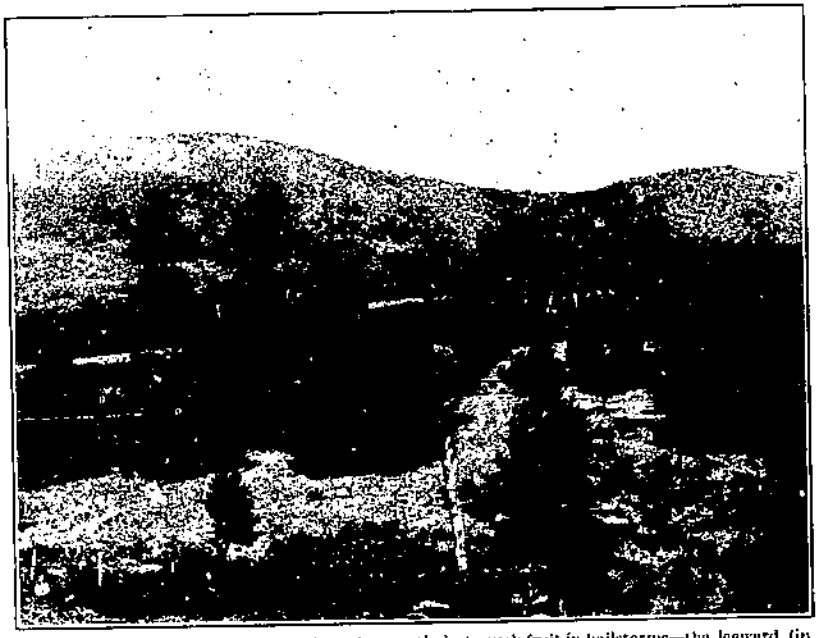

FIG. 7.—A location where orchards have frequently lost much fruit in hailstorms—the leeward (in this case eastern) side of a mountain gap. The general appearance indicates a location otherwise favorable

HAIL

Hail frequently damages the apple crop in some orchards in the Cumberland-Shenandoah Valley apple region, both by reducing the yields and by lowering the quality of the fruit left on the trees. In the period 1922–1926 some damage from hail was reported each year, but particularly in 1924 and 1925. Apple growers whose orchards were located on the immediate leeward (eastern) side of mountain gaps reported more frequent damage than did other growers. (Fig. 7.)

Orchards should not be set on sites where hail is known to occur frequently. Where orchards are already located, hail damage must be considered as one of the risks of the business which may sometimes be serious.

DROUGHT

Droughts occasionally damage the apple crop in various sections of the valley. Drought affects first, and most seriously, those orchards located on hillsides where the soil layer is thin, is lacking in moisture-retaining vegetable matter, and is subject to washing. Orchards on locations that are favorable from the standpoint of an elevation that gives good air drainage and protection from frost, frequently suffer from drought, which results in small-sized fruit and a general lack of thrift in the trees. Orchards with deep soils, well supplied with humus, suffer little from drought. Thin soils and soils in poor tilth may be improved by regularly plowing under green crops that have been grown for the purpose. Where soil washing is serious, sod must usually be maintained or the orchard must be terraced.

Drought damage was more general in 1925, as reported by the growers visited, than in other years. Drought damage is associated with certain locations, and in the opinions of the growers only a few of the blocks studied were seriously affected.

SLOPE

In the 494 orchard blocks there were 486 groups of trees, each containing a single variety, located on a definite slope, for which the yields were recorded. Forty-two groups of trees had no noticeable slope. Of the 486 groups of trees, 170 were on an eastern slope, 96 on a southeastern, 93 on a western, 89 on a southern, and 38 on a northern slope. A slope is important in comparison with a level area largely because it insures a certain degree of atmospheric drainage. If a nearly level area has adequate air drainage, a slope would offer little or no superior advantage. The relative merits of slope in any particular direction depend almost entirely on the surrounding topography (which governs the direction of prevailing winds, storms, and air currents) rather than on the direction of the slope itself. The slight differences in the reported yields in these orchards indicate that for this region as a whole the direction of slope is not an important factor.

