

THE UNIVERSITY OF MINNESOTA  
Agricultural Experiment Station

THE COST OF PRODUCING  
APPLES IN MINNESOTA  
1916-1920

BY

W. G. BRIERLEY and W. J. KOPPEN  
DIVISION OF HORTICULTURE

AND

G. A. POND  
DIVISION OF AGRONOMY AND FARM MANAGEMENT



UNIVERSITY FARM, ST. PAUL

AGRICULTURAL EXPERIMENT STATION  
ADMINISTRATIVE OFFICERS

W. C. COFFEY, M.S., Director  
ANDREW BOSS, Vice-Director  
F. W. PECK, M.S., Director of Agricultural Extension and Farmers' Institutes  
C. G. SELVIG, M.A., Superintendent, Northwest Substation, Crookston  
M. J. THOMPSON, M.S., Superintendent, Northeast Substation, Duluth  
P. E. MILLER, M.Agr., Superintendent, West Central Substation, Morris  
O. I. BERGH, B.S.Agr., Superintendent, North Central Substation, Grand Rapids  
R. E. HODGSON, B.S. in Agr, Superintendent, Southeast Substation, Waseca  
RAPHAEL ZON, Ph.D., Director, Forest Experiment Station, Cloquet  
F. E. HARALSON, Assistant Superintendent, Fruit Breeding Farm, Zumbra Heights,  
(P. O. Excelsior)  
W. P. KIRKWOOD, M.A., Editor, and Chief, Division of Publications  
ALICE McFEELY, Assistant Editor of Bulletins  
HARRIET W. SEWALL, B.A., Librarian  
T. J. HORTON, Photographer  
R. A. GORTNER, Ph.D., Chief, Division of Agricultural Biochemistry  
J. D. BLACK, Ph.D., Chief, Division of Agricultural Economics  
ANDREW BOSS, Chief, Division of Agronomy and Farm Management  
W. H. PETERS, M.Agr., Chief, Division of Animal Husbandry  
FRANCIS JAGER, Chief, Division of Bee Culture  
C. H. ECKLES, M.S., D.Sc., Chief, Division of Dairy Husbandry  
W. A. RILEY, Ph.D., Chief, Division of Entomology and Economic Zoology  
WILLIAM BOSS, Chief, Division of Farm Engineering  
E. G. CHEYNEY, B.A., Chief, Division of Forestry  
W. H. ALDERMAN, B.S.A., Chief, Division of Horticulture  
E. M. FREEMAN, Ph.D., Chief, Division of Plant Pathology and Botany  
A. C. SMITH, B.S., Chief, Division of Poultry Husbandry  
F. J. ALWAY, Ph.D., Chief, Division of Soils  
C. P. FITCH, M.D., D.V.M., Chief, Division of Veterinary Medicine

STAFF OF DIVISION OF HORTICULTURE

W. H. ALDERMAN, B.S., Horticulturist

*Section of Pomology*

\*W. J. Koppen, M.S., Assistant in Horticulture  
W. G. BRIERLEY, M.S., Associate Horticulturist  
J. A. MIDDLETON, M.S., Assistant in Horticulture  
A. C. HILDRETH, B.S., Assistant in Horticulture

*Section of Fruit Breeding*

J. H. Beaumont, B.S., Assistant Horticulturist  
A. N. WILCOX, M.S., Assistant Horticulturist  
J. S. SHOEMAKER, M.S., Assistant in Horticulture

*Section of Vegetable Gardening*

F. A. KRANTZ, M.S., Assistant Horticulturist  
BASIL I. BURRELL, B.S., Assistant in Horticulture

*Section of Floriculture and Landscape Gardening*

CLARENCE E. CARY, B.S. in Agr., Assistant Horticulturist  
L. SANDO, Florist

\* Resigned July, 1919.

DIVISION OF AGRONOMY AND FARM MANAGEMENT

ANDREW BOSS, Agriculturist

*Section of Plant Breeding*

H. K. HAYEN, S.D., Plant Breeder  
FRED GRIFFEE, M.S., Assistant Plant Breeder  
H. E. BREWBAKER, M.S., Assistant Plant Breeder  
\*O. S. AAMODT, M.S., Wheat Breeder

*Section of Farm Crops*

A. C. ARNY, M.S., Associate Agronomist  
F. W. MCGINNIS, M.S., Assistant Agronomist  
F. H. STEINMETZ, M.S., Assistant Agronomist  
F. L. HIGGINS, B.S., Assistant in Agronomy  
W. I. THOMAS, Assistant in Agronomy

*Section of Co-operative Seed Production and Distribution*

ANDREW BOSS, Agriculturist  
A. D. HAEDECKE, Assistant in Agronomy  
R. F. CRIM, B.S., Extension Specialist in Agronomy

*Section of Cost Accounting*

G. A. POND, M.S., Assistant Agriculturist  
ANDREW T. HOVERSTAD, B.S., Research Assistant

*Section of Farm Organization*

ANDREW BOSS, Agriculturist  
L. B. BASSETT, Associate Agriculturist  
L. F. GAREY, M.A., Assistant in Farm Management

\* Co-operating with the Bureau of Plant Industry, U.S.D.A.

## CONTENTS

	Page
Acknowledgements .....	6
Object of the survey .....	7
History of Minnesota orcharding .....	7
Extent of apple growing in Minnesota .....	8
Present status of commercial orchards .....	9
Competition with other sections .....	9
Soils .....	10
Exposure .....	11
Review of literature on orchard production costs .....	11
Method of survey .....	14
Orchards used in survey .....	15
1. Number of orchards surveyed .....	15
2. Percentage of tillable land in orchards .....	16
3. Orchard valuation .....	17
4. Size of orchards .....	18
5. Age of orchards .....	18
6. Number of trees per acre .....	20
7. Varieties .....	20
8. Yield per acre .....	21
9. Price per bushel .....	24
10. Average gross returns .....	24
11. Common management practices .....	25
Labor charges .....	26
Factors of cost .....	26
I. Labor requirements .....	26
II. Material costs .....	34
III. Fixed costs .....	35
IV. Overhead costs .....	36
Summary of costs .....	37
Distribution of labor .....	37
Distribution of costs .....	39
Average net returns .....	40
Distribution of returns .....	40
Owner's income .....	40
Income from owner's labor .....	40
Interest on investment .....	41
Net return .....	41
Total income .....	41
Conclusions and observations .....	42
Literature cited .....	43
Summary .....	44

## ILLUSTRATIONS

	Page
A typical Minnesota orchard.....	Cover
Fig. 1. Distribution of orchards in Minnesota.....	8
Fig. 2. Comparison of total costs and net returns per acre in Minnesota and other sections .....	13
Fig. 3. Comparison of total costs and net returns per bushel in Minnesota and other sections.....	13
Fig. 4. Location of orchards from which data were obtained and those vis- ited without obtaining data.....	15
Fig. 5. Range in percentage of tillable land in orchard on farms studied..	16
Fig. 6. Range in acre valuation of the orchards studied.....	17
Fig. 7. Range in acreage of the orchards studied.....	18
Fig. 8. Range in age of the orchards studied.....	19
Fig. 9. Range in number of trees per acre in the orchards studied.....	21
Fig. 10. Range in yield per acre in the orchards studied.....	22
Fig. 11. Effect of yield on costs and returns.....	24
Fig. 12. Distribution of man labor.....	38
Fig. 13. Distribution of horse labor.....	38
Fig. 14. Distribution of costs .....	39
Fig. 15. Distribution of returns.....	39

## ACKNOWLEDGMENTS

At the beginning of this survey F. W. Peck, then in charge of the section of cost accounting, in the Division of Agronomy and Farm Management, helped materially in the planning of the work. The authors desire to express their appreciation of his assistance. The paragraph on soils is by C. O. Rost, of the Division of Soils. Helpful suggestions relating to the data on spraying have been received from A. G. Ruggles, of the Division of Entomology and Economic Zoology. Thanks are due to the county agricultural agents who cooperated in gathering the orchard data and also to the growers who furnished the data.

# THE COST OF PRODUCING APPLES IN MINNESOTA,

1916-1920

By W. G. BRIERLEY, W. J. KOPPEN,<sup>1</sup> and G. A. POND

## OBJECT OF THE SURVEY

The question has frequently arisen as to whether apples can be produced profitably in Minnesota. Often this question has been answered in the negative, but such answers generally have been drawn from instances of poorly managed or neglected orchards. In order to ascertain the present status and the possibilities in apple production in Minnesota, an orchard survey was made in 1918, 1919, and 1920 by the section of pomology, Division of Horticulture, co-operating with the section of cost accounting, Division of Agronomy and Farm Management. In this survey the object was to gather data on costs, yields, and income, in order to determine directly from the growers whether the enterprise is profitable in Minnesota.

## HISTORY OF MINNESOTA ORCHARDING

At the time Minnesota was admitted into the Union it was generally believed that the winters in this region were much too severe for the successful culture of fruit trees. However, a group of staunch pioneers proceeded to attempt to grow apples. Peter Gideon planted his first orchard, near Excelsior, in 1854; John S. Harris made his first attempt in 1857, at La Crescent. Repeated failures were experienced by these men and their contemporaries. Orcharding principles were not well understood; plantings were often made on unadapted sites, and varieties were planted which were entirely unsuited to the climate. Profiting by their failures, these pioneers looked around for hardier varieties. The Wealthy was produced by Peter Gideon from seed planted in 1862; and the introduction of Russian varieties, including the Duchess (Oldenburg) began in 1867. By gradual accumulation of experiences with successful ventures, and by the elimination of tender varieties in several "test" winters, orcharding was placed upon a fairly safe basis by the close of the nineteenth century. It was about this time (1900) that most of the orchards used in this study were planted.

<sup>1</sup> Formerly Assistant in Horticulture.

### EXTENT OF APPLE GROWING IN MINNESOTA

On most of the farms in the southern half of the state are home orchards varying in size from a few trees up to several acres. In the northern half of the state these home orchards are much less common and are practically non-existent north of the latitude of Duluth.

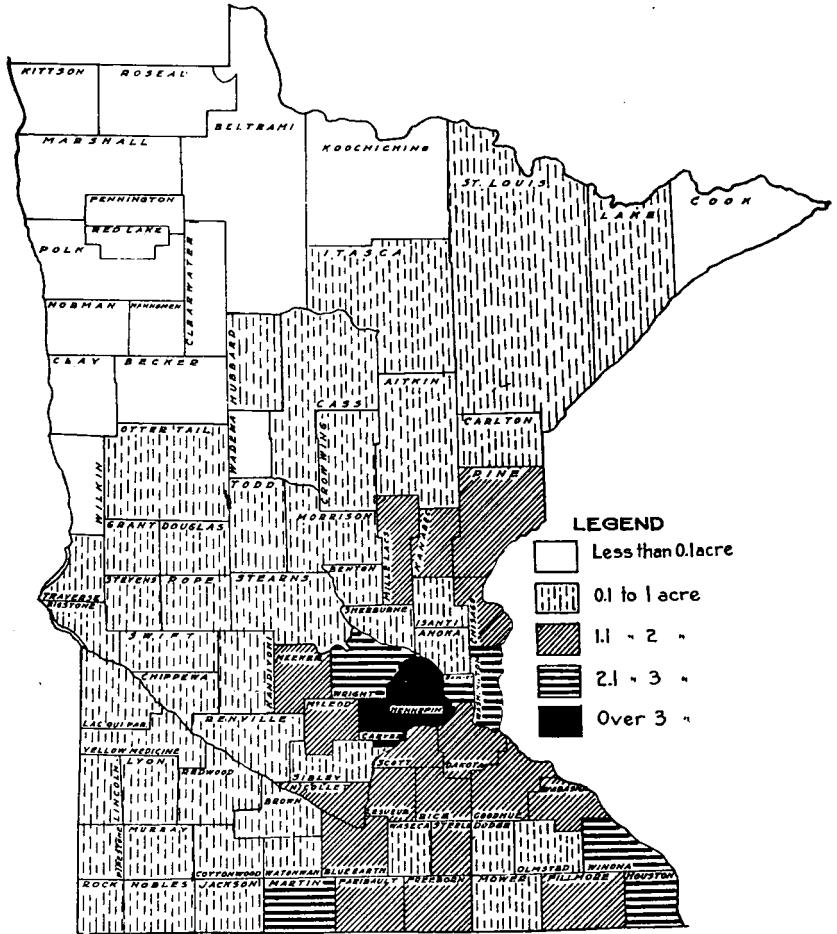


Fig. 1. Distribution of Orchards in Minnesota Expressed in Acres per 1000 Acres of Improved Land

The distribution of orchards in Minnesota, as derived from figures given in the 1920 census, is shown in Figure 1. The principal commercial orchards are found in the vicinity of Lake Minnetonka, in the Mississippi Valley, and in the central-southern part of the state. Occasional commercial orchards are found west of the Minnetonka region as far as the South Dakota line, and also in the southwestern



part of the state. Of the total of 13,052 acres of bearing apple trees as computed from the number of bearing trees in Minnesota according to the 1920 census, probably not more than 2000 acres, or approximately one-sixth, can be considered in commercial production. However, with proper management and the selection of suitable sites and varieties, it is evident from the data obtained in the best orchards that orcharding with a reasonable expectation of profitable returns is possible in Minnesota.

