EXPERIMENT STATION

OF THE

KANSAS STATE AGRICULTURAL COLLEGE,

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HORTICULTURAL DEPARTMENT.

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COLD STORAGE FOR FRUIT.

INTRODUCTION.

The first problem for the fruit grower to solve is how to grow fruit; how to grow more and more of it and how to make it better and better in quality. Given the solution of this problem and another awaits him, that of handling his products in such a way that the returns from them will pay for his labor and encourage his future effort. A good quality of fruit sells itself if placed on the right market at the right time. A number of Kansas fruit growers have proved this rule true in the markets of both America and Europe, and, while proving it, have established a reputation for our fruit that will give the rule a ready and easy application in the future. It is only a few growers, and not the ordinary producers, that are scoring these triumphs for Kansas fruits. The ordinary producer is still laboring to trade the several grades of his Rambos, Winesaps and Pippins, mixed together, for sugar, coffee and flour, in the local grocery store.

There are two classes of men in the fruit business in Kansas, one class active, alert, ambitious to improve both the quality and

* NOTE.—While the investigations and experiments herein described were carried on jointly by the two authors, the resignation of Professor Faville from the station staff, January 1, 1899, left the preparation of the Bulletin largely to Mr. Hall.

quantity of their products, and hopeful of finding better methods of handling what they produce; the other class producing and selling at random, not, as yet, having applied to horticulture the principles by which business is made successful. With a desire to cooperate with the first class and stimulate and direct the second, the Department of Horticulture has been investigating during the last two years the question of cold storage in relation to the keeping, handling and marketing of the fruit crop.

In years of abundance great quantities of fruit go upon the market mixed and unsorted. As the supply increases the demand seems to diminish, the market sags, gluts and breaks down beneath the burden. Decay, waste and use soon reduce the surplus, and a short time brings about a scarcity of fruit of good quality. So the glut becomes a common and regular occurrence, and scarcity succeeds the glut; meanwhile, production languishes for the want of a governor to regulate the supply and provide for the market a steady quantity depending upon the demand. While this condition of affairs is injurious to the producer, making his business almost profitless, it is equally injurious to the consumer, for it surfeits him at one season and starves him at another, precluding the possibility of regularity in his supply. The proper disposal of his crop is giving the Western fruit grower more concern than any other question. Moreover the changeable climate adds gravity to the question, since it diminishes the time thru which fruits will normally keep.

The development of the idea of storage has been the necessary outcome of these conditions. Every sort of structure that has given indications of worth in keeping fruit has been tried, and a variety of storage structures are now in use.

METHODS OF HOME STORAGE.

Fruit should never be stored in cellars beneath dwelling houses. There is always more or less decay, and the decaying fruit becomes the propagating place of disease germs which permeate the dwelling above, attacking the health of the family and causing sickness and sometimes death. Such a baneful practice of storage should always be avoided. Most of the fruit growers recognize the importance of the health factor and erect their storage structures apart from the dwelling.

Many of the contrivances are simple and inexpensive, others are well planned and constructed at considerable expense. In one instance apples were piled on the ground and covered with straw. In another a hot-bed pit in a protected corner of a kitchen garden was excavated and enlarged to dimensions of 8 by 20 feet and 3

I.—STORAGE CAVES OF JOHN TRENT, PERRY, KANSAS.

feet deep. The bottom and sides were lined with straw. It was then filled with Winesaps of good quality, which were picked from the trees while still hard, tho well colored. The pit was then covered with a layer of straw a foot deep and protected from rain by a piece of oiled muslin stretched over the top. The following winter was mild, and the location being warm the straw served the purpose of protecting from frost, and the fruit came out in the spring in excellent condition. The writers examined the fruit in the pits March 8, and found it sound and of handsome flavor, just in that fine, tempting condition that marks the best season of the Winesap. Had the winter been cold, the results might have been different. Such methods are not safe one winter with another.

Plate I represents the outside view of a cave such as is in common use for the storage of potatoes and apples in the Kaw River Valley. Such a cave is usually constructed on a hillside sloping towards the north, so that the entrance is protected from the southwest winds that prevail during summer and autumn. In moist soils the cave must be walled, in dry soils no walls are required. Upright posts along the sides support the top, which is made of poles; over the poles is a layer of coarse hay, and over the hay, soil to the depth of two feet. Several flues are made for ventilation. Such a cave may be built any desired dimensions; some are being planned with doors in each end and large enough to allow a passageway for a wagon thru them. The best system of ventilation and the most even and desirable temperature can be maintained by use of an underground ventilation pipe leading from an opening in the floor of the cave to a similar opening on the surface of the ground several rods away. The pipe should be large enough to provide sufficient air for the cave and should have valves at each opening to regulate the supply. The air in passing thru the pipe is cooled in summer and warmed in winter and thus brought to near the proper temperature for good results in keeping fruit. To complete the system, several flues should lead thru the top of the cave to the open air above. The sum of the capacities of these flues should at least be equal to the capacity of the ventilator leading into the cave.

REFRIGERATION BY MEANS OF ICE.

From the structures mentioned, it is but a step to those involving the use of ice. It is a step that has not generally been taken by farmers of this state, but in many cases it would be a profitable step to take. Almost every locality has its supply of ice which comes naturally in the winter, and this, if saved and utilized, would be a source of comfort and profit all the year round; but if let alone,

soon wastes away and is lost. A small ice and cold storage building can be cheaply constructed and, where a supply of good ice can be depended upon, is to be highly recommended. Fruits, vegetables, meats and dairy products can be kept with excellent success in this way. Temporary structures for this purpose can be made very cheaply, but we strongly recommend that the cold storage house be built with the view of permanence and continuous use. Such a house is illustrated in detail in Plates II, III, and IV.

The building is designed to be located in a hillside of such a slope that the first floor will be on the level of the surface at one end and the second floor a few feet above the surface at the other. The building is 18 by 38 feet, interior measurement, two stories in height and divided into four rooms, two on each floor. On the second floor is the ice storage room, 18 by 21 feet, in which the future supply of ice is stored, and the ice chamber, 15 by 16 feet, in which is held the ice that cools the refrigerating room directly below. A door in the ice chamber communicates with the outside. This is for the unloading of ice and is the only outside entrance into the second story. The refrigerating room is 16 by 18 feet, and is the compartment in which the temperature is to be reduced, and in which perishable products are to be stored. Leading into this room is the cooling room, 18 by 21 feet, wich is to be used as a general purpose storage cellar. A small entrance room protects the doorway into the cooling room. This is the only entrance onto the ground floor.

Plate II shows the longitudinal section and a half plan of the foundation. The building rests upon a 20-inch stone foundation. Between the foundation walls is bedded twelve inches of broken stone. Over this pass the 2- by 10-inch sills with 16-inch centers. The floor joists are bedded in dry sand or dry well-packed cinders. The floor is double with two layers of building paper between the two thicknesses.