SOILS

The soils of the Cumberland-Shenandoah Valley and the Piedmont section studied are, in general, suitable for apple production. In most of the sections, however, there are soils and soil formations on which orchards show effects attributable to poor soil conditions. Such soils should be avoided. Thin shale soils lying on hardpan or rock, and otherwise rich soils of shallow depth over rock are of this kind. (Fig. 8.) Trees planted in the poorer soils do not thrive and those planted in shallow soils, even if the soils are rich, are likely to

be short lived and to suffer from soil exhaustion, drought, and disease. There is an abundance of rich mellow soils with deep well-drained subsoil in the region, and the best orchards are found on them.

Soils that were originally suitable for orchards may lose much of their value through unwise treatment or neglect before or after the orchard is set. The observers noted many orchards in which the soils were deficient in humus and were unretentive of moisture. A site which is desirable because of elevation and other factors may lose its value for profitable orcharding if care is not exercised to keep the fertile soil in place. Soil lacking in humus will wash away more easily than soil well filled with decayed vegetable matter. It was estimated that about one-eighth of the total orchard acreage in one locality was made unsuitable for profitable orcharding because of

FIG. 8.—Solid rock sometimes lies under a very thin layer of soil. The apple tree finds very meager support when planted in the thin top layer because of lack of moisture and plant food

soil washing. The yield per tree on the part that was badly washed averaged one-third less than the yield per tree on the remainder. Soils in orchards on hillsides should be kept well filled with humus, or should be terraced, or kept in sod, depending on the steepness of the slope, the character of the soil in any particular case, and the relation thereof to soil washing. (Fig. 9.)

CULTURAL PRACTICES

The prevalence of relatively low yields of apple trees in the region seems to be variously associated with factors other than direct damage from frost, hail, and drought and the depredations of insects and disease. Soil and tree management vary greatly in different orchards. Although it is not possible with the data at hand to determine the best practice for every case, the more common practices are given as reported by the orchard owners. (Tables 14 and 15.)

FIG. 9.—The trees in the background are on a hillside where erosion and leaching have so reduced soil fertility that the trees have been stunted

TABLE 14.—*Sod orchards, variation in cultural practices, 1926*

Methods and practices	Orchard blocks the owners of which reported the practices indicated				
	Virginia		West Virginia		Pennsylvania
	Valley section	Piedmont section	Berkeley County	Jefferson County	All sections
	Number	*Number*	*Number*	*Number*	*Number*
Sod orchards, total	38	62	11	25	36
Grass cut and left on ground	33	57	10	24	31
Hay removed	5	5	1	1	5
Fertilizer applications:					
Nitrate of soda (pounds per tree)[1]—					
0	17	23	5	13	11
1	4	11		4	2
2	5	14	1	1	5
3	5	4		2	1
4	4	5	2	2	7
5	1	1	3	2	6
6	2	4		1	4
Acid phosphate (pounds per tree)—					
0	29	39	11	25	24
1	3	7			2
2	1	5			2
3	1	6			2
4	1	2			2
5	2	1			2
6	1	2			2
Spraying (times sprayed): [2]					
0	2	2			
1		2			
2	7	11	3	2	4
3	9	18	6	5	6
4	7	12	2	1	12
5	11	12		13	9
6	1	3		1	3
7	1	2		3	
Pruning: [2]					
Good	17	36		7	7
Fair	12	24	3	9	10
Poor	9	2	8	9	17

[1] A few growers used sulphate of ammonia.
[2] No record in 2 cases in the Pennsylvania group of orchards.

TABLE 15.—*Tilled orchards, variation in cultural practices, 1926*

Methods and practices	Orchard blocks the owners of which reported the practices indicated				
	Virginia		West Virginia		Pennsylvania
	Valley section	Piedmont section	Berkeley County	Jefferson County	All sections
	Number	*Number*	*Number*	*Number*	*Number*
Tilled orchards, total	49	18	51	8	10
Number of cultivations:					
1	3	4	2		2
2	12	14	7		
3	8	10	13	3	7
4	8	11	12	1	
5	11	0	8	1	2
6	5	0	6	1	3
More than 6	2	3	3	2	5
Cover crops used:					
Weeds	32	12	28	5	11
Nonlegumes	3	4	9	1	2
Legumes	14	32	14	2	6
Fertilizer applications:					
Nitrate of soda (pounds per tree) [1]—					
0	14	14	22	3	8
1	8	9	5		2
2	8	11	8		
3	7	3	5	1	2
4	5	6	6	1	3
5	5	4	2	2	2
More than 5	2	1	5	1	2
Acid phosphate—					
0	34	21	46	8	15
1	3	5			1
2	2		1		1
3	2	5	2		
4	2	3			1
5		4	1		
More than 5	6	10	1		1
Spraying (times sprayed)—					
0		1			
1	2				
2	7	3	8		1
3	9	5	7		3
4	11	10	8		5
5	15	16	18	7	8
6	3	10	3	1	1
7	2	3	7		1
Pruning: [2]					
Good	34	37	19	7	6
Fair	13	9	25	1	4
Poor	1	2	7		8

[1] A few growers used sulphate of ammonia.
[2] No record in 1 case in valley section of Virginia and in Pennsylvania.

