A SURVEY OF

COLD STORAGE LOCKERS IN OKLAHOMA

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TABLE OF CONTENTS

INTRODUCTION

Food preservation by use of cold storage lockers is a relatively new business in Oklahoma. This business, however, is advancing very rapidly as shown by the number of new plants now in operation. The cold storage locker industry has been operating in the United States for only a few years.

The number of cold storage locker plants in operation in the United States is estimated by the Consumer's Guide (1) to be 2,500. As the years pass this number increases, and the increase is quite rapid. More than 850,000 individual lockers are in service, indicating that approximately this number of families are availing themselves of locker storage service. With an estimated consumption of two pounds per family per day, approximately 2,000,000 pounds of meat are removed from the lockers each day.

A modern cold storage plant has the following rooms: a chill room, a cutting room, a quick-freezer room, and a locker room. Many plants have in addition to these rooms, slaughter rooms, curing rooms, processing rooms for fruits and vegetables, and storing rooms.

Most of the cold storage locker plants in Oklahoma are strictly service organizations. These organizations vary in kind and amount of service. "Complete service" includes slaughtering the animal, chilling the carcass, cutting, wrapping, storing, and processing of the meat, It also includes the processing of the by-products, the grinding and mixing of sausage, and the rendering of lard. A few plants are equipped to process and store fruits and vegetables.

Cold temperatures greatly hinder the growth and reproduction of most bacteria; the amount of bacterial growth inhibited depends upon

the severity of the temperature. Thus the freezing of meats has been found to be a method of preventing spoilage. At temperatures below freezing, meat will keep a very long time in excellent condition.

Many problems pertaining to the freezing of meats, fruits, and vegetables; the length of storage; and the proper charges for the various services are as yet unsolved. Much interest has been shown in the cold storage locker business in Oklahoma as evidenced by the number of inquiries sent to the Meats Division of the Oklahoma Agricultural and Mechanical College. In order to obtain more information pertaining to the number of cold storage locker plants, the size of the plants, the operating costs, and the problems involved in the cold storage locker business in Oklahoma, questionnaires were sent to sixty-four ice, creamery, and cold storage companies throughout the state.

REVIEW OF LITERATURE

There is considerable difference of opinion concerning the location of the first cold storage locker plant. Authorities generally agree on the fact that it was located somewhere in the Pacific Northwest. Centralia, Washington is given credit by Ice and Refrigeration (3) for having the first plant. The Artificial Ice Company of Billings, Montana is credited by Spring (15) as having installed the first cold storage plant in 1929. Another authority (2) claims the first was started in Uniontown, Washington, about 1929. Warner (21) claims the oldest commercial venture of this character was launched about ten years ago, but most of this new development has occurred within the last five years. Many of these lockers have been operated less than two years, and several less than one.

Schaars (13) gives the following reasons why so many patrons like this method of handling their meat as well as certain fruits and vegetables.

1. Frozen meats, which taste practically the same as fresh non-frozen meats are more palatable when eaten over a period of time than either canned, cured, or smoked meats.
2. Spoilage of home cured meats is eliminated.
3. Butchering can be done any time of the year.
4. The home work of canning and curing is eliminated.
5. Carcasses can be used to a better advantage if an experienced meat cutter does the cutting. More attractive cuts are to be had.
6. The varieties of meat can be increased. One can have lamb, beef, veal, poultry, and fish as well as pork.

Briefly, the convenience, the greater availability of more palatable meats, and the economy of the locker storage service have had a widespread appeal among farmer patrons. The usual size for each locker was found by Emig (6) to be two by two by two feet or slightly larger. This gives a capacity for about 300 to 350 pounds of meat.

One of the important problems confronting the cold storage locker business is determining the correct temperatures for freezing and storing of various meats, fruits, and vegetables. The freezing of foods has undergone a drastic change in the last five years, Mohr (9) and Birdseye (5) found the change from slow freezing in lockers to quick freezing by conduction on vacuum plate or air travel at 3,500 c.f.m., yields a transition from a dry, tasteless, freezer-burned product to one that is bright, juicy, palatable, and even more tender.

Longer storage has likewise been made possible by learning better methods of maintaining correct relative humidity. The development of locker design to help prevent dehydration, or locker room freezer-burn, has done much to keep the products in a more nearly perfect condition. Birdseye (5) in his investigations concluded that freezing of meat slowly caused large ice crystals to form which compressed and ruptured the tissue. Foods quickly frozen by direct or indirect contact with the refrigerant have the following advantages: the small ice crystals thus formed do not injure the tissues; the texture, flavor, color, and odor of the product are retained; there is no shrinkage from loss of water.