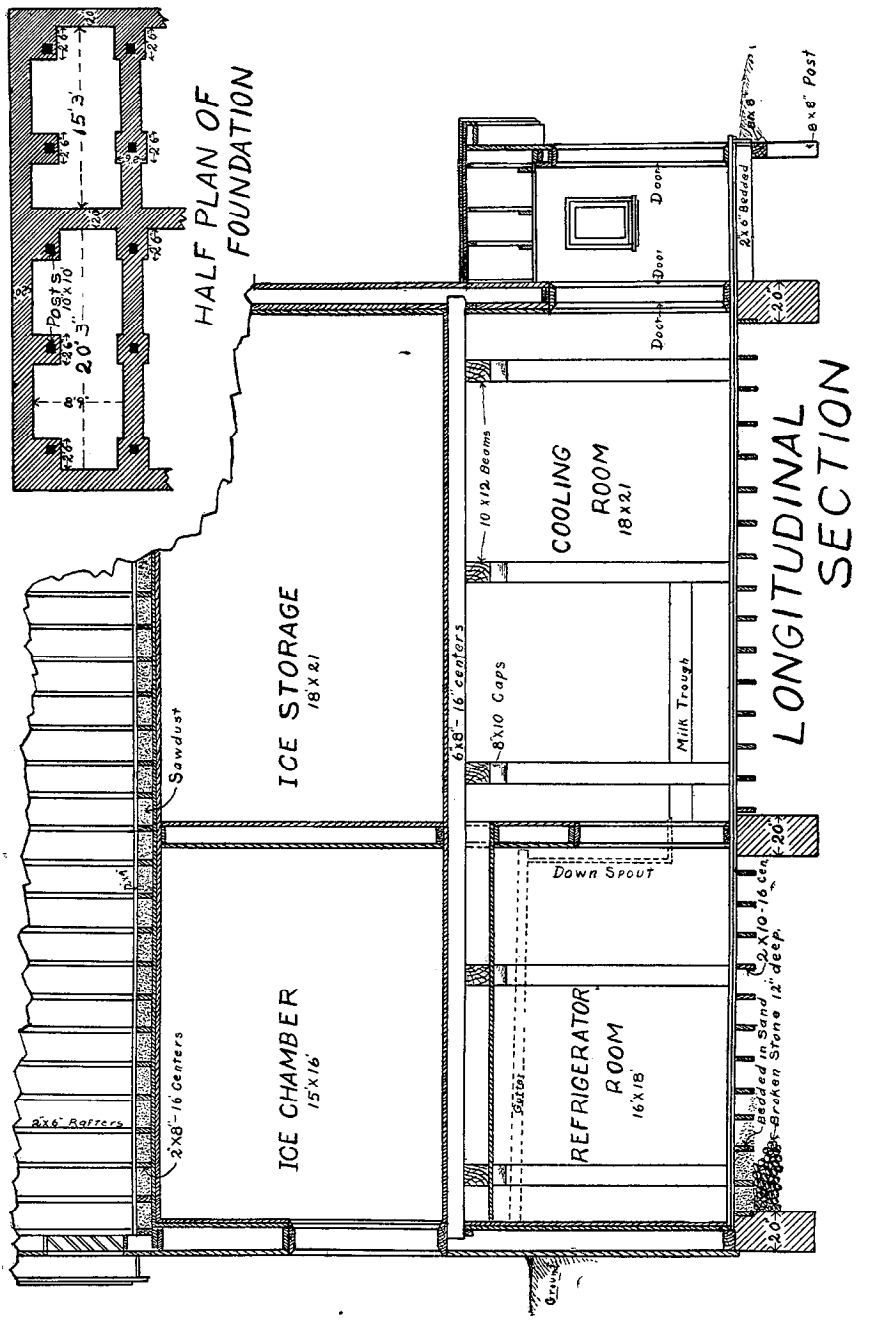
Three rows of 10- by l0-inch posts (shown in Plate III), 7½ by 8½ feet, carrying 8- by l0-inch caps, support the 10- by 12-inch beams, upon which are laid the 6- by 8-inch joists for the second floor. Two-inch flooring is laid over these. The flooring is laid tight in the storage room and provided with a slope toward the center. A gutter catches the drainage and carries it into the gutter from the ice chamber (not shown in the drawing). To prevent leakage, the floor of the storage room must have a sheet-iron covering. The floor of the ice chamber is laid with 2- by 4-inch lumber with one-inch spaces between. This provides for air circulation and water drainage. A sloping catch floor, shown in Plate IV, leads the

water into the gutter which carries it down and out thru the cooling room. The construction of the outside walls is shown in detail in Plates III and IV. The upright studding, 2 by 6 inches, are 20 inches apart. On the inside is an inch of rough boarding, two layers of building paper, a second inch board, then an inch air space, then two other thicknesses of inch boarding with double thicknesses of building paper between. On the outside of the studding is a double thickness of inch boarding with two layers of building paper between. Beyond that, building paper, an inch space and the weather-boarding. The space between the studs should be packed a foot from the foundation with mineral wool or sawdust. The inch dead air spaces and the double layers of building paper should be continuous around the room. If there is a break that admits air the dead air space loses all its qualities of insulation and becomes an air conductor. The ceiling over the ice chamber and storage should have a double thickness of boards and paper the same as the walls. The spaces between the joists should be filled tightly with dry sawdust, or better yet, mineral wool.

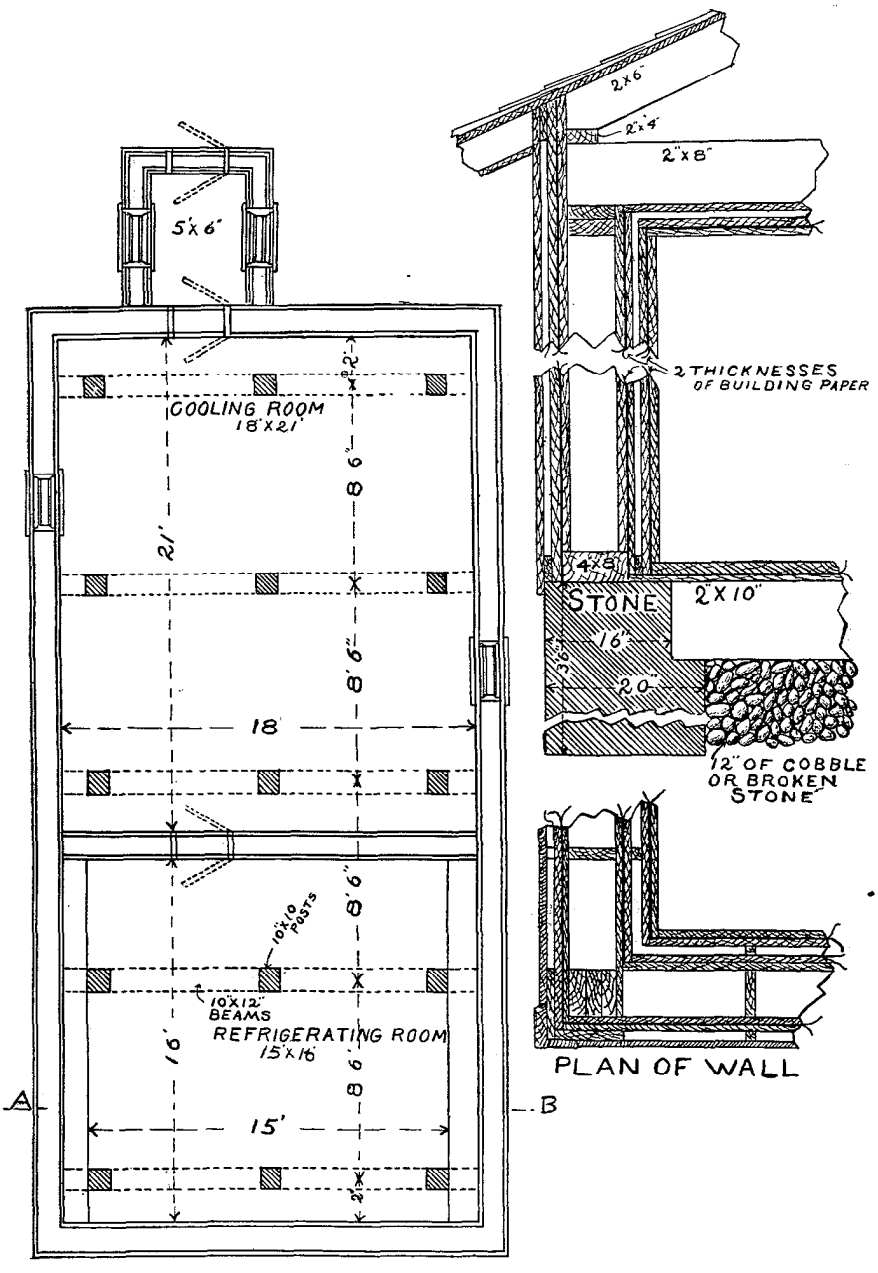
Much of the efficiency of the building for cold storage depends upon the insulation of walls, ceiling and floor. These parts should be constructed so that they will be almost non-conductors of heat. Hence, the use of mineral wool, sawdust, building paper and "dead" air spaces. These are all poor heat conductors. Air conveys heat rapidly by circulation, but where confined, so that the process must go on by conduction, it is very slow. On this account, still or "dead" air becomes one of our most useful insulating materials in cold storage construction.

The lumber for the insulation should be free from offensive odors. Pine is objectionable on this account. The outside lumber that comes in contact with the soil should be hard and durable. A coat of crude petroleum and a layer of tarred paper before the soil is banked will make it almost indestructible. The lower story may be made of stone, but the insulation will have to be provided besides, as a stone wall will allow the passage of heat very freely. The whole building, roof and all, should be painted white, in order to retard the absorption of heat from the sun.