Practice with respect to cultivation was almost equally divided—172 blocks were kept in sod, 175 were regularly cultivated, and 147 were in sod in some years and plowed up in others.[4] There were many instances of good yields in both sod and clean-cultivated orchards. Local conditions should determine the method; but in steep, rough places it is nearly always advisable to have the orchards in sod. In many orchards it is probably advisable to employ the clean-culture method with cover crops, as this method will better maintain soil tilth. Sod culture saves the expense of cultivation and makes for easy movement through the orchard especially during a wet season, but sod orchards require a greater quantity of nitrates, the cost of which tends to offset this saving.

[4] Of the 147 orchard blocks which were neither plowed nor kept in sod during the entire period of the study, 82 were in Virginia, 19 in West Virginia, and 46 in Pennsylvania.

Most owners of sod orchards agree that it is best to leave the grass on the ground after cutting, but a few growers made hay of it. Fertilizer was not generally used in the sod orchards in quantities large enough to be effective. The greater number sprayed the trees less than five times. Pruning was described by the observers as good or fair in the majority of these orchards.

Among the owners of tilled orchards there was even less uniformity of practice than among owners of sod orchards. Some apparently kept the orchards under dust mulch thoughout the season, but the majority worked the land fewer than five times. Legumes were used for cover crops more frequently than nonlegumes, but the majority, except in the Piedmont section of Virginia, did not bother with a formal cover crop, relying on weed growth. Fertilizer was more generally used by those who cultivated their orchards than by those with sod orchards, the quantities used running up to heavy applications. Sprayings were also relatively more frequent among the orchardists in this group. Pruning in most cases was described by the observers as "fair" or better.

The use of more fertilizer in many orchards, particularly of nitrates, would greatly increase yields. So many factors affect yield that it is difficult to determine the actual influence of a single factor. Nevertheless, the beneficial results from the use of 4 or more pounds of nitrates per tree can hardly be disputed,[5] and probably 6 to 8 or more pounds of nitrates on a full-bearing tree, especially in sod orchards, would be worth while. There have been exceptions, where nitrogen has been used on trees that have received good cultivation and the soil was well maintained as to humus content. Trees must be kept well nourished if regular and good crops are to be expected. It is frequently alleged that in orchards that receive heavy applications of nitrate of soda the apples fail to have proper color and early maturity. Lack of color may be due to dense foliage and may be avoided to some extent through proper pruning. Lack of maturity is not a question of too much nitrate of soda as often as it is of unseasonably high temperatures and rainy weather, such as was experienced in 1926 at the customary time of picking.

INSECTS AND DISEASES

Insects and diseases are constant threats to the growers of the region and frequent losses occur as a result of the production of large quantities of low-grade fruit whenever control is neglected. In the principal apple-producing counties of these three States a free spray information service is available through the State Agricultural Experiment Station. This type of service consists of the dissemination of exact information as to the dates of emergence of insects and the dispersion of disease spores which vary from season to season with the weather conditions. This makes possible the exact timing of the necessary spray applications to effect the largest possible degree of control of insects and diseases.

Many orchardists in the region who have used this service constantly produce crops of clean fruit of high quality. There are others who spray too few times and then not thoroughly enough.

On the average there were 50 acres of orchard to be sprayed for every spray outfit on the farms visited. To attempt to spray 50 to

[5] Bul. 203, Fertilization of Apple Orchards, Agricultural Experiment Station, Morgantown, W. Va.

100 acres of orchard with one spray outfit, year after year, simply means that this operation is not done well, and a large percentage of undesirable fruit results. In general, one spray outfit for each 30 acres of orchard would give more satisfactory results.