### PRESENT STATUS OF COMMERCIAL ORCHARDS

The majority of the commercial orchards in the state were planted about 1900, and were in fair condition at the time of the survey (1918-20). However, the standards of orchard management were not high. A few orchards were very well managed, but the majority ranged from fair management down to neglect. In addition to the handicaps of winter injury and disease, many orchards still are found located on poor sites, or include too many varieties, many of which are inferior for market purposes. But the chief reasons for the poor returns in the majority of orchards are too close planting and neglect of maintenance. As will be shown later, there are 122.3 trees per acre in the average orchard. This crowding prevents proper development and lessens production. Pruning, in many orchards, is not done as well as it should be. Inefficient spraying is still far too common and is generally due to too few applications, omitting essential applications, or working with poor equipment. In far too many orchards poor soil management is the rule. Old sod is commonly found. In some orchards a hay crop is cut at the expense of tree vigor and production. The well managed orchards show that if growers in general would improve their methods they would also greatly increase the yields and net returns.

### COMPETITION WITH OTHER SECTIONS

Minnesota growers who produce a good grade of fruit are in a favorable position in regard to competition from other sections. Averages of estimates in the Monthly Crop Reporter (1) of the value of apples at the farm over the six-year period, 1915-20, shows that the price per bushel for Minnesota is above the average for sections which are heavy producers of apples. These figures are presented in Table I.

TABLE I  
ESTIMATED VALUE PER BUSHEL OF APPLES AT THE FARM\*

Year	Minn.	Idaho	Ill.	Colo.	Mich.	W. Va.	Ore.	Wash.	N. Y.
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
1915.....	102	98	61	95	75	67	96	78	79
1916.....	140	150	125	125	95	75	100	94	80
1917.....	180	120	150	135	140	125	100	115	125
1918.....	200	200	205	200	130	120	130	115	105
1919.....	320	260	270	210	235	230	150	170	200
1920.....	235	170	...	192	90	133	160	139	100
6-yr. av..	196	166	162	159	127	125	122	118	115

\* From Monthly Crop Reporter, January issues of 1916-21.

This price condition is largely due to the fact that the greater part of the apples consumed in Minnesota are shipped in from other states. These shipments, largely from Michigan, Illinois, Missouri, and Washington, are sold in Minnesota at a price which includes shipping charges. The Minnesota grower, not having to pay high shipping charges, finds that the competition with other sections is, on the average, beneficial rather than harmful. In other words the Minnesota grower finds the price per bushel largely determined for him on the basis of the price in other sections plus shipping charges. This enables the local grower to operate on a favorable margin between costs and gross returns.

## SOILS

The soils of the Lake Minnetonka district and of the central southern district have been derived from the weathering of glacial drift. The drift material was deposited by a great glacier which originated in an area north of Winnipeg and spread out in all directions, reaching to Central Iowa as its southern extremity. The soil has a relatively high content of lime, the greater proportion being of relatively fine texture. This has prevented the removal of lime by leaching. Only rarely is the soil acid enough to need lime even for alfalfa and sweet clover, the crops most sensitive to any deficiency. The topography is rolling to gently undulating. Numerous bogs and marshy depressions occur among the knolls and ridges. These are unsuited to orchard planting.

The soils of the southeastern Minnesota district may be grouped broadly into three divisions: (1) the upland, consisting mainly of silt loam, (2) the high river terraces, and (3) the bottom lands.

The materials from which the soils have been derived are varied. They include a mantle of fine unconsolidated, stone-free material, known as loess, which covers most of the upland. Underlying the loess and exposed as upland in some places, is the glacial drift. In

eastern Houston County the loess has been laid down on native rock consisting of alternate layers of limestone, shale, and sandstone. Soils developed on the slopes and on the bottom lands have been formed by disintegrated materials from these formations. The topography varies from gently undulating to rough. The soils of groups 2 and 3 show much greater variation in texture than the true upland soils. Those of groups 1 and 2 are more suitable for orchard planting than those of group 3 and it is on the soils of these groups that the most successful orchards are grown.

### EXPOSURE

Practically all successful orchards in Minnesota are located on sites protected from the dry summer winds from the southwest and the cold winter winds from the northwest. Along the Mississippi River the easterly slopes provide ideal sites which are well protected. In the Lake Minnetonka section advantage is taken of the protection afforded by the lake. Individual orchards located elsewhere in the state are largely protected by lakes or by windbreaks or natural shelter belts; or are planted on easterly slopes. While many orchard failures have been due to mismanagement or neglect, a considerable number have been due to unfavorable sites.

### REVIEW OF LITERATURE ON ORCHARD PRODUCTION COSTS

Interest in the subject of costs and profits in apple orcharding was evident more than 30 years ago, but all the early studies were of a minor nature in connection with cultural studies, as seen in the work of Voorhees (2) in 1897. In 1905 Warren (3), (4) presented some cost data secured in his orchard surveys of Wayne and Orleans counties in New York. Cost data appear in the reports of orchard surveys conducted in Oregon in 1908 by Lewis et al. (5), (6). Similar reports of surveys made by other workers have appeared from time to time. The first specific report on costs of production appears to be that of Hartman and Eustace (7) in 1909. Contributions to the fruit periodicals by several writers followed in 1911. Burritt (8), (9), Hedrick (10), and Miller (11) published reports on costs and profits from 1912 to 1914. Following closely upon these reports were the publications of Lewis and Vickers (12), Gardner (13), and Auchter (14) in 1915. In 1914 the Office of Farm Management of the United States Department of Agriculture began a systematic study of the costs of producing apples in the major apple sections of the country. Reports of these investigations by Miller and Thompson

(15), (16), (17), (18), (19), (20), appearing from 1917 to 1920, constitute the most valuable contributions to the literature bearing on the costs of apple production which have so far been published. Folger and Thompson (21) in 1921 in "The Commercial Apple Industry of North America" presented a very useful summarization of the work of Miller and Thompson together with observations on the several phases and items of the cost of apple production.

Miller and Thompson (*loc. cit.*) in their reports on the western districts show a range in costs per box of packed apples from 71 cents in the Payette Valley to \$1.02 in the Hood River Valley. Costs per acre are shown to range from \$226.96 in the Hood River district to \$469.73 in the Wenatchee Valley. Net returns per acre computed from the data presented in these bulletins show a range from \$19.46 in the Hood River Valley to \$158.85 in the Wenatchee Valley. The net return per bushel ranges from 9 cents in the Hood River Valley to 33 cents in the Yakima Valley. In the report of their New York surveys the same authors report costs per acre as \$118.78, costs per bushel as 47 cents,<sup>1</sup> net returns per acre as \$66.36, and net returns per bushel as 26.3 cents. Auchter (14), in his report on West Virginia orchards, shows the cost per acre to be \$49.88, the cost per bushel 41.6 cents, the net return per acre \$40.20, and the net return per bushel 33.3 cents. In the Minnesota investigations the costs are found to be \$125.20 per acre and 83.6 cents per bushel, while the net returns are found to be \$90.79 per acre and 60.7 cents per bushel. The costs per bushel are high because the yield is relatively low, but the comparatively large net return per bushel is sufficient to enable the grower to realize a fair net return per acre. While it is difficult to make comparisons because of the wide differences in management problems and of changing conditions in each section, it is of interest to growers in Minnesota that the net returns which they receive compare favorably with the figures for other sections. It should also be noted that the figures for Minnesota include the years 1917 to 1919 when prices were at the highest point in years. This is offset, at least in part, by the fact that labor and material costs were at their peak, so that figures for net returns per acre and per bushel very likely are representative of normal years. Comparisons of orchard cost data for Minnesota with those from other sections are shown in Tables II and III. Figures 2 and 3 show these comparisons graphically.

<sup>1</sup> Bushel figures computed as  $\frac{1}{4}$  of barrel.

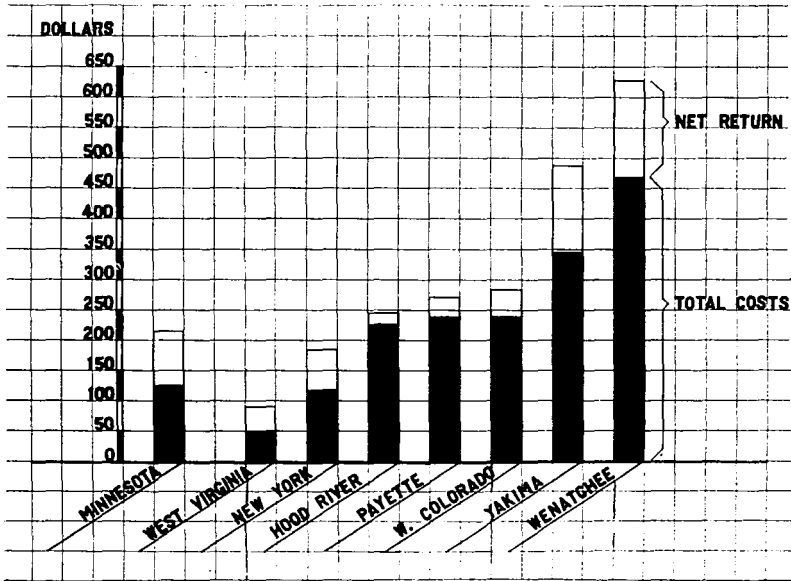


Fig. 2. Comparison of Total Costs and Net Returns per Acre in Minnesota and Other Sections

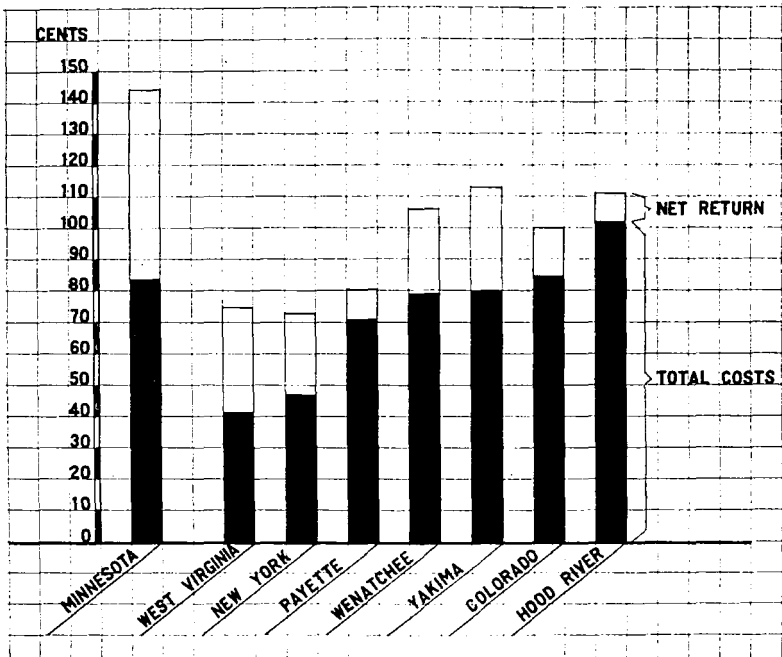


Fig. 3. Comparison of Total Costs and Net Returns per Bushel in Minnesota and Other Sections

TABLE II  
COMPARISON OF BUSHELS SOLD, COST, GROSS RETURN, NET RETURN, AND INVESTMENT PER  
ACRE IN MINNESOTA AND OTHER SECTIONS  
Arranged on the basis of acre costs

Locality	Bushels sold	Cost	Gross return	Net return	Investment
Minnesota .....	149.8*	\$125.20	\$215.99	\$90.79	\$510.00
West Virginia .....	120.6	49.88	90.08	40.20	500.00
New York .....	252.0	118.78	185.14	66.36	514.00
Hood River, Ore. ....	222.0	226.44	246.42	19.98	990.74
Payette Valley, Idaho.....	337.0	239.61	270.95	31.34	631.16
Western Colorado .....	284.0	239.70	284.00	44.30	653.49
Yakima Valley, Wash. ....	432.0	345.69	488.16†	142.47	1079.67
Wenatchee Valley, Wash. ....	593.0	469.66	628.51†	158.85	1925.00

\* Entire yield was sold in Minnesota.