Moulton (10) states when meat is frozen slowly the greater part of the water goes through the sheath of the fiber and freezes between the muscle fibers. The frozen muscle fibers are shrunken, distorted, and surrounded by large areas of ice. When such meat is rapidly thawed,

this water is not well reabsorbed by the muscle fiber but remains outside.

When muscle tissue is frozen quickly enough, no water will separate outside the individual muscle fiber, but will remain as tiny ice centers dispersed throughout the muscle substance. Such muscle tissue will not drip on being thawed and cut up.

The quantity of drip obtained from meat frozen at a constant rate is affected by the period between slaughter and freezing and the pH of the tissue according to Sair and Cook (12). These two factors act independently of each other. In pre-cooled meats the maximum amount of drip is obtained at a pH of five and two-tenths, and as the pH increased the net drip decreased to zero at about a pH of six and four-tenths. Pork, beef, and mutton behave similarly both with respect to the form of the drip-pH relation and the quantity of drip exuded at a given acidity. Beef is normally more acid than the other meats tested, and this can account for its greater tendency to drip in commercial practice. Large ice crystals are always produced by slow freezing regardless of the pH of the material. The absence of drip from slowly frozen tissue at a pH of six and four-tenths is therefore not due to crystal size, but must be attributed to the greater reabsorbing power of the proteins in this region. Protein denaturation does not affect the quantity of drip obtained when meat is slowly frozen or stored for periods up to three days in the freezing zone. The weak reabsorptive power of the proteins at a pH of five and two-tenths must be attributed to the isoelectric condition in this region, rather than to their denaturation. It is only in this isoelectric region that the production of small crystals by quick-freezing will reduce the quantity of drip.

The pH of meat was found by Smorodintsev and Bystrov (14) to decrease progressively during freezing and storage at minus eight degrees

to minus eighteen degrees fahrenheit, and also during thawing. The quantity of acid valences increase more during thawing (twenty-five percent) than during freezing (fourteen percent); the basic valences decrease to a greater extent during thawing (twenty percent) than during freezing (nine percent). During prolonged storage the decrease in basic valences is considerably greater than that of acid valences, resulting in an increase in the acid-base coefficient and a decrease in pH. During storage the acid and basic valences are gradually and progressively linked by the ampholytes of the tissues.

Ritchie (11) found that pork should not be stored longer than six months, and that an even shorter period of storage is desirable. Tressler, Birdseye, and Murray (20) have observed a material tendering effect caused by the quick-freezing and subsequent storage of the meat for one week at low temperatures. On the average, this amounted to about twenty percent. Tressler (17) states the changes which may occur in the food may be classified as physical, chemical, and enzymic. He also found (18) certain changes in the fats and proteins of the tissues underneath desiccated areas which occurred simultaneously with the drying out of the tissues.

According to Heller and Larwood (8) large sections of the Southwestern part of the United States have alkaline soils which impregnate surface waters with salts and in addition there are in these regions extensive beds which contaminate the deep wells and many springs. The salts present in the waters are sodium chloride, calcium chloride, calcium sulphate, and magnesium sulphate. Analyses of waters from such sections have shown these salts in certain instances to be present in excess of 200,000 parts per million, and 5,000 to 50,000 parts per million are common.

Storage of Fruits and Vegetables

Little information is available in regard to the preparation and storage of fruits and vegetables in cold storage lockers, although considerable literature is available concerning the commercial freezing and storage of such products.

Tressler (16) discusses three criteria which are used to determine the quality of frozen vegetables. The criteria in question are bacterial count, enzyme, and vitamin C content. These three factors tell as much about the quality of frozen vegetables as the bacterial count, butterfat, and phosphotase test do about the quality of pasteurized milk.

METHOD OF PROCEDURE

Questionnaires were sent to sixty-four possible owners of cold storage lockers. Out of this number forty-seven were returned to the Meats Division of the Oklahoma Agricultural and Mechanical College. Of the forty-seven returned, thirty-one reported locker boxes were in use in their plants.

The addresses of the sixty-four possible owners of cold storage lockers were obtained by writing to Chamber of Commerce of several towns and cities, and county agents in various counties throughout the state. The primary purpose of the survey was to ascertain the problems, costs, and finances involved in the cold storage locker business.