OFFYEAR

Apple trees, as generally cared for in this region, tend to bear every other year. The trees do not bear heavily, and set fruit buds the same year. After a heavy crop one year the tendency is for the orchard to bear a light crop the next. Well-nourished trees, properly pruned, tend to bear every year. Thus irregular bearing is, to a considerable extent, taken out of the category of necessary evils, and responsibility for it can be placed largely in the hands of the grower. No evidence was found that any variety was particularly irregular in bearing if well cared for in all respects.

FAILURE OF FRUIT TO SET

A number of growers attributed low yields to failure of fruit to set. It was commonly observed that the low yields of the Winesap and varieties of the Winesap family were ascribed to this factor. These varieties are largely self-sterile and must be cross-pollinated by some other variety. Self-sterile varieties should not be planted in solid blocks or isolated from other orchards. Where self-sterile varieties have been so planted the results may be improved by top-working every fourth or fifth tree in every fourth or fifth row with some variety that is a good cross-pollinizer. Bees are essential in any orchard and are effective in securing pollination even during cold, wet seasons.

The blossoming period is a critical one for the apple tree in this region. Climatic conditions are variable; the weather may be cold, and rain may fall often enough to keep the flowers drenched almost the entire period of blossoming. Such conditions are unfavorable to pollination.

PLANTING DISTANCES

Many orchards show the effects of crowding. The older orchards in the region were usually planted 30 by 30, 33 by 33, and 36 by 36 feet, and in some cases they have been planted even closer one way, such as 15 by 30 feet. In orchards which were planted 30 by 30 feet, 25 years ago, and in which the trees are thrifty, the branches are now touching in the row middles. This not only makes cultivation and spraying difficult, but it influences yield and color of fruit largely because so much of each tree is shaded. Such orchards will present even greater difficulties as the trees grow older. In the more recent plantings, permanent trees have been spaced 40 by 40 feet, the distance advised by growers of long experience.

While trees are young—say, under 20 years old—close spacing gives a larger yield per acre than does the standard spacing for mature trees of the standard varieties. Increased earning power of the orchard in the early years after setting is the usual reason for close planting. No disadvantage is experienced from close planting if the trees are set out according to a system which provides for the removal of a sufficient number to leave the permanent trees far enough apart when they have attained full growth. An orchard of standard varieties set

40 by 40 feet will have 27 trees per acre. If fillers are placed at the intersection of the diagonals of the squares made by the permanent trees, the production of 21 additional trees may be obtained during the early bearing years of the orchard.

In cases in which there is plenty of land suitable for orchard a better plan would be to grow the additional trees on other land rather than to grow them as fillers. The additional cost would often be more than offset by the fact that the trees would be a permanent part of the orchard. The chief difficulty with close planting is that growers yield to the temptation to postpone removal of the fillers until after the orchard shows the effect of overcrowding. (Figs. 10 and 11.) On poor soils the trees do not grow so large, and closer plantings might seem safer than if the trees were thrifty, but the experience is that even on these soils standard spacing is desirable.

MISSING TREES

During the life of an orchard many trees are lost. The number of trees lost and the percentage of loss in different sections are shown in Table 16. Disease is probably the chief immediate cause of loss, particularly with certain varieties. Loss tends to be high where trees lack thrift because of thin soils, drought, and the like. Some varieties and some sections show a greater tendency to loss of trees than others. Piedmont Virginia seems to lose a higher percentage of trees of all the important varieties than do the other sections. To a large extent this is because of the nature of the soil and the character of the sites planted.

TABLE 16.—*Trees planted originally, and trees missing in 1926, all varieties*

State and section	Total number of trees planted	Trees missing	Percentage of total number of trees missing
Pennsylvania:	*Number*	*Number*	*Per cent*
North Mountain	7,263	[1] 1,871	25.8
Greencastle	21,506	2,080	9.6
Waynesboro	24,830	[1] 2,093	8.4
Fairfield	11,237	1,418	12.6
York Springs	3,905	164	4.2
Cumberland County	12,570	491	3.9
Biglersville	22,070	1,017	4.6
Total	103,471	9,134	8.8
Virginia:			
Valley	[2] 169,548	13,971	8.2
Piedmont	175,409	21,808	12.4
Total	344,957	35,779	10.4
West Virginia:			
Berkeley	104,757	9,007	8.6
Jefferson	65,918	5,743	8.7
Total	170,675	14,750	8.6

[1] 110 trees in the North Mountain section and 100 trees in the Waynesboro section had been replanted.
[2] The number of trees planted in 1 orchard block in Augusta County was not reported.