† Yakima and Wenatchee returns are averaged from data in "Better Fruit" for years covered by the survey.

TABLE III  
COMPARISON OF COST, GROSS RETURN, AND NET RETURN PER MARKETED BUSHEL IN MINNESOTA  
AND OTHER SECTIONS  
Arranged on the basis of bushel costs

Locality	Age of trees, years	Years covered by data	Cost	Gross return	Net return
Minnesota .....	8-36	1916-20	\$0.84	\$1.44*	\$0.60
West Virginia .....	10-50	1910-12	0.42	0.75	0.33
New York .....	30-60	1910-15	0.47	0.73	0.26
Payette Valley, Idaho.....	15 (Av.)	1910-14	0.71	0.80	0.09
Wenatchee Valley, Wash. ....	7-11	1909-14	0.79	1.06†	0.27
Yakima Valley, Wash. ....	9-15	1910-14	0.80	1.13†	0.33
Western Colorado .....	12-20	1910-14	0.84	1.00	0.16
Hood River, Ore. ....	9-18	1910-14	1.02	1.11	0.09

\* Average price per bushel including culls, as all fruit is sold.

† Yakima and Wenatchee returns averaged from price data in "Better Fruit" for years covered by the survey.

## METHOD OF SURVEY

Each grower was visited by the field men and the data were recorded on prepared record sheets. Emphasis was placed upon normal conditions. In most cases the figures were obtained on the basis of a five-year average altho some records cover only three years. The earlier records taken in 1918 and 1919 were supplemented by additional data relating to yields and prices up to and including 1920.

In arranging and tabulating the data, figures which seemed to depart very markedly from the normal were discarded. In this connection it should be noted that in nearly all the items of this survey the range is wider than in similar studies for other fruit sections. This is due to the widely differing methods in use in the several operations and is clearly seen in the data for spraying.

All the averages used in the tables and discussions are weighted.

ORCHARDS USED IN THE SURVEY

1. NUMBER OF ORCHARDS SURVEYED

Only 64 orchards are included in this survey. Many orchards visited were in poor condition while the ownership of others had recently changed. In other orchards the owners were not willing to go into details of their operation and cost. However, a good average of costs and returns in Minnesota orchards is shown by the data from the 64 orchards. The location of the orchards from which data were obtained and those which were visited without obtaining data is shown in Figure 4.

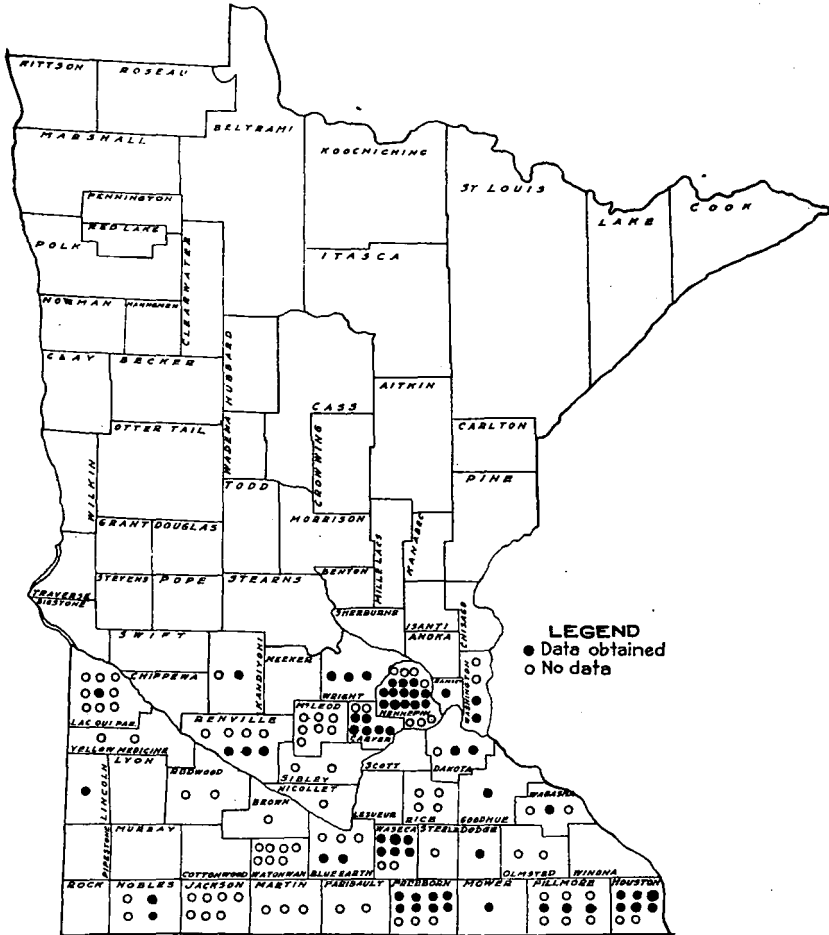


Fig. 4. Location of Orchards from Which Data Were Obtained and Those Visited Without Obtaining Data

The location of the dots within the counties is without significance.

## 2. PERCENTAGE OF TILLABLE LAND IN ORCHARDS

The 64 orchards from which data were obtained aggregate 487.4 acres, of which 407.4 acres are bearing and 80 acres are not of bearing age. The acreage in bearing orchards averages 33.9 per cent of the tillable area of the farms surveyed. In three cases the orchard takes up the entire tillable area of the farm. In eight cases the bearing orchard plus the area in trees not of bearing age comprise over 83 per cent of the tillable area. In seven other cases the area in orchard including trees not of bearing age is more than 50 per cent of the tillable area. The lowering of the general average is due to the inclusion of several orchards on large farms. Fourteen of these orchards make up less than 3 per cent of the tillable area. In the case of the smaller farms a large proportion of the area not in orchard is used for the production of other fruits or for vegetables. Poultry and bees are also commonly found on the smaller farms. The percentage grouping of the orchards is shown graphically in Figure 5.

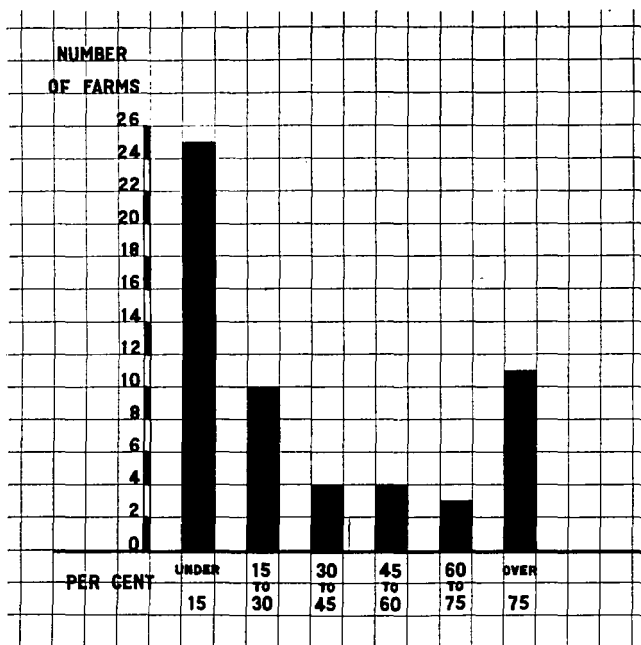


Fig. 5. Range in Percentage of Tillable Land in Orchard on the Farms Studied

There is a direct correlation between the high percentage of tillable land in orchard and good orchard management. All but three of the better managed orchards make up over 20 per cent of the tillable area while only two of the poorer orchards exceed this figure.



Apparently when one-fifth or more of the tillable land of a farm is in orchard, the owner as a rule devotes enough attention to the management of the orchard to make it profitable. When less than one-fifth of the tillable land is utilized in orchard the owner usually devotes most of his time to the other farm enterprises and is likely to neglect the orchard.

### 3. ORCHARD VALUATION

There is a wide range in valuation according to the estimates of the several orchard owners. As nearly as possible the values given are for the orchard itself. Excessive values have been avoided as far as possible. In all cases an attempt has been made to eliminate from the estimates all effects on land price arising from proximity to lakes or towns. Some of the orchards are located within the corporate limits of towns and many are on the shores of summer resort lakes or very close to them. Figured in this way the average value of an acre of bearing orchard is \$510. Valuations range from \$150

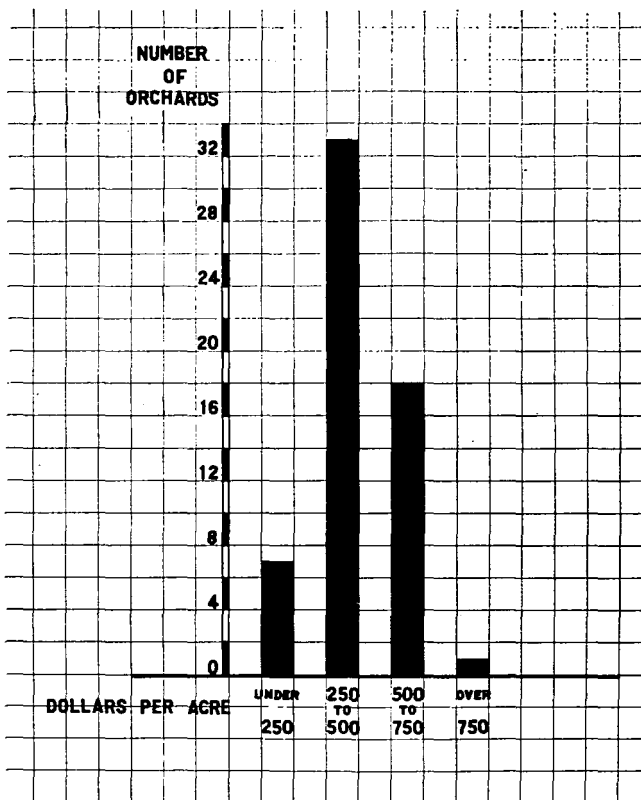


Fig. 6. Range in Acre Valuation of the Orchards Studied

to \$800. The lower values are given by growers who consider the orchard to be of no more value than the ordinary farm crop and who do not properly manage their orchards. The higher values are given by growers who are primarily in the fruit business and the majority of these men would ask much more than the estimated value if the orchard were to be sold. The acre valuation grouping of the orchard is shown graphically in Figure 6.