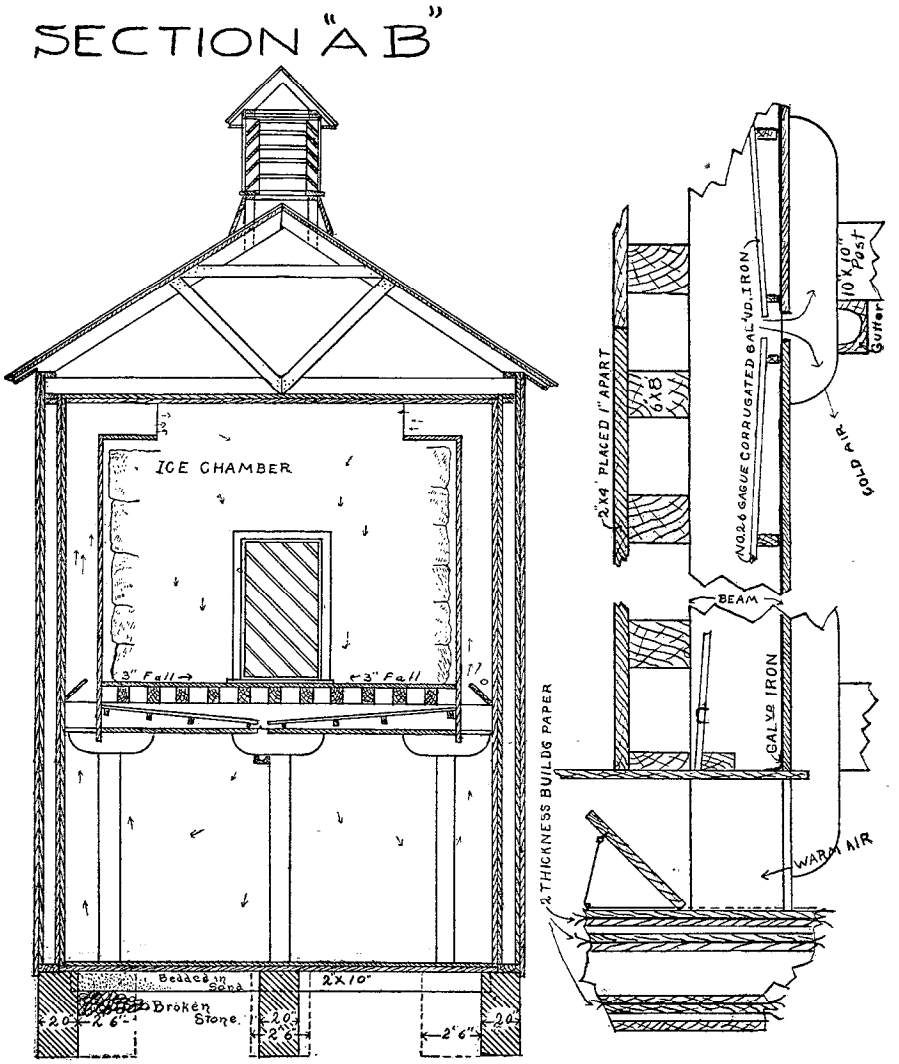
For windows in the storage room, three sashes should be used, thus giving two air spaces. The sashes should be immovable, air-tight, and protected from the rays of the sun. The doors should be tight-fitting, and to this end, should be padded on the edge. There should be two doors for each passage, one opening in, the other out. Doors should be made of two thicknesses of lumber with an inch of saw-



II.—LONGITUDINAL SECTION OF COLD STORAGE HOUSE.



111.—GROUND PLAN OF COLD STORAGE HOUSE.



IV.—CROSS SECTION OF COLD STORAGE HOUSE.

dust packed between. An ante-room should protect the entrance to the building. This also should be supplied with double packed doors.

The interior of the storage house must not be subject to rapid fluctuation in temperature. For this reason the refrigerating room should have no door opening directly outside. The plan of approaching the refrigerating room thru both the ante-room and the cooling room is not an undue precaution.

Plate III shows section A. B. thru the ice chamber and refrigerating room. The ice chamber is 15 feet in width. A space of 18 inches extends on either side from the refrigerating room to the ceiling, and continues over the ice in the chamber. This is for the passage of the warm air from the refrigerating room to the ice chamber. The current of air is controlled by means of valves in the lower part of the passage. The circulation depends upon the fact that cold air is heavier than warm air and tends to fall, crowding the warm air out of place. The ice in the chamber being in blocks without packing material between, allows the air to pass thru. In contact with the ice it becomes cooled and settles down through the cold air duct into the refrigerating room and forces the warm air upward through the passages on the sides of the room and over the ice, where it is cooled. After cooling it falls, and thus the circulation is kept up.

A system of ventilation, tho not shown in the figures, will be necessary in the building. Ventilation pipes leading from the ice chamber thru the roofs are all that will be necessary. These should be arranged so that they may be opened or closed at will.

The meltage water from the ice chamber and storage room will serve a very useful purpose if conducted thru a tank in the cooling room. This provides an excellent place for cooling and keeping milk. This is indicated in Plate II.

If the storage room and ice chamber are filled with good ice during the winter, the quantity will be sufficient to last thruout the season. The ice in the storage room may be packed in chaff or sawdust, but that in the ice chamber should be without packing. When the ice in the chamber is exhausted it should be replenished from the storage room. After the building is supplied with ice in the winter the outside door should be packed with sawdust and not again opened. An inside ladder provides sufficient passage way into the ice chamber. Such a structure is large enough for the requirements of an ordinary fruit farm, but the plan will work successfully with either larger or smaller dimensions.

ADVANTAGES OF HOME COLD STORAGE.

1. The ice and cold storage house at the home provides a means of keeping products that are of daily demand in the home and on the local market; also those products that are quickly perishable but not of sufficient importance to be sent to the city warehouse. Butter, milk, eggs, poultry and fresh meats of all kinds can be kept in summer without deterioration; while the summer fruits that decay rapidly under ordinary conditions can be kept in cold storage and used or sold at pleasure. The crate of berries that Saturday

night finds undisposed of will not decay before Monday in cold storage.

2. With cold storage at home fruit can be stored quickly and without the injuries caused by shipping. This is of especial importance if it is to be sold on the local market. The shipping of fruit injures it unless the most extreme care is taken. Fruit is often shipped to distant warehouses and, after the storage season, is shipped back to the same locality from which it came. This would be avoided by home cold storage. Fruit should be stored as soon as taken from the tree. This is impossible when dealing with distant warehouses, but possible where we have home cold storage.

3. Fruit in home cold storage can have the constant personal care of the owner. He can examine it when he wishes and sort when necessary; he can sell it by the bushel or barrel in a week or a month and pay no extra storage fee.

4. Should the commodity deteriorate in quality, or the price fail to advance, the owner is out nothing for transportation and little for storage.

MECHANICAL COLD STORAGE.

This system employs mechanical apparatus in the artificial production of cold. Machinery was first applied in the production of ice by Americans, in 1834. Several machines were brought into use about the same time, the operations of most of them being based upon the principle of elasticity of gases, air being the agent employed in some. In 1865 Ferdinand Carr, of France, introduced an ice machine based on the principle of heat absorption. The machines now generally used are based upon the same principle. Several years passed before ice-making machines were applied for the purpose of refrigeration. In most plants the two uses are now combined.

Gases are reduced in volume by pressure; most of them can be reduced till they liquefy. Under pressure they also evolve heat. Refrigerating machinery depends upon this property of gases to liquefy and evolve heat under pressure. The agent commonly used. is anhydrous ammonia. At ordinary temperature it liquefies under a pressure of 150 pounds per square inch and gives off heat. When the pressure is removed the liquid vaporizes and absorbs the same quantity of heat as was given off in liquefaction. The heat is drawn from the objects with which it is in contact. In actual practice, the ammonia is liquefied in a cylinder and the heat produced is carried off by a stream of cold water flowing over the cylinder. The liquefied ammonia is then liberated into coils of pipe passing thru a vat of brine. Here it vaporizes, absorbing heat, which it

draws from the brine. The latter can thus be cooled to the necessary temperature, 5° or 10° Fahr. usually being sufficient. The brine, which does not freeze at this temperature, is then pumped thru pipes passing thru the storage room, from the atmosphere of which it rapidly absorbs heat. The temperature of the room is reduced in this way to the required degree. Thus the heat of the storage room and its contents passes into the brine; from the brine it passes into the ammonia, and from the ammonia into the water which carries it away. The whole arrangement is simply a process of conducting heat from the storage rooms. Neither the ammonia nor the brine is wasted by the process but is recovered and used over and over again.