The following questionnaire was sent out:

COLD STORAGE LOCKER SURVEY

A. Building:

1. Is your locker room in connection with an ice plant, creamery, or operated as a single unit?_____
2. If so, what is your ice production capacity?_____
3. What are the dimensions of your building?_____
4. List the construction materials._____
5. What materials are used for wall insulation in cooler, and give thickness._____
6. Give dimensions and temperature of freezing room._____
7. Give dimensions of wholesale storage rooms, other than lockers, if any in your plant._____
8. Give dimensions and capacity of slaughter room._____
9. Give make, capacity, and source of power for your refrigeration unit._____
10. List any undue trouble with your unit due to water etc._____

B. Locker Rooms:

1. What are the dimensions of your locker rooms?_____
2. Number of locker boxes?_____
3. Average number of boxes rented per year?_____
4. Manufacturer of locker boxes?_____
5. Dimensions and construction of locker boxes?_____
6. What is the temperature range of the locker room?_____
7. How are the lockers ventilated?_____

8. Date of installation of locker business?_____
9. Dimensions of pickling and processing room?_____
10. Dimensions of cutting room?_____

C. Management:

1. Owner of plant_____Address_____
2. Manager of plant_____Address_____
3. How is plant managed? That is, does manager come to plant every day to oversee renting of lockers, removal and additions of meat, etc.?_____
4. Does every locker have an individual key?_____
5. During what hours may meat be obtained from the lockers?_____
6. Who is responsible for stolen or spoiled meat?_____
7. Is an account of removals or additions to the lockers kept?_____
8. Have you had any complaints of lost or spoiled meats from the customers?_____
9. What are the contributing factors to meat spoilage?_____
10. How long can meat be kept in your lockers?_____
11. Do you slaughter for patrons?_____
12. Do you cut wrap and process for patrons?_____
13. Do you make deliveries?_____
14. How many men are employed in connection with the locker service in your plant?_____
15. What foods are stored other than meats?_____
16. What is the estimated population of your trade territory?_____
17. Percentage of patronage: Rural_____Urban_____
18. Percentage winter months_____Summer months_____
19. What kind of paper do you use in wrapping meat?_____

D. Costs and Income:

1. What are your operating costs per month?_____
   a. Salaries_____b. Power and light_____
   c. Water_____d. Interest_____e. Miscellaneous_____
2. Initial cost of plant?_____
3. Cost charged to locker service?_____
4. Cost of equipment for locker service?_____
5. List of equipment: Saws, grinders, etc._____
6. Charges for lockers?_____
7. Charges for cutting and wrapping meat?_____
8. Charge for processing meat? (Curing, sausages, and lard)_____
9. Charge for deliver?_____
10. Other sources of income if any?_____
11. How was your business financed?_____
12. How many signed patrons were listed before construction started?

DISCUSSION

Cold Storage Locker Buildings

Associate Businesses

Locker rooms have been installed in ice plants, in creameries, and in cold storage locker plant buildings. The latter operate as single units, having no other connecting business. Of the plants reporting, 66.7 percent of the cold storage lockers operated in connection with ice plants, 14.3 percent in connection with creameries, and the remaining 19.0 percent as single units. Both the largest and smallest number of lockers per plant were found in ice plants. All cold storage lockers in connection with creameries reported over 100 and less than 200 lockers. A majority of the single units reported over 200 lockers per plant.

Ice Production Capacity

The ice production capacity of the ice plants reporting averaged thirty-one tons. These ice plants reported an average of over 250 lockers per plant. These figures indicate the importance of ice production in Oklahoma, and the popularity of locker storage in connection with this business. Guest (7) states that a locker plant, with all lockers rented, cannot possibly get sufficient revenue from locker rents and meat cutting to operate at a profit sufficient to justify the investment. However, "complete service" plants are profitable.

Dimensions of Buildings

The size of the buildings vary considerably as indicated by Table I.