#### 4. SIZE OF ORCHARDS

The orchards used in this survey averaged 7.6 acres in size, including trees not of bearing age. The size ranges from 1.2 to 30 acres. The size of orchard has no bearing on the quality of the management. Some of the best managed orchards are of four acres or less and some of the larger orchards are not well managed. The acreage grouping of the orchards is shown graphically in Figure 7.

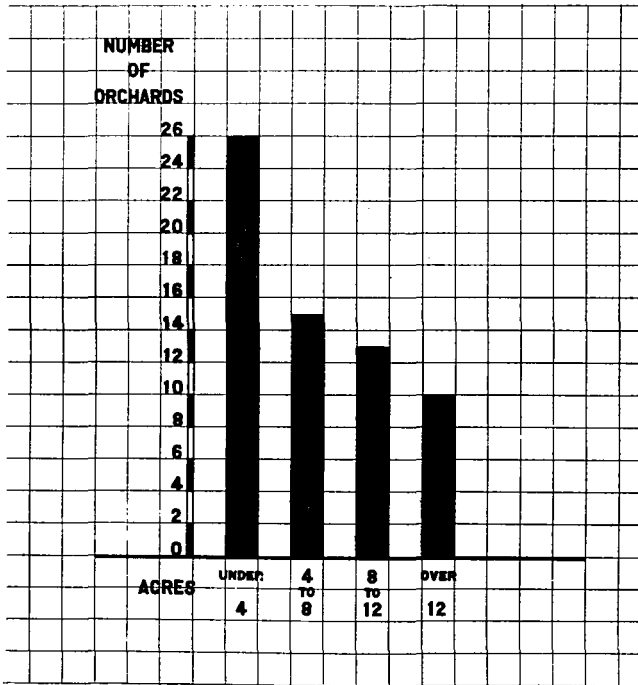


Fig. 7. Range in Acreage in the Orchards Studied

#### 5. AGE OF ORCHARDS

The average age of the orchards surveyed is 15.6 years, the range being from 8 to 36 years (on the basis of 1920). Only two of the orchards are more than 25 years old. The varieties commonly planted

in Minnesota begin to bear when about six or seven years old. Full bearing is reached at from 12 to 16 years. While the data show that the majority of the orchards were planted between 1900 and 1906, it is also evident that older orchards are few in number or could not be used in the survey on account of poor condition. The age grouping of the orchards used in the survey is shown graphically in Figure 8. Table IV, made up from a questionnaire sent to representative orchardists, shows that even our hardiest varieties do not have a life expectancy of 40 years and the average life of an orchard is 29 years.

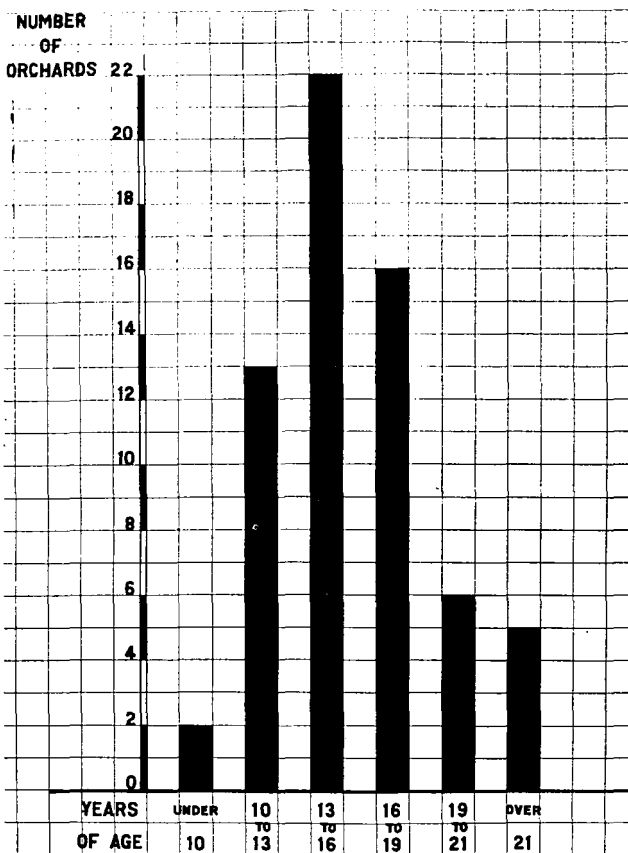


Fig. 8. Range in Age of the Orchards Studied

TABLE IV  
ESTIMATED LENGTH OF LIFE OF APPLE VARIETIES COMMONLY GROWN IN MINNESOTA

No. of replies	Variety	Estimated length of life, years	Range
62	Hibernal .....	37.5	30-60
71	Duchess (Oldenburg).....	35.5	15-75
60	Patten (Greening).....	34.3	20-75
54	Transcendent (Crab).....	34.3	10-75
43	Anisim .....	28.2	15-60
70	Wealthy .....	26.2	10-50
29	Florence (Crab).....	26.2	15-60
64	Northwestern (Greening).....	16.9	8-60
74	All varieties .....	29.0	8-75

#### 6. NUMBER OF TREES PER ACRE

There is an average of 122.3 trees per acre in the orchards surveyed, the range being from 53 to 302 trees. More than 70 per cent of the acreage in this survey has a population of more than 100 trees per acre. This serious crowding not only reduces the average yield per acre but interferes with all orchard operations. Most of the bearing wood in these crowded trees is in the upper third of the head, which doubtless accounts for the low average yield of 1.2 bushels per tree. The yield per tree in orchards with greater distance between trees exceeds this average yield several times, so that a single tree is actually outyielding from two to four of the crowded trees. It is very poor management to keep the orchard so crowded, and the recommendation is now being made generally to thin out the trees so that each tree may get more sunlight and feeding area. The minimum distance should be not less than 25 feet on the square in new orchards and the old orchards will be vastly improved if thinned to approximately this distance. Such common varieties as Wealthy and Duchess (Oldenburg) do not make a large tree under Minnesota conditions. For this reason orchards can be planted more closely here than in other sections, but it is evident that the average orchard is much too crowded. Some of these orchards are now being thinned and are responding with increased vigor and yields. The acre population grouping of the orchards in the survey is shown graphically in Figure 9.

#### 7. VARIETIES

The leading commercial varieties in proportion to the number of trees planted are Wealthy, Duchess (Oldenburg), Northwestern (Greening), and Patten (Greening). Almost every variety having the necessary hardiness may be found to some extent. The more common ones are Hibernal, Salome, Wolf River, Malinda, Charlamoff, Anisim; and Florence and Virginia crabs. By top-working on hardy stock many

orchards contain a varying number of trees of McIntosh, Grimes (Golden), Jonathan, Delicious, and King David. While these varieties when top-worked may be of value in the protected locations along the Mississippi River, they are of doubtful value elsewhere with the possible exception of McIntosh.

8. YIELD PER ACRE

The average total yield per acre for the orchards surveyed is 149.8 bushels, the range being from 31.2 to 400.6 bushels. Culls are included in this figure, as all the orchardists who are primarily in the orchard business sell their culls in one of three ways as follows: (1) to buyers with the rest of crop; (2) at reduced price in local market or at the roadside; and (3) as cider or vinegar. In general, the proportion of the crop designated as culls is small, as grading is not rigid. Actually, however, the proportion of poor apples is high on account of crowding of the trees, poor pruning, and poor spraying.

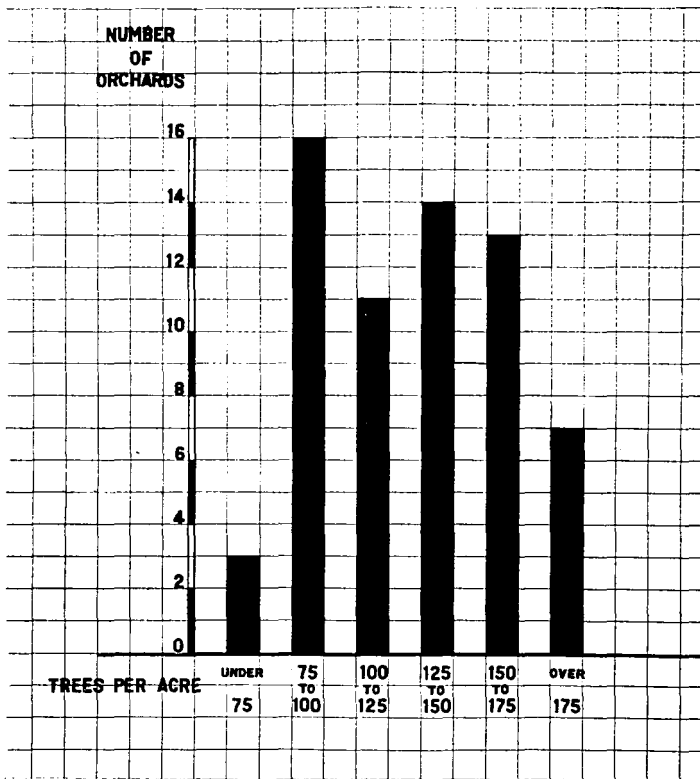


Fig. 9. Range in Number of Trees per Acre in the Orchards Studied

Of the 149.8 bushels total yield per acre, 135.8 bushels were packed and sold. An average of 12 bushels per acre were culls but these were generally sold as previously stated. About two bushels per acre were used at home or given away. The orchard yields are shown by groups in Figure 10.

Proper management has a decided effect upon yield. In 12 well managed orchards comprising 86 acres, the average yield is 254.2 bushels per acre; while in the 4 best orchards the average yield is 310.9 bushels. Yields such as these compare favorably with the yields in other sections, as shown in Table V.

TABLE V  
AVERAGE ACRE YIELDS IN MINNESOTA AND OTHER DISTRICTS

	Bushels per acre
Minnesota .....	150
West Virginia (14).....	121
Hood River, Oregon (17).....	222
Western New York (20).....	252
Western Colorado (16).....	284
Payette Valley, Idaho (19).....	337
Yakima, Washington (18).....	432
Wenatchee, Washington (15).....	593

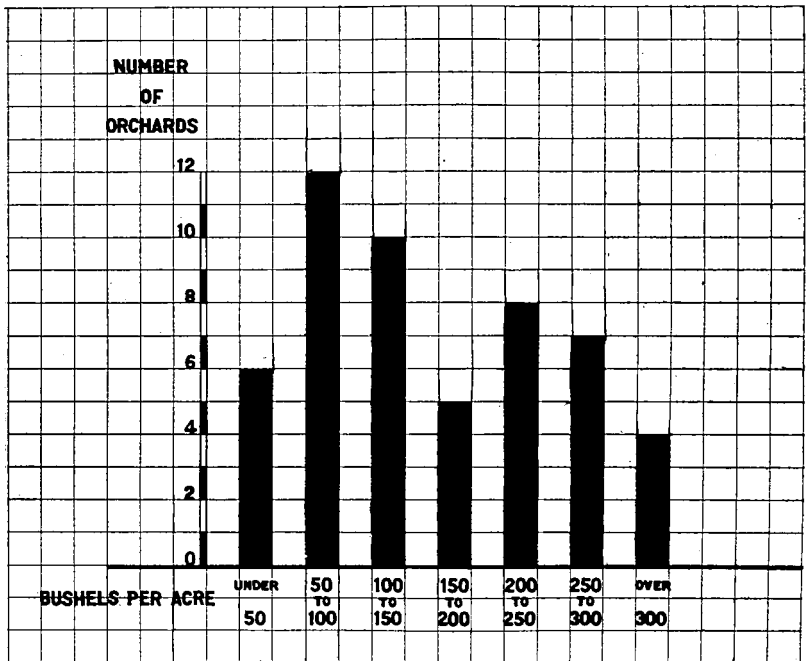


Fig. 10. Range in Yield per Acre in the Orchards Studied

TABLE VI  
EFFECT OF YIELD ON COSTS AND RETURNS ON BASIS OF ACRE AVERAGES

Group .....	1	2	3	4	5	6	7
	Less than						
Yield, bushels .....	50	50-100	100-150	150-200	200-250	250-300	Over 300
Number of growers.....	8	11	11	5	8	7	4
Size of orchard, acres.....	4-7	9-3	9.8	3.4	3.9	6.7	5
Yield per acre, bushels.....	42	86	128	177	235	270	347
Acre valuation .....	379	\$557 *	\$410	\$423	\$643	\$623	\$687
Value of spray equipment.....	\$11.32	7.04	14.90	29.38	32.50	24.24	22.75
Value of other equipment.....	\$9.90	14.56	6.00	6.44	8.32	7.32	9.29
Acre costs							
Maintenance .....	\$9.25	\$13.28	\$13.26	\$25.36	\$18.91	\$21.99	\$19.93
Crop handling .....	7.62	15.81	23.14	34.15	38.02	42.45	30.21†
Materials .....	6.36	13.83	26.47	28.88	28.33	43.77	43.11‡
Fixed costs .....	28.32	37.05	30.36	35.92	49.14	46.15	50.35
Overhead .....	1.55	2.40	2.80	3.73	4.03	4.63	4.31
Total costs .....	\$53.10	\$82.37	\$96.03	\$128.04	\$138.43	\$158.99	\$147.97
Gross returns .....	36.41	106.02	174.72	229.45	288.23	386.84	453.56
Net returns .....	-\$16.69	\$23.65	\$78.69	\$101.41	\$149.80	\$227.85	\$305.59