This system of producing cold is better adapted to large than small plants and is in use in nearly all the large cold storage warehouses of the country. At the present time warehouses employing this kind of refrigeration are found only in the larger towns and cities. But a few have been erected in Kansas, and these are situated in the larger towns along the Missouri and Kaw rivers.

ADVANTAGES OF STORING FRUIT IN THE CITIES.

Fruit stored in the warehouses of the larger cities has several advantages which with commercial growers are very important.

1. It is nearer the market, where it can be disposed of on the shortest notice. This enables the holder to take advantage of a sudden turn in price for the better. By use of the telegraph he can dispose of his whole crop in a few minutes.

2. By storing in city warehouses, fruit does not usually have to be shipped after it has been in storage. Shipping after storage is an injurious process and should be avoided. But if it must be done, the facilities for loading in the large warehouses are such that the fruit need not undergo change of temperature or injury. Adjoining the storage rooms are loading sheds which are kept very cool. The refrigerator cars in which the fruit is to be shipped are run into the sheds and the fruit is taken from the storage room directly into the cars, which are already cooled to a low temperature.

3. Fruit in city warehouses is practically on exhibition all the time, and if it is of superior quality it is a standing advertisement for the owner. Buyers find out to whom to look for such fruit. Commercial reputation and standing is no small thing in these pushing times. A man must not only grow fruit of first quality, he must make it known that he grows it. He will profit by storing it where buyers can find it.

RATES OF STORAGE.

There is storage capacity in the warehouses of eastern Kansas and Kansas City, Missouri, for 300,000 barrels. Rates of storage vary from 40 to 50 cents per barrel for the season (September till May), depending upon the quantity stored. It is stored by the month when desired, a rate of 15 cents for the first month and 10 cents for subsequent months being in common operation. It is the large quantities of fruit that are wanted in the storage houses. As each lot must be kept almost separate, so that it is accessible, and can be removed whenever desired, the advantage of large lots over small ones can be readily seen.

TEMPERATURE FOR PRESERVING PRODUCTS.

The following table, compiled partly from tables published in American Gardening, partly from "Hiles's Ice Crop," and partly from results obtained in our own experiments, shows the best temperature for preserving some of the most common horticultural products, and indicates the packages in which they should be stored and the time they may be expected to keep:

Product.	Temperature, degrees.	Package.	Time.
Apples, summer	38 to 42	Barrels or boxes	2 to 4 months.
Apples, winter	32 to 35	" "	5 to 8 months.
Pears	33 to 38	" "	2 to 4 months.
Peaches	36 to 38	Crates	2 to 4 weeks.
Grapes	38 to 40	In sawdust in boxes	6 to 8 weeks.
Plums	38 to 40	Crates	2 to 4 weeks.
Berries and cherries	40	Quart boxes	1 to 3 weeks.
Bananas	40	Crates	8 to 12 weeks.
Lemons, oranges	40	"	8 to 12 weeks.
Figs, raisins	40	Boxes	8 to 12 weeks.
Watermelons	40		3 to 6 weeks.
Muskmelons	40		2 to 3 weeks.
Tomatoes	38 to 42	Crates	2 to 4 weeks.
Cucumbers	38 to 40	"	1 to 3 weeks.
Celery	35	Boxes	
Cranberries	34 to 38	Barrels	
Onions	34 to 40	"	
Potatoes	36 to 40	"	
Asparagus, cabbage	34	Boxes	

EXPERIMENTS IN THE PRESERVATION OF FRUITS IN COLD STORAGE.

Kansas fruit growers have watched the cold storage movement with keen interest; they have been among the first to try its effects upon their products, and as it has been a matter of experiment, some of them have lost by it while others have gained. The varying results have necessarily produced diversity of opinion as to the efficacy of the system. Those who have met with success are ready to uphold cold storage and insist on its practical value in the fruit business, while those who have been unsuccessful hold various opinions regarding the cause of their failure, some blaming the cold storage men for mismanaging the fruit while in storage, or carelessness in handling it, others holding the whole cold storage practice in disrepute, and still others cautiously admitting that their methods of handling the fruit before it went into storage were somewhat at fault and that the cause of the failure of the fruit in storage might possibly trace back to that.

These results seemed to demand an investigation of the methods employed in the handling and marketing of fruits by the cold storage process and strongly indicated the possibility of making cold storage much more applicable to fruit than it is at present. Early in the season of 1898 the department made arrangements with the cold storage department of the Armour Packing Company, of Kansas City, and the Moeser Ice and Cold Storage Company, of Topeka, to conduct a line of experiments in their warehouses for the purpose of determining the utility of cold storage for the products of the fruit grower.

The minutiae of these experiments have rested very considerably upon the officials of the storage companies whose co-operation we have had. Without their ready and faithful assistance our experiments could not have been carried out. The cold storage department of the Armour Packing Company, of Kansas City, with whom most of our work has been done, has shown especial interest in the investigations and has given us much assistance in planning the details of the experiments and in keeping timely records upon the condition of the fruit. Also to the efficient superintendent of the department, Mr. W. J. Murray, are due our thanks for many valuable suggestions and opinions upon the matters of information contained in this bulletin.

In the experiments planned, it was our hope to determine, or at least throw greater light upon, the following questions:

1. What kinds of fruit can be stored with safety?

2. What are the best methods of handling fruit designed for storage?

3. What are the best packages and methods for shipping?
4. How long will fruit keep in cold storage?
5. What are the proper temperatures for keeping the different sorts of fruit?
6. How should fruit be managed while in cold storage?

PEACHES.

First Shipment.— On the afternoon of August 22, Governor Briggs and Family Favorite peaches were picked from the trees for shipment to cold storage. The crop was very heavy and the fruit had not been thinned. The result was that the quality was not first-class. A spe1l of dry, hot weather had unduly hastened the ripening, in many cases softening the fruit on one side while still hard on the other. By careful sorting a sufficient quantity of fair fruit was obtained for the purpose, none being taken except that which was firm and sound. It was taken immediately to the cellar and packed carefully into one-third bushel boxes which were first lined with paper. Paper was put over the top of the fruit, the lids were nailed on, and the boxes put into a cool room with a temperature of 50°. Early the following morning the fruit was taken to the depot and shipped in a refrigerator car to Kansas City.

The fruit was taken into the warehouse August 24. Its condition on examination being marked as "poor." It was at once divided into two lots, one of which was kept at a temperature of 34°, the other at 40°. The fruit was sorted twice but decayed rapidly during the latter part of September, no difference being noted in the effect of the different temperatures.

Second Shipment.— On August 31, Oldmixon and Elberta peaches were picked for this shipment. Fruit of better quality was used and was picked while quite solid, two or three days before it would have been picked for the local market. It was carefully sorted, so that none but sound specimens were used. A part of these were then wrapped individually in soft paper and packed very firmly into one-third bushel boxes, the boxes being lined on all sides with paper. Several layers of paper were put over the top and the lid nailed on. Another part of the fruit was treated differently, as follows: An egg-case supplied with pasteboard fillers was used. Each filler held a layer of fruit, and separated each fruit from others of the layer. Between the different layers pasteboard sheets were placed and perforated to allow the passage of air thru the case. Openings in the sides of the case admitted air from the outside. The case when full contained five layers of fruit. Over the fruit was placed an inch layer of excelsior, and the lid nailed on.

After cooling the fruit in a room at a temperature of 50°, it was shipped in a refrigerator car to Kansas City.

The shipment was taken into the warehouse September 1. The superintendent of the cold storage department, writing September 2, says: "The fruit arrived and was delivered at the packing-house yesterday morning in excellent condition. The peaches appeared to be as perfect as tho just picked from the trees; don't think your egg-case package can be improved upon for transporting fruit of this kind. The wrapped peaches packed in small crates also seem to be in good condition; but the egg-case with excelsior in the top and bottom and holes for ventilation, in my opinion, is the best package I have yet seen."

The fruit was held in the original package while in storage and kept in good condition at a temperature of 40° till toward the end of September. October 13, it was noted that 75 per cent of those wrapped in tissue paper appeared in good condition, and that those had kept best which had been picked before fully ripe. All, however, had lost in flavor. In a letter of December 19, the superintendent writes: "I would say that your egg-case package with ventilation is the best package I have ever seen used. Peaches in this package held from five to seven days longer than any other stock."