This individual variation may be due to the different uses made of the building. Creameries housing cold storage lockers reported the smallest average size building. Ice plants with cold storage lockers had the largest buildings, with single unit plants nearly as large. The average length of the buildings from plants reporting was 87.75 feet, the average width 50.25 feet. The average number of individual locker boxes for this size building was 209. However, with a building this size approximately 300 lockers could be installed. (Table I)

Table I

Averages for Different Size Plants				
Number of lockers	0 - 99	100 - 199	200 - 299	300 - up
Building dimensions	48' x 80'	63' x 82'	42' x 81'	48' x 108'
Freezing room Dimensions:	---	7' x 9'	7' x 12'	7' x 11'
Temperature:	---	-10° F.	-15° F.	-20° F.
Locker room Dimensions:	12' x 22'	16' x 26'	22' x 34'	22' x 39'
Temperature:	+13° F.	+15° F.	+9° F.	+8° F.
Cutting room dimensions	---	11' x 14'	11' x 18'	11' x 15'
Processing room dimensions	---	---	12' x 18'	---

Construction Materials

Brick was the most widely used construction material. Over seventy percent of the plants reported the use of brick. Other materials used were concrete-tile block, native stone with stucco covering, and frame and stucco. Many plants used a combination of construction materials

all of which were fire proof. The initial cost of the plant went up when more costly construction materials were used. However, the cost was probably offset by lowered upkeep, and more attractive buildings.

Insulating Materials and Thickness

Insulation of the various refrigerated rooms of a cold storage locker plant presents a major problem. The efficiency of the refrigerating unit largely depends upon this factor. Cork has long been used as an insulating material. Corkboard was the most commonly used insulator in the plants reporting. The thickness varied according to the temperature of the rooms and the temperature of the adjacent rooms. Four inches was the minimum insulation thickness reported; eighteen inches was the maximum. Three thicknesses of corkboard were used in many plants. These thicknesses were four, six, and eight inches. Sixteen to eighteen inches of re-granulated cork was used in a few plants. A majority of the plants used at least eight inches of insulating material in the sub-freezing rooms. Only four inches were needed in walls between the chill room and the locker room, and only six inches in walls between the quick-freezer room and the locker room. Outside locker room walls required six inches of corkboard. Outside quick-freezer rooms required eight inches. Insulation of doors is very important too. Built-in doors may be used where temperature changes between the two rooms differs not more than thirty degrees fahrenheit. Outside doors, that is, doors which extend beyond the outside wall were used where there was over thirty degrees fahrenheit difference in temperature. Minor insulating materials used were rockwool, and celotex.

Dimensions and Temperature of Freezing Room

Freezing rooms, known also as quick-freezing rooms or sharp-freezing rooms, were usually small. These rooms required thick insulation due to the low temperature maintained. Their construction costs were high; therefore, they were no larger than necessary. The dimensions of the freezer rooms from the plants reporting did not vary according to number of locker boxes installed, but was nearly the same for all plants having 100 or more lockers. (Table I) The average dimensions for all plants having 100 lockers was 7 feet by 10.5 feet. A few plants did not maintain strictly quick-freezing rooms as their, so called, quick-freezing room carried the same temperature as the locker room.

The temperature needed for quick-freezing varied according to the kind of foods frozen and the size of the packages it was frozen in. It is known, however, (9) (5) that quick freezing is more desirable than slow freezing. Extremely low temperatures in quick-freezing rooms increased the operating costs and required very thick insulation. The average temperature for all the plants was minus fifteen degrees fahrenheit. (Table I) One plant reported a temperature drop of minus forty degrees fahrenheit. This plant was a frozen food company handling frozen foods as well as meats. All plants reported freezing room temperatures of below zero degrees fahrenheit.

Slaughter Rooms

City regulations prohibit slaughtering in various cities throughout the state. Only twenty-five percent of the plants reported having slaughter rooms. Other plants were not "complete service" plants and did not slaughter for patrons. Slaughtering for patrons is one of the

newer phases of the cold storage locker business and only the more modern plants were carrying out this practice. Additional space, equipment, and labor is required for slaughtering, and many plants were not in a position to offer this service. The size of the room varied according to the number of animals slaughtered. An average room size of ten feet by twenty-five feet was reported by a few plants. Several plants evidenced the fact that they had an outsider do slaughtering for them. In a few cases this was the cutter for the locker plant.

Cold Storage Locker Rooms

Dimensions of Locker Rooms

The dimensions of the locker rooms varied according to the size of the plant and the number of locker boxes installed or to be installed. The average size for plants with 300 or more lockers was 22 feet by 39 feet. (Table I) Plants having over 200 and less than 300 lockers reported an average room size of 22 feet by 34 feet. These plants evidenced the fact that their locker capacity was 300 or more, and they did not have the room filled. Those plants having only 100 lockers reported an average room size of 12 feet by 22 feet. A few plants reported having two locker rooms. These plants had two rooms averaging 19 feet by 22 feet and housed over 500 lockers.