\* This valuation is high because the valuations of individual orchards are much too high in proportion to the returns. One orchard of 13.7 acres is valued by the owner at \$800 per acre; another of 6.5 acres is valued at \$750 per acre, and a third of 15 acres is valued at \$600 per acre.

† This item is low because two individuals sell "orchard run" in the orchard without packing or hauling charges.

‡ This item is proportionately low because three of the four individuals have low package costs. These growers sell in the orchard or through a cooperative association and most of the baskets are returned.

Poor management is largely the cause of poor yields, altho in some instances the orchards are handicapped by either poor sites or poor varieties, or are failing on account of age.

That yield materially affects returns is shown in Table VI and Figure 11. Group 1, with an average acre yield of 42 bushels, has a net loss of \$16.69 per acre. While costs increase with larger yields the gross returns increase more rapidly, leaving larger net returns as seen in successive groups up to Group 7, in which a net return of \$305.59 per acre is obtained. While these groups do not include large numbers of growers the trend toward greater returns from higher yields is clearly indicated.

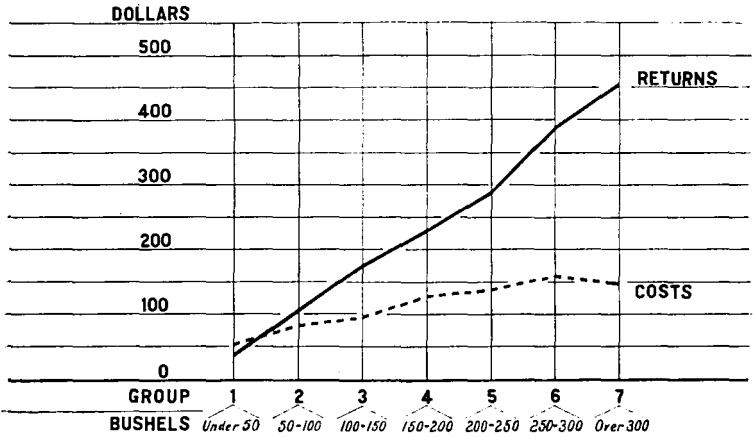


Fig. 11. Effect of Yield on Costs and Returns

9. PRICE PER BUSHEL

The average price received during the period of these investigations was \$1.53 per bushel for the packed fruit. The two bushels per acre used at home or given away are credited at the same figure. The average price received for culls was 43 cents per bushel. The average price received for all apples sold (1916-20) was \$1.44 per bushel.

10. AVERAGE GROSS RETURNS

The average gross returns per acre amount to \$215.99 on the basis of 135.8 bushels of packed apples at \$1.53 per bushel, two bushels used at home at \$1.53 per bushel, and 12 bushels of culls at 43 cents per bushel. The range is from \$23.75 to \$506.81 per acre. This range is shown by groups in Figure 11 and Table VI, in which it may readily be seen that low net returns are correlated with low yields and larger net returns with increased yields. Of the better managed orchards, 9 show gross returns of more than \$200 an acre,



9 others show returns of more than \$300 an acre, 4 show returns of more than \$400, and one shows \$506.81 as an average. The 28 orchards having the highest gross returns total 175 acres, or 6.5 acres per orchard. The gross returns from these orchards averaged \$307.81 per acre. Taking all factors into consideration, these orchards are much more representative of the possibilities in Minnesota orcharding than are the remaining ones, as these are fairly well managed. The costs per acre in these orchards are higher than the average, as more work is done in the maintenance of the orchards and in the handling of the crops, but the net returns are also materially larger as seen in Table VI and Figure 9.

## II. COMMON MANAGEMENT PRACTICES

As pointed out in a previous paragraph the general standards of orchard management are not high. In practically all the orchards, however, general maintenance includes manuring, pruning, brush disposal, spraying, and mowing. All these operations are considered in computing the factors of cost for the average orchard. A few orchards are cultivated, thus requiring plowing and cultivating to be included in the maintenance charges. While this practice should be followed much more generally than at present, it can not be included among the usual charges. Similarly, the costs of other unusual maintenance or handling operations—as resetting trees, thinning fruit, and propping—are not included. The usual handling operations include picking, hauling from the orchard, grading and packing, and hauling to market or shipping point.

Storage is not common, as most of the varieties grown are not winter varieties. In a few cases Wealthy and Northwestern are stored from four to six weeks. While charges should be made for storage in orchards where it is practiced, it is not included among the common charges. For the same reason interest and depreciation on storage structures are not included.

Practically all the fruit handling is done in the orchard or in some building used temporarily for this work. It has been found difficult to estimate the proportionate amount of the value of such a building which should be charged to orchard use. As the buildings generally are of cheap construction, whatever charge should be made for this item is amply provided for in the overhead charges.

The packages used in handling the fruit are the Minnesota standard bushel basket<sup>2</sup> and the standard barrel of 3-bushel capacity. The basket is much more commonly used than the barrel, but in a few

<sup>2</sup>The "Minnesota standard bushel basket" has a capacity of 2150 cubic inches. The standard weight of "green" apples is legally 50 pounds but the standard bushel basket will not hold this weight of fruit. The actual weight ranges from 40 to 45 pounds with the average nearer the lower figure. It would be more logical to have the legal standard fixed on the capacity basis, making it similar to the standard barrel in that respect.

scattered orchards and in the Houston County section in the southeastern corner of the state the barrel is the usual package.

The marketing practices are variable. In the Lake Minnetonka section the Excelsior Fruit Growers' Association handles a large part of the crop on the co-operative basis. Many growers in this section, however, sell to buyers or sell direct on the markets in the Twin Cities. Growers farther away from the large cities either sell to buyers or ship on commission. The price per bushel has been computed on the basis of the price in the local market or F.O.B. shipping point.

## LABOR CHARGES

From 1914 to 1919 the wages of farm labor increased very materially but began to decline in 1920, and at the present time are again near the pre-war level. The charges as determined in cost of production studies for farm crops in Minnesota for this period are 25 cents per hour for man labor and 15 cents per hour for horse labor. This rate for man labor may be low for skilled orchard help but in general the owner does the greater part of the work himself. Unskilled help has to be used for some operations but the owner directs all the work. The managerial ability or special skill of the owner will make his time worth considerably more than the 25 cent rate. Remuneration for this managerial ability, however, is covered in the net return received from the enterprise. This will be discussed further in a later paragraph.

## FACTORS OF COST

### I. LABOR REQUIREMENTS

#### A. MAINTENANCE ITEMS

1. *Manuring*.—Like other orchard operations in Minnesota the practice of manuring varies widely. Some growers do not use manure or any other fertilizer nor do they cultivate, and in consequence their orchards have a half-starved appearance. Some growers manure occasionally but do not make it a regular practice. About half the orchards surveyed are manured more or less regularly. Some manure their orchards every year, some every other year, and others every third or fourth year. Some manure half the orchard each year, others a third or a fourth each year, according to the amount of manure available. Averaging these diverse practices is not wholly satisfactory, but on the average the operation requires 6.96 man hours and 11.54 horse hours per acre. The range is very wide, as may be expected. Man hours range from 1.2 to 64 hours per acre, horse hours from 1.8 to 128 hours.

The amount of manure applied per acre averages 3.74 tons, ranging from 1.3 to 12. For each ton of manure applied 1.86 man hours and 3.08 horse hours are required.

The labor costs for this item are \$3.47 per acre and 2 cents per bushel. The material costs are \$5.61 per acre and 4 cents per bushel.

2. *Pruning.*—Some pruning is done in all but 3 of the 64 orchards surveyed, but in 3 other orchards no specific data could be obtained. The figures for this operation are based on 58 orchards comprising 359.8 acres. The average time spent in pruning is 17.83 hours per acre (range, 2 to 69 hours), 0.12 hours per bushel, and 0.15 hours per tree, for trees averaging 16 years old. Interpreted in another way, the average grower prunes a tree in 8.76 minutes, or 6.85 trees per hour.

There is no correlation between the hours per acre in pruning and the profitableness of the orchard. This is due in part to the varying number of trees per acre, but the degree of severity of the pruning and the ability of some workers to prune much more rapidly than others also directly affects the time per acre.

While the average number of trees pruned per hour is 6.85, the range is from 2.1 to 30. A few poorly handled orchards report a much higher figure, but the work in these cases is so poorly done or so little is done that the data can not be included in the general summary. In semi-neglected orchards or with slow workers, only 2 or 3 trees are pruned per hour. In the best managed orchards the range is from 4 to 12 trees per hour.

From the foregoing data it appears that the growers pruning from 4 to 12 trees per hour take from 5 to 15 minutes per tree. As the average age of the trees in the orchards surveyed is 16 years, it is evident that growers who take less than 5 minutes per tree are not pruning properly.

The age of trees has an effect on the time of pruning, as shown in Table VII, in which the orchards are divided into three groups, (1) the orchards of 8 to 13 years, (2) the bearing orchards in their prime, and (3) the older orchards. Young trees require approximately the same time as the old trees, but the trees in their prime, from 14 to 19 years old, take  $\frac{3}{7}$  more man hours per acre and approximately  $\frac{1}{3}$  more time per tree. Similarly there are fewer trees pruned per day and per hour in the second group.

TABLE VII  
EFFECT OF AGE OF TREES ON THE RATE OF PRUNING

Age of trees, yrs.	No. of orchards	Total acres	Av. No. of trees per acre	Trees pruned per 10 hours	Man hours per acre	Man hours per tree	Trees per man hour
8-13	13	83.5	10.2	84.6	12.0	0.12	8.46
14-19	34	232.2	131	62.3	21.1	0.16	6.23
20-36	11	44.1	122	96.1	11.5	0.10	9.61
Total	58	359.8					
Average			122.3	68.5	17.8	0.15	6.85

Based on these averages, the cost of pruning is \$4.46 per acre, 2.9 cents per bushel, and 3.6 cents per tree. It should be pointed out, however, that when skilled pruning labor is hired the cost is usually markedly higher, as the wages received in such cases range from 50 cents to \$1 per hour.