Third Shipment.— On September 17, Ringgold peaches (clingstones) were picked and stored in our cool room, which had a temperature at that time of 45°. September 21, they were sorted over to obtain firm and sound fruit for shipment. These were then put into pasteboard cups made to fit the peaches. The cups with the fruit were then packed by layers into a crate. Perforated pasteboard sheets were placed between the layers to keep them separated and allow the passage of air thru the case. Openings in the sides of the case provided for the access of air. The case was shipped in a refrigerator car on the same day to Kansas City.

The case arrived at the storage room September 23, and was placed at a temperature of 38°. The package had held the fruit well during shipping but seemed rather inferior to the egg-case package. The peaches of this shipment held firm for about fifty days, then commenced to decay from the pits and became worthless in a few days. They had lost in flavor before they began to decay.

This fruit will not hold up in storage for any great length of time, and it is not available for storage at all unless it is packed and handled carefully. If proper care is exercised, so that the peach goes into storage in just as fine condition as it comes off the

tree it can be carried two, three, and sometimes four weeks. Too much stress cannot be laid on careful handling by the grower and shipper. Ninety-five per cent of the peaches that come to market are roughly handled and unsafe to put in storage even for a few days. From 10 to 30 per cent are so bruised that decay starts at once and the decay of one peach in a box will rapidly spread to others.

A peach to be available for cold storage should be of good quality and perfectly sound; it should be picked while firm and packed so that it cannot be bruised in shipping; a contrivance for holding each peach separate is to be recommended. Refrigerator cars should always be used. The proper temperature for keeping the peach is about 38°.

GRAPES.

Three shipments of grapes were made, each of which was divided between the Topeka and Kansas City warehouses. In most cases the same varieties were not sent to the two houses on account of the supply being limited. Concords and Wordens were, however, sent to both. In all cases the fruit was picked and handled with the utmost care. Immature, overripe and defective berries were cut out. The packing was also carefully done, in order that the fruit might not be loose or slack in the baskets. At the time of packing, the stems of the fruit in a number of baskets were dipped in melted paraffine in order to seal the cuts, but as this had but little effect in the preservation of the fruit no mention is made of it in the records on the following page. After packing, the fruit was allowed to cool down for several hours in a room at a temperature of 50° and then shipped in refrigerator cars to the warehouses. In the Topeka house the fruit was held in the original baskets. In the Kansas City house it was divided, one part being held in the original baskets, one in open trays, one bunch deep, and one in thoroly dry sawdust. Two temperatures were used in the test. The following records indicate concisely the treatment and behavior of each variety during the entire test:

GRAPES WITH ARMOUR PACKING COMPANY, KANSAS CITY.

Variety.	Condition when shipped.	Date of shipment.	Kind of package used.	Temperature of storage rooms.		How handled in storage rooms.	Flavor December 1.	Condition December 1.
Elvira	Just ripe	Aug. 17	8-lb baskets	36°	40°	Loose in trays	Fair.	Fair.
Hays	" "	"	" "	"	"	" "	Gone	Loose from stem and decaying.
Concord	Not fully ripe.	"	" "	"	"	" "	Gone.	Loose from stem and decaying under skin.
Cambridge	Just ripe.	"	" "	"	"	In original baskets	Gone	Mouldy.
Worden	" "	"	" "	"	"	" "	Fair	Fairly good.
Deleware	Ripe	"	" "	"	"	In sawdust.	Gone.	Nearly as good as ever.
Othello	Not fully ripe	Aug. 23	" "	"	"	" "	Gone	Mouldy.
Beagle.	Over-ripe.	"	" "	"	"	Loose in trays	Gone	Decayed.
Eva	" "	"	" "	"	"	" "	Gone.	Loose from stem and decaying under skin
Duchess.	Just ripe	"	" "	"	"	In original baskets	Fair	Fairly good.
						Loose in trays	Fair	Holding to stem fairly well.
Elvira	Ripe.	Aug 31	" "	"	"	In original baskets	Gone	Poor.
Concord	Over-ripe.	"	" "	"	"	" "	Fair	Fairly good.

GRAPES WITH MOESER ICE AND COLD STORAGE COMPANY, TOPEKA.

Variety.	Condition when shipped.	Date of shipment.	Kind of package used.	Average temperature of storage room.	Condition October 13.	Condition November 12.
Concord	Not fully ripe	Aug. 17	8-lb. baskets		Still firm.	Dropping badly and decaying.
Worden	Ripe	"	" "	Aug 18-31 35 24°	Dropping badly	Off the stem; flavor still fair and berries plump.
Hays	Just ripe	"	" "		(Stems sealed with paraffine) keeping well.	Holding fairly well; decaying, but not falling off.
Delaware	" "	"	" "			In good condition, not dropping from stem or decaying; slightly off flavor; marketable.
Brighton	Not fully ripe.	"	" "	Sept. 37 40°	Holding up well; should be marketed	Has held well; berries decaying, but still clinging to the stem.
Cottage	Over-ripe	Aug. 23	5-lb. baskets		Dropping badly	Off the stem.
Eumelan	" "	"	8-lb. baskets	October	About gone; dropping badly.	Off the stem.
Centennial	Just ripe	"	" "	33 8°	Becoming soft and flabby; flavor good	Holding fairly well; decaying some, but not falling off.
Norwood	Ripe	"	" "		Nearly all dropped; flavor poor	Off the stem.
Agawam	Not fully ripe.	Aug. 31	" "		Fine condition; good as at first	In good condition; not dropping from stem or decaying; marketable.
Worden	Ripe	"	" "		Dropping badly; flavor good; two weeks past market.	Off the stem; berries plump and good.

The grapes packed in sawdust are not, except the Delaware, included in the notes taken December 1, but in another examination made about the same time it was found that in almost all cases this method of storing gave the best results. The berries seemed to hold to the stem better than in either of the other cases. They were also slower to show mildew, owing to the fact that the sawdust absorbed the moisture that evaporated from the grapes and kept them dry. A difficulty with sawdust packing is that it adheres to the fruit and stem so that in shaking it off the berries are detached. Cut cork was suggested as better packing material than sawdust. Next after packing in sawdust the method of storing in trays gave best results, as it kept the fruit drier than the baskets.

Dryness is essential to the successful preservation of grapes. Moisture causes the growth of mould, which at once ruins the fruit. With the present moist storage rooms some good absorbent such as sawdust must protect the fruit. Better success with grapes would be attained in a room cooled by dry, cold air currents than by the present systems of refrigeration. Such storage rooms are already being planned in some warehouses. Grapes do not require a low temperature, 38° to 40° being as low as necessary, provided the temperature is steady and the proper conditions regarding dryness are preserved.

As may be observed from the records, the grapes held up in good condition from six to eight weeks. The results of other seasons agree in fixing this as the limit for grapes grown in our section. The length of time varies considerably with the different varieties. Delaware, Agawam, Brighton, Duchess, Centennial, Concord, Worden and Hays, ranking in the order named, have kept the best. It is noticeable that the red grapes head the list, the first three being red. The fourth and fifth of the list are white, while the black grapes represented by Concord and Worden rank in the sixth and seventh places. The varieties that kept best are those that rank as early grapes. However, no extremely late varieties were tried. Had they been tried the results might be different. The climate in which the grapes grow modifies their keeping qualities. A grape maturing slowly in a climate of moderately cool, regular temperature will keep longer than one whose ripening is hastened by excessive heat.

PLUMS.

August 17, a shipment of Robinson plums was made to Kansas City. The fruit was carefully sorted and boxed in small tomato crates, holding four tills each. The crates went in cold storage cars and were taken into the warehouse August 19, being marked

"good" at the time of receipt. The room in which they were placed was held at a steady temperature of 40°. The fruit lasted till September 21, on which date it was sorted, one half being found decayed was dumped, the other half was sold.

August 31, Weaver plums were shipped in the method described above to the Topeka warehouse. These were also received in good condition and placed in storage at a temperature that varied from 34° to 38°. This fruit decayed somewhat more rapidly than the Robinson, lasting only till the 25th of September.