FIG. 10.—These trees were set 30 by 30 feet and crowding is evident. It is now difficult to cultivate and spray, and the yield as well as quality is reduced. Most varieties suited to this region, when planted on the heavier soils, should be set 40 by 40 feet

FIG. 11.—Interplanted trees (Yellow Transparent) being removed. The need for space is obvious. Overcrowding is a rather common fault observed in orchards that were set out more than 20 years ago

The loss of trees is serious and is an important factor in accounting for the low production per acre. Among the important varieties the loss in trees ranged from 3.6 to 35.4 per cent of those planted, with most frequent losses between 6 and 10 per cent, and an average for all varieties of 9.8 per cent. (Table 17.) The trees included in this study were mostly under 25 years of age.

TABLE 17.—*Percentage of original number of trees of important varieties planted, which were missing in 1926*

Variety	Virginia		West Virginia	
	Valley section	Piedmont section	Berkeley County	Jefferson County
	Per cent	*Per cent*	*Per cent*	*Per cent*
Arkansas (Mammoth Black Twig)	3.6	3.1	4.8	7.8
Ben Davis	9.7	23.1	9.3	9.8
Black Ben	3.7	40.0		
Bonum		16.1		
Delicious	3.7	5.0	0	1.8
Gano	7.0	18.0	6.1	4.7
Grimes Golden	14.2	35.4	13.7	13.2
Jonathan	5.3	7.7	6.5	7.2
King David	11.7	50.0		1.6
Lowry	0	6.2		
Northwestern Greening	17.2		17.0	3.2
Rambo	0		0	
Roma Beauty	0	7.0	4.0	1.5
Royal Limbertwig		2.3		
Stayman Winesap	4.6	7.7	4.2	4.0
Winesap	8.3	10.2	4.7	7.9
Yellow Newtown (Albemarle Pippin)	9.1	18.4	8.2	0
Yellow Transparent	2.1		6.0	0
York Imperial	8.1	10.5	7.9	9.4

The method of pruning sometimes contributes to tree losses as well as to low yields. Where trees are pruned in such manner that all the fruiting wood is out on the end of branches, there will be considerable limb breakage, and frequently an entire tree is split or broken to such an extent that it must be removed. When trees are pruned in this fashion there is much wasted bearing space. (Fig. 12.)

SUMMARY

The Cumberland-Shenandoah region of Pennsylvania, Virginia, and West Virginia as a whole is well adapted to fruit growing, but almost every community has some poor sites, and intelligent choice of orchard sites is essential to success.

Frost is responsible for much less damage in this region than is usually believed.

Cultural practices average far below the standard that is essential to success, and losses are often attributed to frost and offyear when they are actually due in part to poor practices and might easily be overcome with good cultural practices and proper measures for disease and insect control.

There is a rather striking inverse correlation between the temperatures from February 7 to March 21 and the yield of apples in this region. Abnormally high temperatures during this period almost invariably cause development of buds to such an extent that injury by frost or freezing, later in the season, is almost a certainty if the site does not have unusually good air drainage.

All the soils in this region are not equally well adapted to fruit growing, and even on those soil types which are well adapted, care should be exercised to avoid places where the rock comes so close to the surface as to allow insufficient soil depth, or where excessive washing is likely to take place; and even in the best soils a high percentage of humus is essential to success.

Sites exposed to cold winds, pockets or depressions in the surface in which the air stagnates, and sites on the leeward side of gaps in mountains should be avoided because of a tendency to excessive injury by freezing, frost, and hailstorms, respectively.

FIG. 12.—Bad pruning is costly. These trees have been pruned so that the bearing wood is at the ends of long weak limbs. It is costly to place props under a large number of trees, and even if this is done there will be much splitting and breaking of limbs when they are burdened with fruit

One of the outstanding mistakes in this community, in planting orchards, has been that of planting trees too close together. Reports from growers seem to indicate that 40 by 40 feet is the minimum planting distance.

The failure of fruit to set, in some orchards, was the result of planting self-sterile varieties in solid blocks or in fields isolated from other orchards. In the case of self-sterile varieties, mixed planting is necessary. Bees are essential in any orchard for pollination purposes.

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