3. *Disposal of brush.*—The most common method of brush disposal is for one man to work with a low wagon or sled drawn by two horses. Two men are frequently used in the operation. Occasionally the work is done with one horse. As the loads are light, the most economical crew is two men and one horse. This sort of crew, however, would leave one horse standing idle in the barn in the majority of cases. The average time requirements for this operation are 3.54 man hours (range 2.14 to 6.66) and 3.55 horse hours (range 1.64 to 6.66) per acre; and 0.02 man hours and 0.02 horse hours per bushel. The cost of the operation is \$1.42 per acre and 9 cents per bushel.

4. *Spraying.*—The practice of spraying in the average Minnesota orchard has not been highly developed. Of the 64 growers 11, or 17.2 per cent, did little or no spraying. Fifty-three, or 82.8 per cent, sprayed more or less thoroly.

During the period of this survey the general practice was to spray twice. These were generally the pink and calyx sprays. Very few growers apply the dormant spray, as scale insects are not commonly found.

Some growers hire others to spray for them. This method is expensive and the spray generally is not efficiently applied. The greatest objection to the practice, however, is that the sprays are not applied at the proper time and the result is poor control of orchard pests and a low grade of fruit.<sup>3</sup> In nine of the orchards surveyed

<sup>3</sup> Those who do custom spraying generally have orchards of their own which are sprayed at the proper time. The spraying for others is done either before or after the critical time for each operation.

the spraying was of this kind. In these orchards spraying was a cash cost and no data on the use of labor were obtained.

Of the 44 orchards from which data were obtained, 8, or 18 per cent, were sprayed once; 27, or 61 per cent, were sprayed twice; 8, or 18 per cent, were sprayed three times; and one was sprayed four times. There is a steady improvement in spraying practices at the present time and it is very likely that a resurvey of these orchards would show at least three spray operations, with a considerable increase in the number applying four sprays. The number of power outfits is increasing, also adding considerably to spraying efficiency. Table VIII shows the grouping of 44 orchards according to the type of spray outfit, the number of sprays applied, and the orchards and acreage in each group.

TABLE VIII  
ORCHARD GROUPS SHOWING NUMBER OF SPRAYS APPLIED AND TYPE OF OUTFITS USED

No. times sprayed	Barrel		Power		Total	
	Orchards	Acres	Orchards	Acres	Orchards	Acres
1	6	25.9	2	9	8	34.9
2	9	64.1	17	117	27	182.6
3	3	11.8	5	70	8	81.8
4	..	...	1	4	1	4.0
Total	18	101.8	25	200	44	303.3

There seems to be a tendency to apply more sprays when power outfits are used. The two outfits used for only one spraying are not being used efficiently from the standpoint of investment and depreciation or from the standpoint of efficient orcharding. Eleven of the 18 men using barrel outfits have from 4 to 15 acres of orchard and should use power outfits. Four of these 11 men are fairly successful growers who could improve their product and otherwise spray to better advantage with power outfits.

The type of outfit, whether barrel or power, makes a great difference in the labor charges, as shown in Table IX.

TABLE IX  
EFFECT OF TYPE OF SPRAYING OUTFIT ON LABOR CHARGES PER ACRE\*

	Type of outfit		Total	Average
	Barrel	Power		
Number of records.....	18	25	43	
Number of acres.....	101.8	200	301.8	
Age of trees.....	17	16		16
Acres per day.....	1.89	3.61		2.71
Man hours per acre.....	12	6.3		8.23
Horse hours per acre.....	7.9	4.4		5.62
Labor cost per acre.....	\$4.18	\$2.23		\$2.80

\* For one operation.

The average power outfit is twice as efficient as the barrel outfit in use of time. With barrel outfits 12 man hours and 7.9 horse hours were required per acre while with the power outfit only 6.3 man hours and 4.4 horse hours were required. Based on these figures, the labor cost for one spraying on one acre is \$4.18 for the barrel outfits and \$2.23 for the power outfits. An attempt was made to determine the most economical labor crew, but some of the group populations were so small that definite conclusions could not be drawn. However, the data indicate that the most economical crew as seen in the cost per acre and per bushel is three men and one or two horses. For the barrel outfits one horse may be used economically but two horses are needed for the heavier and more efficient power outfits.

Objection to the use of power outfits is sometimes made on the basis of cost and depreciation. The data show that with interest and depreciation added to material and labor costs the power outfits carry an average charge per spraying of \$6.28 per acre, 4.2 cents per bushel, and 5.1 cents per tree.<sup>4</sup> The charges for barrel outfits are \$6.55 per acre, 4.4 cents per bushel, and 5.4 cents per tree. The differences in favor of power outfits are not great, but in addition there is a great saving in hard hand work, much better pressure, greater efficiency, and a marked saving in time for each spraying, which is a vital consideration.

A similar comparison of the use of rods and guns in power spraying is found in Table X.

TABLE X  
COMPARISON OF RODS AND GUNS IN LABOR COST AND EFFECTIVENESS IN POWER SPRAYING

	Trees per acre	Hours per acre		Acres per day	Trees per day	Labor costs	
		Man	Horse			per acre	per tree
Rod	155	10.7	6.9	1.86	289.1	\$4.71	3.04 cents
Gun	112	4.7	3.8	5.23	588.3	1.74	1.55

This table shows that guns covered approximately three times as much area in a day as rods; at about one-third of the labor cost. However, the number of trees per acre is quite different and a comparison of the number of trees sprayed each day by each type of equipment is a much fairer basis. The table shows that guns sprayed twice as many trees per day as rods, and the cost per tree with guns was one-half the cost with rods. This saving of time is of great importance, as the critical period for any one application is short and this time may be further reduced by stormy weather.

<sup>4</sup> On the basis of two sprayings yearly, one half of the annual charges for interest and depreciation is used in figuring these costs.

The spraying data show that an average of 125 gallons of spray material (range 50-450 gallons) is applied per acre for spraying, or approximately one gallon per tree. This amount is low, judging from the amount used by the better growers who averaged 2 gallons or more per tree. On the basis of the usual spray formula of 1.5 pounds of arsenate of lead and 1.25 gallons of lime-sulphur concentrate per 50 gallons, 3.75 pounds of arsenate of lead and 3.125 gallons of lime-sulphur were used per acre.

The average labor requirements per acre for a single operation are 8.23 man hours and 5.82 horse hours. The labor costs are \$2.89 per acre, 2.4 cents per tree, and 1.9 cents per bushel. As the usual practice during the years covered in the survey was to spray twice, these charges are doubled in the summary.

5. *Mowing*.—While mowing is a common practice in nearly all Minnesota orchards, data were obtained in only 33 instances. Many growers are still following the poor practice of cutting the grass for hay. In 13 orchards surveyed hay was taken off but was fed and the manure returned to the orchard. A few sold the hay, making no return in fertility to the orchard. The hay, whether fed or sold, is of low grade and altho an average of 1.2 tons per acre was obtained it was not worth over \$15 per ton at the time of this survey, or \$18 per acre. The practice of taking hay out of the orchard has long been considered injurious, as it leaves the ground bare so that the loss of moisture is heavy. As this loss occurs at the time when the fruit is developing in size, it is obvious that the loss may greatly exceed the value of the hay.

Ten orchards were pastured regularly except just before harvest. The pasture value averages \$4.53 per acre per year, but the damage to the trees generally exceeds this small return.

Of the 33 growers who followed the practice of cutting the grass for mulch, 23 cut only once, 8 cut twice, and 2 cut three times. It is of interest to note that all the orchards in the last two groups are above the range for yield and profit.

For the mowing operations, a crew of one man and two horses is generally used. Hand mowing is usually done around the trees where the machine can not go readily. On the basis of one operation, the time spent per acre is 6.17 hours of man labor (range 1.2 to 18.2 hours) and 4.07 hours of horse labor (range 0 to 13.3 hours). The labor requirements per bushel are 0.04 man hours and 0.03 horse hours. The costs of the operation are \$2.15 per acre and 1.4 cents per bushel.

## B. HANDLING ITEMS

1. *Picking.*—Picking is usually done in late August and throughout September. The proportion of winter apples is small, so little picking is done in October. Some growers pick the largest of the early varieties in late July, when there is a demand on local markets for early apples. This requires a second picking later, or the trees may be gone over several times if prices are good. In general, picking proceeds from the earliest varieties to the latest and the trees are picked clean in one operation. No special picking receptacles are used, as the general practice is to pick into the standard bushel or half-bushel baskets. All types of ladders are in use, but the preference is for the three-legged orchard ladder.

Data on the picking operation show a labor requirement of 50.31 man hours per acre (range 12.8 to 160 hours and 0.32 man hours per bushel (range 0.09 to 0.58 hours). The average picker can pick 31.5 bushels per day (range 17 to 100). This average daily picking is low, because of the low average yield per tree. In orchards where the trees are crowded the crop is mainly in the upper third of the tree, making picking more difficult and requiring the pickers to move the ladder frequently. In the better managed orchards, especially those in which the trees are not crowded, the average daily picking compares favorably with that in other sections.

Extra help is usually required in this operation. Some growers pay by the day and others by the bushel.

Average costs for picking are \$12.58 per acre and 8.4 cents per bushel.

2. *Hauling from the orchard.*—The labor involved in hauling the crop from the orchard varies with the amount of crop and the distance to the place where packing is done. Most of the growers who sell in baskets do the packing in the orchard and haul direct from there to the shipping point or market. It is difficult under these conditions to separate from the data on hauling the portion representing the haul from the orchard to market.

The practice among growers is about evenly divided between one- and two-horse rigs. The driver may load and unload the wagon but is usually helped by pickers. A few growers sell direct from the orchard to buyers who purchase the entire crop and do the packing and hauling.

Man-labor requirements for this operation are 9.02 hours per acre (range 2.8 to 27 hours) and 0.05 hours per bushel. Horse hours average 12.41 per acre (range 5 to 27 hours) and 0.07 per bushel. Based on these labor charges, the costs for this item are \$4.12 per acre and 2.7 cents per bushel.



3. *Grading and packing.*—Grading and packing are so difficult to separate in the data that they have been figured together. As the entire crop is sorted over, the labor has been figured on the basis of total yield altho this leads to a slight error, as the culls are not packed.

As a general rule very little grading is done, but the majority of growers sort out the culls. Those who market in baskets generally sort in the orchard as the fruit comes from the pickers. Little attempt is made to grade as to size and color. The packing consists in properly filling the baskets and leveling off the face. When the fruit is to be shipped the covers are wired on at the sides. Those who market in barrels sort when the packing is done, using some kind of home-made sorting table. The usual methods of barrel packing are followed. Facing, racking, tailing, and nailing the head take about three times as much man labor as the loose packing in baskets. Weighted averages from 145.4 acres of basket handling and 81.5 acres of barrel handling show labor requirements of 14.32 man hours per acre (range 2.4 to 31.7 hours) and 0.09 man hours per bushel. Based on these labor charges the costs for this item are \$3.58 per acre and 2.6 cents per bushel.

4. *Hauling to market.*—The practice of hauling to market shows wide variation. Some growers sell their entire crop in the orchard and the buyer does the hauling. No data are available in regard to the effect of this practice on the price per bushel, but it is to be expected that the grower will not get quite as much as he would if he hauled the crop himself. Other growers sell a part of their crop direct to consumers at the orchard and consequently have no hauling charges for that part of the crop. Some growers who have small orchards, or who do not follow the best methods of orcharding and marketing, haul a few bushels to town with other produce. No way was found to gather data on the hauling charges for these fractional loads.

Of the growers primarily in the apple business, 7 haul by truck and the practice seems to be gaining in favor. Those using trucks are all located within 25 miles of the Twin Cities. They generally make but one trip a day and sell on the early morning market. Four of these growers use light trucks and haul from 18 to 25 bushels to the load. The other three use heavier trucks and haul up to 100 bushels to the load. Not enough trucks were being used to warrant detailed study of their use in hauling.

The majority of the commercial growers haul to market or shipping point by horse and wagon. Thirty-five orchards are in this group but data were obtained from only 19 of them. However, these records were obtained from the most successful growers and include both large

and small orchards, long and short hauls, and barrel and bushel handling, so the data can be considered fairly representative of the whole group.