Both of these varieties are very juicy, and on that account run down rapidly when the process of decay once begins. It was noticeable in both that they held in good shape for several weeks and then dropped suddenly. Other sorts of plums which are not so watery can be kept for a much longer time. In our own cooling room, which had an irregular temperature averaging about 50°, we kept such plums as the Golden Beauty and Moreman for more than a month, while Weizerka, a prune-like, meaty variety, kept for a still longer time without any considerable loss. Forty degrees seems to be about the best temperature for the preservation of plums, and their duration in storage ranges from three to six weeks.

TOMATOES.

The first shipment was a crate of Golden Champion sent to Kansas City August 17. The fruit was almost ripe when shipped. Its condition was marked as "poor' when examined in the warehouse two days later. A similar crate of Honor Bright was shipped August 31. Fruit of this shipment was in about the same condition as the first lot. This crate was kept in a temperature of 34º, while the first lot was at 40°. September 15, the superintendent writes: "Tomatoes are commencing to decay. We think they were too ripe when they were placed in storage, as they have been ripening gradually even in this low temperature, and some of them show signs of decay." Both lots were disposed of September 21, the first lot dumped, the second sorted over and sold. At the suggestion of the superintendent, a third lot was sent September 21; these were picked, leaving the stems on the fruit and taking only that which was just beginning to turn. They were wrapped separately in tissue paper and placed in a crate packed on the bottom and top with excelsior. It arrived at the warehouse in excellent condition and was placed at a temperature of 40°. The stock held firm for about two months, then showed small dark spots on the skin, after which it decayed rapidly. Beneath the darkened portions the flesh was congealed into lumps, around which the fruit decayed.

Green tomatoes have been held in storage for several months, and when removed, instead of ripening, would simply rot. For cold storage, tomatoes should be picked when just beginning to redden. They are then still solid and, at a temperature of 40°, will keep safely four or five weeks.

CUCUMBERS.

A few shipments of cucumbers were made, the principal one on the 31st of August. Good, even specimens were chosen and shipped in one-third bushel boxes. They were held at a temperature of 40°. Expectations that cucumbers would keep well in cold storage were not realized. While they were held longer than they could have been without cold storage, they nevertheless soon showed signs of decay. A note made at the warehouse said that the stock held good for about thirty days. The whole lot was dumped October 15, in a decayed condition. A lower temperature might possibly have given better results, but with our present knowledge we cannot regard the cucumber as a success in cold storage.

GENERAL OBSERVATIONS ON SUMMER FRUITS.

The value of cold storage for juicy summer fruits like berries, grapes, peaches, plums, and vegetables like the tomato and cucumber is not in keeping them from one season to the next, or from early to late season. It cannot do either. It is only in holding them over short periods of stagnation and gluts in the market. A week's time, and frequently only a few days, is sufficient for this.

The drier sorts of these fruits always keep better than those that are very juicy, but they are of poorer quality, and if they come out of storage poor in taste it is usually because they were poor when they went in.

Packages in which such fruits are to be shipped should always be provided with ample ventilation. Admit the air to all parts of the package.

The use of refrigerator cars is indispensable in the shipment of these fruits. No attempt should be made to ship without them. It is also necessary to see that they are properly iced and closed several hours before loading, in order to have them at the proper temperature. Also see that the car is air-tight, except the parts that provide ventilation.

Fruit for cold storage should be cooled down gradually, and before it is shipped if possible. After once being cooled it should never be allowed to warm up again or be subjected to a varying temperature. Here is where some of the storage houses are at fault. They do not maintain a steady temperature. A varying

temperature is the ruination of fruit. The difficulty lies in the construction of the room, in the refrigeration system, or in the integrity of the company.

PEARS.

Our experiment with pears was on a very small scale, owing to the light crop in this section. On September 21, a small lot of Doyenne Robin was sent in crates to the Armour Packing Company. They were received September 23, after several hours unnecessary delay. The fruit was in good condition upon arrival and was stored at a temperature of 38°. They were kept until December 10, at which time their exterior appearance seemed perfect, but on cutting them open they were found to have decayed from the core outward, while the skin seemed to be tough and firm. California pears well packed in small boxes were at this time in perfect condition and of good flavor and color.

On the 4th of October small quantities of Kieffer, Vicar of Wakefield and Winter Nelis were obtained from Mr. B. F. Smith, of Lawrence, and sent to the storage rooms in Kansas City. They were received in good condition and were placed in the apple room at a temperature of about 33°. On December 9, we examined them and found them in good condition. January 23, we saw them again; Vicar of Wakefield and Winter Nelis were still in fair condition; Kieffer was keeping poorly. Vicar of Wakefield held good until the first of February and Winter Nelis a trifle longer, but not so long as Winter Nelis from California. This indicates that climate has a stronger influence on the keeping qualities of fruits than the distance they are shipped, provided proper attention is paid to packing.

Our investigations during this and other seasons show that summer and autumn pears keep best at a temperature of 36° or 38°, while winter pears require a temperature of from 33º to 35°. Pears with large, open cores keep best. Pears intended for cold storage must be picked before they are ripe—almost as soon as grown. When picked, hurry them into storage. Let nothing delay an immediate shipment. Pack into bushel boxes, wrapping each fruit separately if the quality will warrant it. The subject of wrapping fruit is one to which the Kansas grower has paid but little attention. When the attention is turned from the barrel and wagon load to the individual fruit better results will be obtained.

H. E. Van Deman, ex-Pomologist of the Department of Agriculture, speaking at a recent meeting of the Michigan fruit growers, said: “There is nothing very mysterious about the success of the

California fruit growers. In the first place, they take pains to produce high-grade fruit; then they fix it up in the nicest packages they can devise, and wrap every pear, every peach, every fruit, except cherries, in tissue paper. And this fruit they send here, and with it capture the fancy market. The way to beat California is to beat her at her own game. If it pays them to buy tissue paper and wrap their fruits, it will pay you. It won't cost very much to send a box or two to market and see the difference in price. I don't care if you charge double price for the tissue paper and wrapping and so on. Charge everything to the expense of the venture you like, that your conscience will permit, and then make an estimate after you are all thru. I tell you, solemnly, it will pay. One man said he cleared a dollar a barrel above all expenses on every barrel of pears that he wrapped, without difference in quality. Fruit which is wrapped is of better quality. The wrapping retains the flavor. Why do the Florida people wrap their oranges? They wrap oranges with skins as thick as sole leather because it retains the aroma. With a pear, the longer that fragrance escapes the poorer it is. The peach, pear or plum that is wrapped is better than if not wrapped."

Mr. B. F. Smith, of Lawrence, one of the most successful growers of the state, speaks of cold storage for pears as follows: "My experience in cold storage began in 1891, with pears. That year I had a larger crop than usual of Seckel, Beuerre d'Anjou and Duchess. The large crops that year of all kinds of fruit made a dull market for pears.

"My desire for some cool place to hold pears a few weeks till the glut of peaches was out of the way led me to inquire if there was not in all Kansas City a storage house that would retard the ripening till the market was more active.

"I found a place at the Missouri Pacific freight depot where the railway company had a cool storage for some kinds of perishable goods. The temperature there maintained was from 40° to 45°. I put in some Seckel pears and held them thirty days. And some Duchess and Beuerre d' Anjou that were held from forty to fifty days. But they were held too long for that temperature. When the barrels were opened there was probably a peck or more to the barrel that were partially decayed. Yet, I was well pleased with the experiment, having received double the price for the Seckels in third bushel boxes that they would have brought at gathering time, and also received a higher price for the barrels of Duchess and Beuerre d' Anjou, notwithstanding the loss from rotting.

"The seasons of 1892-'93-'94 the pear crops were so small that

there was no occasion for cold storage, the prices being good each season.

"In 1895 the crop of peaches and pears being above the average, the supply was above the demand. Again I sought for cool storage. In the interval between 1891 and 1895 a large cold storage plant had been built in Kansas City, known as the Kansas City Ice and Cold Storage Company.

"The Moeser Bros., of Topeka, also had a plant completed at the same time. I stored pears in both places. Each of these storage houses maintained a temperature for fruit from 32° to 40°. My pears kept better in the above storage houses than in the place of my first experiment, but not having learned the actual temperature necessary for the fruit to continue ripening properly, some varieties lost the richness of flavor that we observe in the fruit when it is ripened naturally I found that 32° for pears was too cold. So in the storage of my pears in 1896 I instructed the managers of the storage house to maintain a temperature as near 38° as possible. Fruit ripe and ready for use when stored should have a lower temperature than fruit that is very firm and not so ripe. It was customary to hold pears in cool storage cellars to ripen before cold storage plants came into use.