Dimensions of Cutting, Curing, and Processing Rooms

Here again the dimensions of the cutting room depend largely upon the size of the plant, the amount of meat to be cut, and the number of meat cutters employed. A majority of the cold storage locker plants in Oklahoma are cutting, wrapping, and quick-freezing for their patrons. The average size of the cutting room reported by the plants was 11 feet

by 15.5 feet. (Table I) A few of the plants operating with over 350 lockers evidenced the fact that rooms as small as this average or smaller were not large enough for their plants. Larger cutting rooms were reported by the plants constructed in 1938.

Pickle rooms are the same as curing rooms. Processing rooms are rooms in which sausage is ground, lard is rendered, and other services preformed. These rooms are found in "complete service" plants only. The size of the pickle room and the processing room depends upon the size of the plant and the volume of business handled. All the plants reporting the use of a processing room had over 200 individual lockers with an average of over 250. The average size of the processing rooms was twelve by eighteen feet. (Table I) Complete community food storage plants when properly designed and equipped will take the farm hog, butcher it, make sausage, render lard, make hickory cured ham and bacon, and quick-freeze the fresh cuts and place them in the locker for long storage. They will also process and store beef, poultry, fruits, and vegetables. With competent management such plants are profitable investments and serve an economic and social need of the community.

Temperature of Locker Room and Curing Room

The correct temperature at which cold storage locker rooms should be held is not definitely known. Different foods require different temperatures. H. C. Diehl of the United States Frozen Pack Laboratory recommends storage of frozen foods at zero degrees fahrenheit. It is essential, he states, "That uniform storage temperature conditions be established." Warner (21) states that zero degrees fahrenheit is generally accepted as the preferred temperature for the sharp freezing and storage of foods.

This should not be confused with the sub-zero temperatures used in "quick-freezing". Although zero is the recommended level for the locker room, ten or twelve degrees above zero is often used and will probably be satisfactory if the lower one is not practicable. Eighteen to twenty degrees fahrenheit is often used, but is probably too high. The most satisfactory temperature level seems to be around plus fifteen degrees fahrenheit and higher temperatures usually result in dissatisfaction. Much variation in temperature is considered undesirable.

Food changes may be physical, chemical or enzymic (17). The chief deleterious physical changes are desiccation and growth in the size of ice crystals. Most enzymic actions occurring in food during cold storage are either oxidative or hydrolytic in nature. Desiccation (drying) occurs rapidly in unprotected foods and produces changes which are very noticeable. Desiccation often occurs very unevenly from the skin of dressed poultry. Tressler (18) has found certain changes in the fats and proteins of the tissues underneath the desiccated areas which probably occur simultaneously with the drying out of the tissue. The proteins become denatured and do not readily take up water which has been lost. The fats, being exposed to air, take up oxygen and slowly become rancid. This condition may be remedied by dipping the poultry in water or in fat just before freezing, or by storing in an atmosphere of carbon dioxide.

Tressler (18) has found that low storage temperature is absolutely necessary if vitamin C content, color, flavor, and other qualities are to be conserved. Above zero degrees fahrenheit vitamin C is rapidly lost from peas, spinach, snap beans, and lima beans.

Bacteria, molds, and yeast do not multiply appreciably at temperatures below twenty degrees fahrenheit and so the changes produced by

organisms are negligible.

The minimum locker room temperature reported by the cold storage locker plants was minus five degrees fahrenheit. The maximum temperature reported was twenty degrees fahrenheit. The average temperature was approximately plus eleven degrees fahrenheit. (Table I)

Temperatures of thirty-six degrees to forty degrees fahrenheit are typical temperatures found in sweet-pickle cellars (10). Temperatures of thirty-eight degrees to forty degrees fahrenheit are perhaps more typical. Higher temperatures than normal speed up the cure, but also the incidence of spoilage is greatly increased. Hence temperatures above fifty degrees fahrenheit usually result in spoilage of the meat. Temperatures below the normal greatly retard the rate of curing. The fact that these temperatures keep the meat sweet is of no practical significance to the meat-curer.