The majority hauling by team use one man and two horses. In a few instances two men are used and one horse was used in two cases.

In the vicinity of Excelsior it is customary to haul the culls to the cider mill operated by the Fruit Growers Association. In all such cases the culls have been figured in the hauling charges. The common practice in other orchards is to sell the culls in the orchard, but some feed them or run stock in the orchard to clear them up.

Salient facts in regard to hauling to market are shown in Table XI. These data are based on the weighted average of 135.8 bushels sold per acre.

TABLE XI  
HAULING TO MARKET

	Number	Range
Growers reporting.....	19	
Acreage reported.....	186.8	1.3 to 26
Distance hauled, miles.....	2.27	0.25 to 6
Bushels per load.....	58	16 to 96
Man hours per acre.....	7.14	3.3 to 12
Man hours per bushel.....	0.05	0.03 to 0.13
Man hours per bushel mile.....	0.02	0.01 to 0.17
Horse hours per acre.....	12.52	6.6 to 20
Horse hours per bushel.....	0.09	0.03 to 0.26
Horse hours per bushel mile.....	0.04	0.02 to 0.17
Cost per acre.....	\$3.66	\$2.31 to \$7.00
Cost per bushel, cents.....	2.7	1.5 to 9.1
Cost per bushel mile, cents.....	1.2	0.8 to 8.4

## II. MATERIAL COSTS

1. *Spray materials.*—A few growers use patent spray mixtures and some use nicotine sulfate occasionally for apples, but such practices did not occur frequently enough to warrant including them in the average. The common spray mixture used contained 1.5 pounds of lead arsenate powder and 1.25 gallons of lime-sulfur concentrate to 50 gallons of the dilute mixture. As the growers used on the average 125 gallons (range 50-450 gallons) of this mixture for a single spray, 3.75 pounds of arsenate and 3.13 gallons of lime-sulfur were used per acre for spraying. As two sprays generally were applied, the amounts of these materials used per acre per year were 7.5 pounds of arsenate and 6.25 gallons of lime-sulfur. The average price of the arsenate was 27 cents per pound, making the acre charge for this ingredient \$2.02.<sup>5</sup> The average price of the lime-sulfur was 25 cents

<sup>5</sup> From quotations by dealers for retail prices in 100-pound lots, 1914-1920 inclusive.

a gallon, making the acre charge \$1.56.<sup>6</sup> For these two spray materials together the costs were \$3.58 per acre, 2.39 cents per bushel, and 2.92 cents per tree.

2. *Manure*.—Manure, while usually produced on the farm, has a cash value. Some growers purchase manure for all or part of their orchards. In either case the manure is charged at an average of \$1.50 per ton. As the average amount used is 3.74 tons per acre (range 1.3 to 12 tons) the charges for this material were \$5.61 per acre and 3.7 cents per bushel.

3. *Packages*.—The average cost for barrels from 1916 to 1920 was 60 cents, ranging from 30 cents in 1916 to more than a dollar in 1919 (1923 prices range from 85 to 90 cents). At 60 cents the average costs were \$29.82 per acre and 20 cents per bushel.

A few growers sold to buyers who furnished the baskets. Other growers got the baskets back so had only replacement charges. Still other growers sold the baskets with the apples. As baskets generally have to be charged against the crop whether bought by the grower or the buyer, there was a charge per acre of \$34.27 for this item, or 23 cents per bushel, based on the price average for 1917-20.

The average cost for barrels and baskets was \$32.04 per acre and 21.5 cents per bushel.

4. *Replacement of picking baskets*.—There is a charge against all orchards for the necessary replacement of baskets, boxes, or crates used in picking. The general practice is to use bushel or half-bushel baskets. Charges for this item should not be confused with charges for baskets broken or lost in the market by those following the practice of having the baskets returned after the fruit is sold. On the average four baskets have to be replaced per acre per year, the cost, at 23 cents each, being 92 cents per acre and 0.6 cents per bushel.

### III. FIXED COSTS

1. *Acre valuation and interest*.—Acre valuation is extremely variable. Some orchards are not in good condition, others are producing

The last paragraph on page 35 is incomplete. Following the words "there is," should be added: an average worth of \$510 per acre (range \$150-\$800). Yearly interest charges at 6 per cent on this valuation amount to \$30.60 per acre and 20.4 cents a bushel.

2. *Taxes.*—Taxes are extremely variable and it is also difficult to estimate the proportion of the tax for a farm which might rightly be charged against the orchard. Because of these difficulties an arbitrary charge of 0.5 per cent of the valuation is made against each acre. This amounts to \$2.55 per acre and 1.7 cents per bushel.

3. *Interest on and depreciation of spray equipment.*—The average value of spray equipment amounts to \$18.24 per acre. The range from \$1.60 to \$80 per acre is very wide, owing to inefficient barrel outfits being used in some cases and to power outfits being used in others. Interest at 6 per cent on the average valuation amounts to \$1.09 per acre and 0.7 cents per bushel.

Depreciation is not as rapid here as in other sections, as the outfits have been used for only two sprayings per year on the average. While depreciation undoubtedly is becoming more rapid with an increase in the number of sprayings, at the time of this survey it was found to amount to 12.5 per cent of the valuation. This amounts to \$2.28 per acre and 1.5 cents per bushel.

4. *Interest and depreciation on other equipment.*—Miscellaneous equipment varies greatly in amount and quality for the different orchards. Ladders, picking baskets, pruning tools, sorting and packing tables, and any special orchard implements are included in this item and have an average acre valuation of \$10.33 (range \$1.50 to \$75). Interest at 6 per cent on this sum amounts to 62 cents per acre and 0.4 cents per bushel. Depreciation of this equipment is charged at 10 per cent and amounts to \$1.03 per acre and 0.6 cents per bushel.

#### IV. OVERHEAD COSTS

This charge is made to cover the costs of such minor items as gasoline for sprayers, spray materials other than listed, extra hauling, telephone, and insurance. So little insurable equipment is in use, and fire insurance on the portion of any building used for handling the crop would be such a small amount, that the overhead will readily cover such expenses. Miller (20), in the report on costs in New York orchards, shows in Table XXIV that somewhat similar charges amount to 2.5 per cent of the gross costs, altho he does not group these charges specifically as "overhead costs." In this study of costs in Minnesota orchards, it is assumed that 3 per cent of all operating costs is ample to cover these minor charges. The total operating costs amount to \$121.56 per acre and 81.2 cents per bushel. Three per cent of these items amounts to \$3.64 per acre and 2.4 cents per bushel. an average worth of \$510 per acre (range \$150-\$800). Yearly interest charges at 6 per cent on this valuation amount to \$30.60 per acre and 20.4 cents per bushel.

SUMMARY OF COSTS

A summary of all costs charged against each acre and bushel is given in Table XII.

TABLE XII

SUMMARY OF ACRE AND BUSHEL COSTS WITH A TABULATION OF MAN AND HORSE HOURS CHARGED AGAINST EACH LABOR ITEM

	Man hours per acre	Horse hours per acre	Costs per acre	Cost per bushel
<b>Labor costs</b>				
Manuring .....	6.96	11.54	\$3.47	2.3
Pruning .....	17.83	....	4.46	2.9
Disposal of brush.....	3.54	3.55	1.42	0.9
Spraying (2 times).....	16.46	11.24	5.80	3.8
Mowing grass .....	6.17	4.07	2.15	1.4
Total maintenance costs.....	50.96	30.40	\$17.30	11.3
Picking .....	50.31	....	12.58	8.4
Hauling from orchard.....	9.02	12.41	4.12	2.7
Sorting and packing.....	14.32	....	3.58	2.6
Hauling to market.....	7.14	12.52	3.66	2.7
Total handling costs.....	80.79	24.93	23.94	16.4
Total labor costs.....	131.75	55.33	41.24	27.7
<b>Material costs</b>				
Spray materials .....			5.61	3.7
Manure .....			3.58	2.4
Packages .....			32.04	21.5
Replacement of picking baskets.....			0.92	0.6
Total material costs.....			42.15	28.2
<b>Fixed costs</b>				
Interest on investment.....			30.60	20.4
Taxes .....			2.55	1.7
Spray equipment—Interest .....			1.09	0.7
Spray equipment—Depreciation .....			2.28	1.5
Miscellaneous equipment—Interest .....			0.62	0.4
Miscellaneous equipment—Depreciation .....			1.03	0.6
Total fixed costs.....			38.17	25.3
Total direct costs.....			121.56	81.2
<b>Overhead costs</b>				
Overhead (3 per cent of direct costs).....			3.64	2.4
Total costs .....			125.20	83.6

DISTRIBUTION OF LABOR

Figure 12 shows the percentage distribution of man labor based on the foregoing table. Picking is seen to be the largest item, comprising 38.2 per cent. Pruning 13.5 per cent, spraying 12.5 per cent, and sorting 10.9 per cent follow in order of importance, while the other labor items use proportionately lesser amounts of man labor.

Figure 13 shows the percentage distribution of horse labor, also based on the figures in Table XII. Hauling to market, hauling from the orchard, manuring, and spraying make almost equal demands on horse labor, while mowing and brush disposal use proportionately lesser amounts.

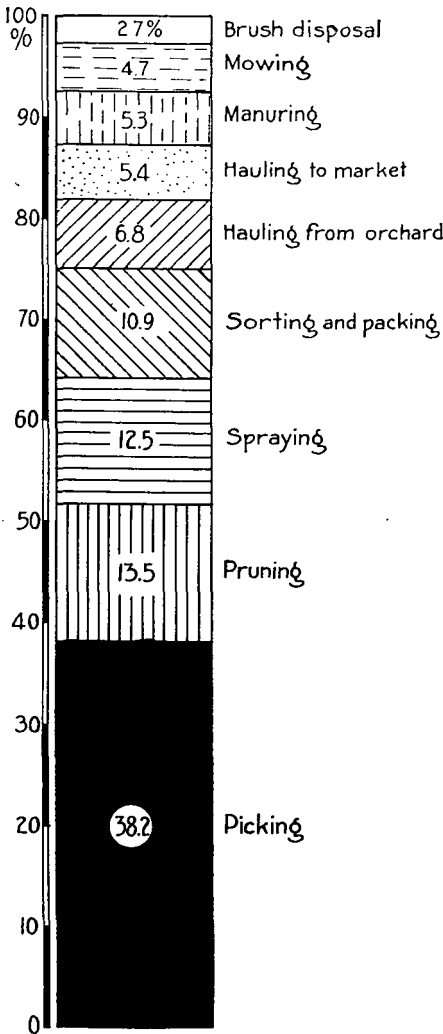


Fig. 12. Distribution of Man Labor

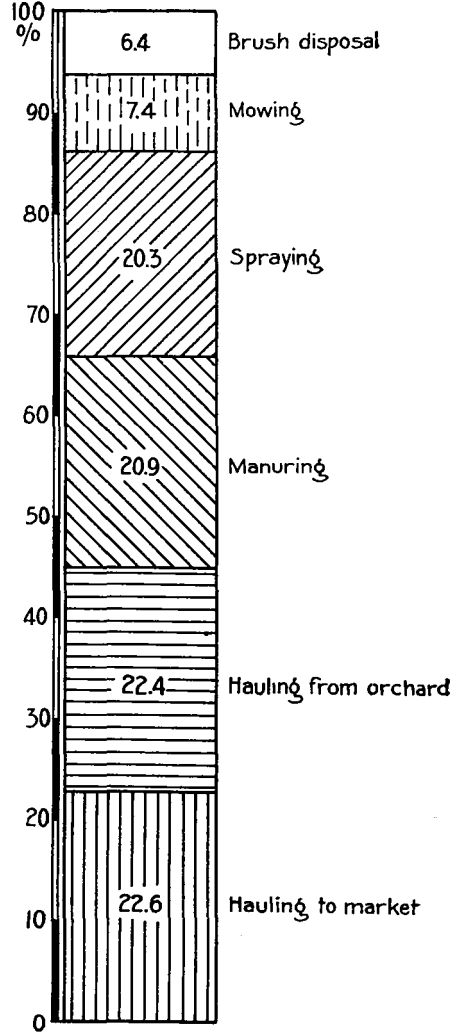


Fig. 13. Distribution of Horse Labor

DISTRIBUTION OF COSTS

The distribution of costs based on Table XII is shown in Figure 14. Material costs, including the heavy package charge, is the largest cost group. Fixed costs, including the charge for interest on investment is the next largest group; with crop handling, maintenance, and overhead following in lesser rank.