"There is no question but that cold storage is a great advantage to the commercial pear grower and shipper, even if the excellence of the fruit is somewhat marred by the low temperature necessary to prevent decay. About sixty days is the utmost limit that Seckel pears should be held in storage. I tried to hold some Seckels seventy and eighty days, but they were nearly a total loss. In 1897 I stored some Duchess and Beuerre d' Anjou about the 20th of September and held a few of them till near the first of March, for experiment. My instructions were to keep the temperature at about 32° to 33°. When they were opened there was about a peck to the barrel of partially decayed pears; the flavor, while fairly good, was not equal to the flavor of those ripened at a higher temperature.

"Summing up my experience, there was some little loss in decay; yet when prices are low in the harvest season the storing of the fruit was a decided success as it enabled my commission men to place a few boxes on the market daily, so that I received about the prices demanded for them.

"Still, when markets are active when the crop of pears are gathered, I would invariably recommend pear growers to sel1 the fruit at picking time and save the expense of storage bill, and the loss by decay, even though it is small."

APPLES.

Our experiments in apples included seven varieties of leading Kansas fruits. On September 29, several barrels each of Winesap, Missouri Pippin and Ben Davis were picked from a young orchard near Manhattan. The fruit was still very solid, though well colored, of very fair quality, and, as we had the privilege of the orchard, none but the best was taken. No fruit was taken from the ground. If an apple fell from the tree while picking, it was allowed to remain. The fruit was placed immediately in the barrel, a few thicknesses of paper being placed in the bottom. The first two layers of apples were carefully faced by hand and the rest lowered into the barrel in baskets and emptied out gently. As the barrels were filled they were occasionally shaken to settle the fruit. When the barrels were full they were taken into a well-ventilated shed, where they remained open till October 5, on which date they wre shipped, part of each variety to Kansas City and part to Topeka.

September 26, Rambos were picked, packed and hauled fifteen miles to the college, where they were stored in a room at a varying temperature of from 45° to 50°. October 12, the barrels were opened and repacked, throwing out all blemished and inferior fruits. The fruit that remained was sound though not first-class in quality. On the same date it was shipped to storage along with some first-class Rawle's Janet which had been picked and packed in the manner mentioned above the day before. The Jonathans were first-class and were picked and packed in the Shawnee county orchards of Judge Fred Wellhouse, about September 25, and placed immediately in storage. October 7, three barrels of these were shipped to Kansas City to be placed with our stock. The York Imperials were picked in October and sent to the storage house at once. The fruit went into the storage houses on the following dates: Ben Davis, Winesap and Missouri Pippin, October 6; Rambos and Rawle's Janet. October 13; Jonathan, September 25; and York Imperial, October 15, all in good condition.

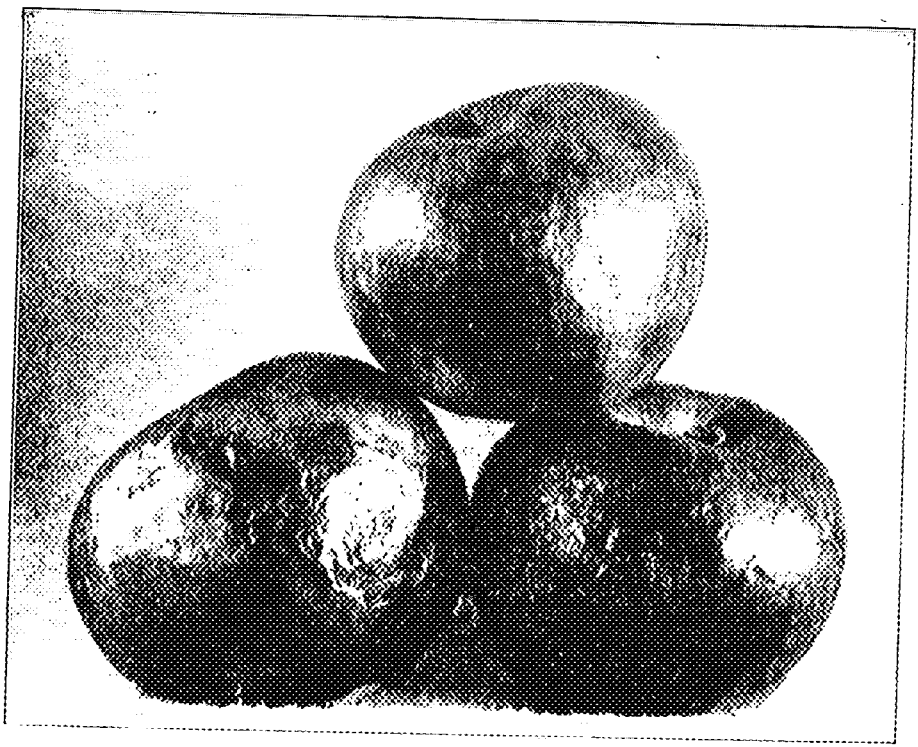
The Kansas City lot has been examined as follows: October 15, all in good shape. December 9, in good condition. January 23, most in good condition, a few decaying specimens among Winesaps, Missouri Pippins and Rambos. February 23, Jonathan and Missouri Pippins mellowing, will not keep safely a great while longer. Rambos in good condition. York Imperial, Ben Davis, Winesap, Rawle's Janet still in fine condition. These four varieties will doubtless hold till the end of the season if they are sorted and repacked. The temperature of the storage room has been 33°.

The Topeka lot was examined as follows: November 12, found one decaying specimen among the Winesaps and three among the Missouri Pippins. All the rest in perfect condition. February l8, Winesap, Ben Davis, York Imperial in good condition, just a few decaying specimens. Rawle's Janet show several decaying, rest sound and firm. Rambos not decaying but mellowing down some. Missouri Pippin mellowing and also decaying considerably. Temperature of storage room 33°.

For keeping summer varieties, the best temperature is from 35º to 40°. For fall and winter varieties 32° to 35º. Considerable difference exists in varieties as to the length of time they will keep and the temperature at which they will keep best. They are questions which our experiments could not determine, and which will require years to be accurately worked out, as well as trial under many different conditions. In general, the drier sorts of fruit will keep longer than the juicy sorts, and apples that ripen late in the season will keep better than those that ripen early.

PICKING AND PACKING APPLES FOR COLD STORAGE.

Attempt to store nothing but first-class fruit. Have barrels at hand and arrangements made for shipment before beginning to pick. Pick the crop as soon as it is grown and has its color. This is while it is still hard, two weeks before ripeness. Use no fruit that is not picked by hand. Sort carefully, throwing out all fruit that falls below the grade and all that is not absolutely sound. Choose good, well-colored specimens for the first layer of the barrel and place them all by hand, stems down. Do not crowd them. Place the second layer by hand either exactly, apple for apple, on the first or else turn them on their sides, blush down, breaking the joints of the first layer. After this pour in the fruit gently from the basket, first lowering the basket into the barrel. Shake the barrel frequently and fill it up, using the same grade and variety of apples every inch of the way. Pack the last layer of the barrel by hand, as evenly as possible, with the stems up. When this is in place apply the press, with a padded head, small enough to fit into the barrel, to settle the fruit. Release the pressure, place on the barrel head, force it into position, drive down the hoops and nail them solid. Turn the other end of the barrel up. Label on it plainly the variety and grade of the fruit and the name of the grower. There must be absolutely no movement of fruit in the barrel. Ship without delay to the storage house. Ship in the evening if possible. If the distance is great, or the connection poor, use refrigerator cars and see that they are iced several hours before putting in the fruit. Go with the fruit if possible; if not, have



V.—WINESAPS AFFECTED BY THE SCALD.

your commission man apprised of the shipment and send him the bill of lading. Trust the commission man, but never lose track of the apples.

The man who attempts to carry apples thru cold storage in a less painstaking way than this will never succeed. Unless the grower and shipper can clear his conscience by this standard he cannot wholly blame the warehouse men for his losses in storage. This kind of handling insures the minimum shrinkage in storage. In the storage houses of the Armour Packing Company, Kansas City, during the season of 1897 and 1898 were thousands of barrels packed by apple speculators, the shrinkage on which averaged less than 2 per cent. In the same room were apples packed by farmers, some of which shrunk as high as 30 per cent. Now, they received exactly the same degree of temperature, dryness, etc., so that the fault was not with the storage room but with the quality of apples and the way in which they were packed.