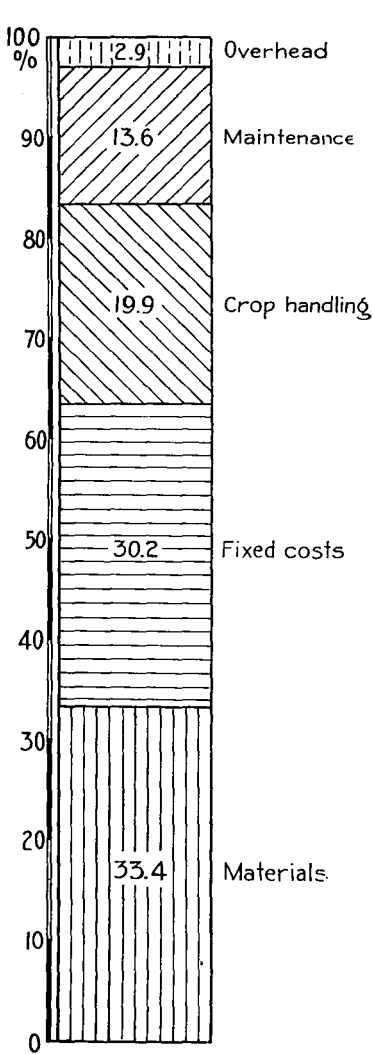


Fig. 14. Distribution of Costs

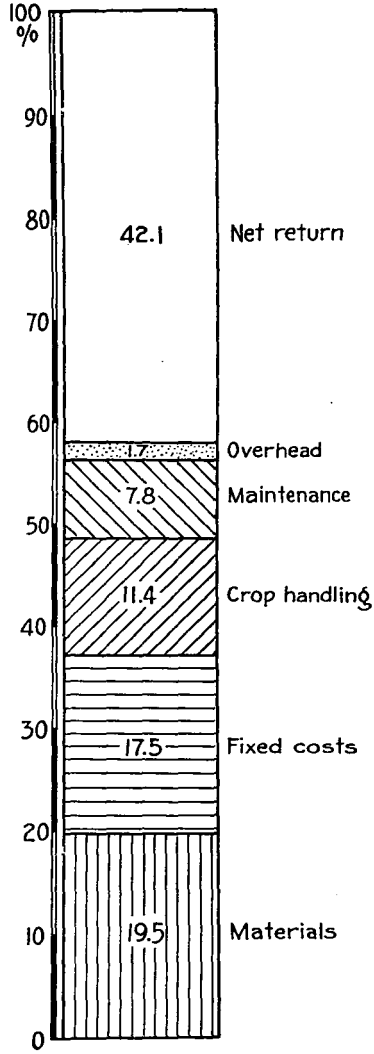


Fig. 15. Distribution of Returns

## AVERAGE NET RETURNS

With an average gross income of \$215.99 per acre and \$1.44 per bushel and average costs of \$125.20 and 84 cents per acre and per bushel respectively, there was an average net income of \$90.79 per acre and 60 cents per bushel for the orchards surveyed.

In 15 poorly managed orchards totaling 75 acres, the average gross returns per acre were \$46.73.

In 28 generally well managed orchards totaling 192 acres, the average gross returns were \$307.81 per acre. Costs and net returns have already been shown by yield groups in Table VI. As large yields and greater returns generally are the results of good management, it is evident that properly managed orchards in suitable locations are yielding very satisfactory returns.

## DISTRIBUTION OF RETURNS

The distribution of gross returns between costs and net returns is shown in Figure 15. It is readily seen from this figure that the cost items, while smaller proportionately than in Figure 14, bear the same relation to each other. The net returns, comprising 42.1 per cent of the gross returns, show clearly that apple growing on the average has been a profitable enterprise in Minnesota.

## OWNER'S INCOME

The orchard owner may consider his orchard income to be derived from three sources: (1) his own labor, (2) interest charges, and (3) net return.

## INCOME FROM OWNER'S LABOR

The owner, according to the survey data, does nearly all the mowing, pruning, and disposing of brush. He does approximately one-third of the mowing, nearly one-fifth of the picking, four-fifths of the sorting and packing, and one-half of the hauling to market. Hauling from the orchard is usually done by hired labor. Some owners do much more of the work themselves, others hire practically all labor. The total hours per acre which the average owner expended in the orchard are 56.35. At 25 cents per hour this amount of time represents an income of \$14.09 per acre. Table XIII shows the number of hours the orchard owner devotes to the different labor items.



TABLE XIII

## HOURS OF OWNER'S LABOR PER ACRE IN THE VARIOUS LABOR OPERATIONS

Operation	Hours per acre
Manuring .....	5.39
Pruning .....	15.62
Brush disposal .....	3.01
Spraying .....	5.49
Mowing .....	2.06
Picking .....	9.76
Sorting and packing.....	11.45
Hauling to market.....	3.57
Total hours .....	<u>56.35</u>
Total income from owner's labor (at 25 cents per hour)	<u>\$14.09</u>

## INTEREST ON INVESTMENT

Interest on the investment in land and equipment must be charged against the gross returns in figuring the net profits of the enterprise. This interest represents the earning power of that amount of capital whether invested in an orchard or not. However, the interest is really income for the owner and is credited as such. The interest charges per acre are \$30.60 on land investment, \$1.09 on investment in spray machine, and 62 cents for investment in miscellaneous equipment, totaling \$32.31.

## NET RETURN

As shown previously the net return averaged \$90.79 per acre.

## TOTAL INCOME

The average total income of the owner for each acre of orchard covered in the survey is shown in Table 14.

TABLE XIV

## OWNER'S AVERAGE TOTAL INCOME PER ACRE

Source	Amount
Owner's labor .....	\$14.09
Interest charges .....	32.31
Net return .....	90.79
Total income .....	<u>\$137.19</u>

Those who have neglected their orchards have less income from labor and less interest and lower net returns, or even a net loss. Those who have given their orchards good care have a larger income from labor, increased interest, and a much larger net return.

If the net return be considered as additional return to labor, the owner may consider his hourly wage to be \$1.86. It is obvious that the time given to planning the management and in solving problems of the orchard business is not included in the actual time spent by the owner in orchard labor. Considerable time is spent in this way by the successful grower, but there is no way to get satisfactory data on the item.

The net return may be considered as additional return on investment. The net return of \$90.79 would then represent additional interest of 16.8 per cent, making the total interest on the investment 22.8 per cent.

### CONCLUSIONS AND OBSERVATIONS

Well managed orchards in Minnesota are producing satisfactory yields and are returning a good net income.

Improvement of the methods of management is imperative in many orchards or the land should be used for other crops.

Most of the orchards in the state should be thinned to give the remaining trees more light, food, and moisture, and to increase the yield.

Most of the sod orchards are low in vigor. Yields could be increased markedly by a change in cultural methods.

As high yields have such an important bearing on the gross and net returns (Table VI), growers should improve their methods of management whenever possible in order to obtain the best possible yields.

Inefficient spraying has been the cause of much of the poor condition of the crop. Three or four sprayings properly applied would produce crops of far better grade.

Grades need to be better defined and sorting done more rigidly.

## SUMMARY

Years covered in the survey.....	1916-20
Orchards surveyed .....	64
Total orchard acreage surveyed.....	487.4
Per cent of tillable land in orchards.....	33.9
Size of average orchard, acres.....	7.6
Average age of orchards, years.....	16.6
Average trees per acre in orchard.....	122.3
Average yield per acre in orchard, bushels.....	149.8

## FINANCIAL FACTS FOR THE AVERAGE ACRE

Investment	
Land .....	\$510.00
Spray equipment .....	18.24
Miscellaneous equipment .....	10.33
	<hr/>
Total investment .....	\$538.57
Costs	
Maintenance .....	17.30
Handling .....	23.94
Materials .....	42.15
Interest, depreciation, and taxes.....	38.17
Overhead .....	3.64
Total costs .....	\$125.20
Gross returns .....	\$215.99
Net returns .....	\$ 90.79
Gross returns per bushel.....	\$ 1.44
Total costs per bushel.....	\$ 0.84
Net returns per bushel.....	\$ 0.61

## LITERATURE CITED

1. Monthly Crop Reporter, U. S. Dept. of Agr. January issues, 1916-21.
2. Voorhees, E. B. Apple growing in New Jersey. N. J. Bul. 119, p. 20-22, 1897.
3. Warren, G. F. An apple orchard survey of Wayne County. N. Y. (Cornell) Agr. Exp. Sta. Bul. 226. 1905.
4. ——— An apple orchard survey of Orleans County. N. Y. (Cornell) Agr. Exp. Sta. Bul. 229, 1905.
5. Lewis, C. I. and Allen R. W. Orchard survey of Wasco County. Ore. Agr. Exp. Sta. Bul. 99. 1908.
6. Lewis, C. I., Bennet, S. L. and Vincent, C. C. Orchard survey of Jackson County. Ore. Agr. Exp. Sta. Bul. 101. 1908.
7. Hartmen, S. B. and Eustace, H. J. Can the general farmer afford to grow apples? Mich. Agr. Exp. Sta. Bul. 253. 1909.
8. Burritt, M. C. Profitable management of a small apple orchard. U. S. Dept. of Agr. Farmers Bul. 491. 1912.
9. ——— Cost of an apple orchard to bearing age. Rural New-Yorker 73: 4245, 344; 4246, 406; 4247, 468. 1914.
10. Hedrick, U. P. Ten years' profits from an apple orchard. N. Y. (Geneva) Agr. Exp. Sta. Bul. 376. 1914.
11. Miller, G. H. Operating costs of a well-established New York apple orchard. U. S. Dept. of Agr. Bul. 130. 1914.
12. Lewis, C. I. and Vickers, H. A. Economics of apple orcharding. Ore. Agr. Exp. Sta. Bul. 132. 1915.
13. Gardner, A. K. The cost of producing apples in Maine in 1914. Me. Dept. Agr. Quarterly Bul. XIV; 3, Sept. 1915.
14. Auchter, E. C. An apple orchard survey of Berkeley County. W. Va. Agr. Exp. Sta. Bul. 151. 1915.
15. Miller, G. H. and Thompson, S. M. The cost of producing apples in Wenatchee Valley, Washington. U. S. Dept. Agr. Bul. 446. 1917.
16. Thompson, S. M. and Miller, G. H. The cost of producing apples in Western Colorado. U. S. Dept. of Agr. Bul. 500. 1917.
17. ——— The cost of producing apples in Hood River Valley. U. S. Dept. of Agr. Bul. 518. 1917.
18. Miller, G. H. and Thompson, S. M. Cost of producing apples in Yakima Valley, Wash. U. S. Dept. of Agr. Bul. 614. 1918.
19. Thompson, S. M. and Miller, G. H. Cost of producing apples in the Payette Valley, Idaho. U. S. Dept. of Agr. Bul. 636. 1918.
20. Miller, G. H. Cost of producing apples in five counties in Western New York. 1910-1915. U. S. Dept. of Agr. Bul. 851. 1920.
21. Folger, J. C. and Thompson, S. M. The commercial apple industry of North America. Chap. XVIII. "Cost of Production," pp. 357-386. The Macmillan Co. N. Y. 1921.