Cold storage cannot improve the condition of fruit. At best it can only hold it at something near the condition it has when it is put in. It cannot save from decay fruit that is imperfect or unsound. A few decaying specimens soon ruin the whole barrel. Sound fruit is the only kind that will keep in cold storage.

SCALD.

The rust or scald is a disease peculiar to apples in cold storage. It is indicated by a brownish discoloration of the skin and by the surface becoming more or less shriveled and roughened, followed by the slow rotting of the fruit. Plate V shows three Winesaps, all affected by the scald. It occurs more abundantly some seasons than others. Last season it was abundant, this season it is scarce. Some varieties are more susceptible to it than others. Green or light-colored apples, like the Greenings and Northern Spy, are more seriously injured by it than the deep-colored varieties. It appears that Kansas apples are usually quite free from its injuries. Sometimes, however, they become affected. As to its cause, we can, as yet, only speculate. It is apparently increased by overheating the fruit while packing or shipping, by rapid cooling of the fruit when put into storage, by improper ventilation and humid atmosphere in the warehouse. We would suggest especial attention to these points on the part of both shipper and storage man.

PRODUCTION OF FRUIT FOR COLD STORAGE.

Cold storage calls for the best fruit that intelligence and skill are able to produce. Its main object in commercial use is to carry fruit to a period of high prices. Fruit that is poor in quality defeats

the very object for which it is held. It can never bring a high price. Just as soon as it begins to advance it meets the competition of canned goods, against which it cannot stand. Nothing but poor prices can be expected for poor fruit, and since poor prices are all that can be expected, it will not pay to handle second- and third-grade fruit in the ways that fancy and first-grade fruit are to be handled. There are a number of ways of profitably disposing of inferior fruit, but cold storage is not one of them.

The success of marketing thru cold storage depends very much upon the variety. It must be one that the consumer will clamor for when he buys and enthuse over when he uses. It must have no disqualifications at all in quality or size to prevent it from taking the highest place in the market. With these qualities must go that of keeping well in storage. It is the combination of these qualities that is giving the Jonathan an enviable reputation as a cold storage success. The York Imperial has not had the trial that the Jonathan has, but where it has been tried it meets every requirement for a good cold storage apple.

Fruit growers know very well that there is considerable variation within varieties. No two trees are found bearing regularly the same quality and quantity of fruit. There is always a difference, and sometimes this difference is great enough to affect immensely the profitableness of an orchard. Last fall a discussion arose among the correspondents of the Kansas Farmer on the merits of the Kieffer pear. Some denounced, while others defended it. After discussion had failed to settle the matter, specimens of the fruit, upon which the writers had based their opinions, were compared, and it was found while each had Kieffers, they had different types of fruit. There are different strains of the Kieffer pear, some good, some poor. There are different strains in all varieties of fruit. In choosing trees from which to grow high-class fruit, we must pay very particular attention to this matter and see that the trees are propagated from profitable stock.

The quality of the fruit depends upon the age and vigor of the tree. In many varieties, old trees tend to produce inferior fruit, and always the impaired condition of the tree results in the deterioration of the fruit. Old orchards should not be allowed to stand after they become unprofitable. Orchards from which fruit is expected should have such treatment as will maintain the tree at its maximum fruitfulness. Thoro cultivation is almost always necessary, and sometimes the fertilization of the soil must be attended to.

Pruning is necessary, tho our best Kansas growers recommend

a very moderate amount of it for the apple orchard. In the peach orchard it is more imperative. The peach tree must be headed back or the branches will grow long and slender, bear fruit at the extremities and break down, to the ruination of the tree. Furthermore, clipping off the young growth prevents over-bearing and, therefore, the necessity of thinning. Pruning is also advantageous on the plum, and, without its regular and intense application on all sorts of small fruits, excellence in quality is impossible.

Almost all fruit trees tend, on some years, to set more fruit than they can properly mature. If left alone the tree struggles along with its burden until the fruit is mature. But nothing of even fair quality is produced, while the abundant fruit becomes the delightful home of insect and fungous pest. Large quantities fall to the ground and are worse than wasted because they furnish a residence for insects and diseases in which to pass the winter safely and be prepared for a bold attack upon the next crop. Such conditions must not and will not prevail in the well-conducted orchard. If too much fruit sets on the tree and the quantity cannot be regulated by pruning, thinning must be resorted to. Thin as early as possible and thin heroically. Here is one place where an untried conscience makes a poor guide. Keep on taking off fruit until there seems little left, and, in nine cases out of ten, there will still be too much. The thinning saves much of the later dropping, which is nature's very wasteful way of thinning. In our orchard last spring were three Robinson plum trees standing in a row, equal in size, age and vigor. All set fruit heavily. On May 8, 50 per cent of the fruit on the north and the south trees was removed. The middle tree was left unthinned. On August 8, the fruit on all the trees was ready for picking. The faulty fruit had mostly fallen off and lay upon the ground. About twice as much had fallen from the unthinned tree as from the other two together. There was more fruit on the unthinned tree than on either of the other two, but it was considerably smaller and more blemished. The limbs of the unthinned tree were bent down and the tree looked overdone, while the leaves were badly attacked by shot-hole fungus. Limbs on the thinned trees were not bent, trees looked thrifty, and the leaves were but slightly attacked by shot-hole fungus. The unthinned tree bore 34½ pounds of fruit. Of those that were thinned, one bore 24¾ pounds, the other 19¾ pounds. The size and quality of fruit was much superior to that from the unthinned tree. Where quality is the element desired, thinning fruit is a very advantageous process.

Prof. H. E. Weed, of Georgia, estimates that the annual yield of

all crops is lessened 25 per cent by the attacks of injurious insects and fungous diseases. He estimates that on horticultural crops 75 per cent of the loss can be prevented by remedies applied with the spray pump. Speaking of methods in spraying, he says:

"Spraying must be done intelligently. We must know where, when and how to obtain the best results. Simply to spray here and there without any definite object in view is time and material wasted. Spraying is no child's play, but is hard work, as all know who have tried it to any extent. Spraying should be an essential part of farm practice. Its experimental stage has long since passed. The best results are not obtained the first year, especially with the fungous diseases. Intelligent spraying at the right time brings the desired result—a larger crop and a greater profit.

"Success in spraying—like success in almost anything—is largely a matter of detail. There are many little things seemingly unimportant which will all affect the results obtained. Unless the work of spraying is worth doing well, it is not worth doing at all. The various fungous diseases and insects affecting each farm crop should be given careful attention and remedies applied in time. Where failure occurs in spraying it is very apt to be on account of the lateness of the application. Spraying is plant insurance. An extra price can always be obtained for an article of extra quality, and with farm crops the extra quality is obtained thru the practice of spraying."

Neither do we in Kansas longer raise any question on the value of spraying; but the questions of where, when and how, are before us also. A discussion of the subject in detail has no bearing in this connection, but we well know that spraying improves the size, quality and soundness of the fruit, and that in growing fruit for cold storage, it must be considered a constant part of the process.

The foregoing thoughts are thrown out to suggest the diligence and care necessary for the production of fruit of such quality as will warrant the further attentions needed to carry it thru cold storage and place it at last on the very top of the market. Not every fruit grower will have the time or inclination for this painstaking process. But the progressive, thinking, stirring man who does will soon gain a mighty advantage in the race, and in these times of "the survival of the fittest" he will fittingly survive.

CONCLUSIONS.

1. Cold storage, if properly conducted, is practicable and profitable for the fruit grower.

2. Where fruit is grown for home use, or the local market, home cold storage is advisable.

3. City cold storage is preferable for large quantities of fruit that are to be placed on the open market.

4. For small fruits, grapes, plums, peaches, in fact all juicy summer fruits, cold storage is applicable only in holding them for a few days or weeks to carry them over a glut in the market.

5. Pears and apples may be safely held in cold storage for several months if properly treated.

6. For good results in keeping fruit of any kind, it must be rather under-ripe, and perfectly sound when placed in storage.

7. The utmost care is essential in picking, packing and shipping, in order that the fruit may arrive at the warehouse in sound condition.

8. Cold storage demands fruit of the highest quality and necessitates especial care in the selection of stock and in the treatment of the orchard. Pruning, thinning and spraying are essential processes.

TOPEKA, KANSAS.
KANSAS FARMER COMPANY.
1899.