Date of Installation and Number of Boxes

The first locker business in Oklahoma, according to the plants reporting, was started in 1935. During 1935, approximately 12.5 percent of the present locker plants were operating. By 1936 the number had doubled. In 1937, 18.75 percent of the present number went into business. Again in 1938 there was an increase, with 37.5 percent doing business. During the first six months of 1939 a number of plants have been built; these represent 6.25 percent of all the plants now operating in the state.

The number of cold storage locker boxes throughout the state is not definitely known. Many plants have gone into operation since the starting of this study, but it is estimated from the plants reporting that Oklahoma has between 6,200 and 7,750 individual lockers in the 31

plants now operating.

The average number of lockers per plant being 200 to 250 this verifies the fact that approximately 6,200 to 7,750 families are availing themselves of this service in Oklahoma. The number of locker boxes installed was in direct correlation with the estimated trade territory. (Table II) Plants reporting less than 100 lockers had an average estimated trade territory of 4,250. Plants with 100 and less than 200 lockers had an estimated trade territory of 5,000. Those plants reporting 200 and less than 300 lockers had an average trade territory of 20,650, and those with over 300 lockers reported an estimated trade territory of 28,725.

Table II

Averages for Different Size Plants

Number of lockers	0 - 99	100 - 199	200 - 299	300 - up
Estimated trade territory	4,250	5,000	20,650	28,725
Percentage rural	50%	48%	53%	56%
Percentage winter months	75%	72%	70%	58%
Average percentage of boxes rented	61%	62%	55%	59.5%

Average Yearly Rental

Plants having less than 200 lockers had a higher percentage of rentals than plants with over 200 lockers. (Table II) These plants also had smaller trade areas, and a higher percentage of urban patronage. Many of the larger plants have recently started operating and have not had an opportunity to determine their percentage of box rentals. Plants

located in large trade territories are usually close to a large city and have to compete with a larger number of meat retailers and frozen food retailers, whereas, those in smaller trade territories do not.

Manufacture and Construction of Locker Boxes

Over eighty-five percent of the locker plants throughout the state reported the use of commercially built locker boxes. The remaining fifteen percent used home made lockers. These plants usually built the lockers as they were rented. Home made lockers were usually constructed from light wood or hardware cloth with wood frames. The manufactured locker boxes were built by the following companies:

Nebraska Appliance Company, Wichita, Kansas
Knickerbocker Stamp Company, Parkersburg, West Virginia
Lincoln Locker Company, Lincoln, Nebraska
Jensen Machinery and Dairy Manufacturing Company, Wichita, Kansas
Capitol Iron Works Company, Topeka, Kansas

The usual size for each locker was found by Emig (6) to be two by two by two feet or slightly larger. This gives a capacity for about 300 to 350 pounds of meat. The average dimensions of the locker boxes from the plants reporting were sixteen by eighteen by thirty inches. Only a few plants reported having locker boxes in two sizes. The size of the plant had little to do with the size of the locker boxes. The manufacturers of lockers make the boxes in several different sizes. The larger boxes cost a trifle more , but are found large enough to hold the families frozen food supply. A majority of the plants reported their boxes were made of steel. Others were made from galvanized wire, hardware cloth, and wood. The steel boxes were liked by the patrons over the other types of construction materials. Many of the boxes were

constructed so that the door opened the whole front of the locker making easy access to the contents within. When the door is smaller than the front, entrance is made difficult especially with the larger packages.

To prevent packages from sliding out of a box in which the whole front opens, some box manufacturers inserted a small stop on the floor of the locker box just inside the door. The more modern boxes, especially those next to the floor were installed on rollers and the entire box pulled out when it was opened. This type of box was found to be ideal for floor boxes because they are more accessible. These boxes, however, retail at a slightly higher price than ordinary boxes.

Whether locker ventilation is essential for successful storage of frozen foods is a problem yet to be solved. Longer storage has been made possible, however, by learning better methods of maintaining correct relative humidities (9). The development of lockers designed to help prevent dehydration, or locker room freezer-burn, has done much to keep the products in a more nearly perfect condition. It is realized that temperatures alone are not enough. The control of air circulation and correct relative humidity prevent chemical changes in meat juices that were not known to take place. The scientific handling of these problems is broadening the field of locker service.

A majority of the cold storage locker plants reported some type of ventilation for their lockers. Some locker boxes have perforated sides, others lowered back and sides, and a few were made with heavy mesh wire. Only a few were solid and without some type of ventilation.

The Management of Cold Storage Locker Plants

Plant Ownership and Managership

Approximately fifty percent of the cold storage locker plants in

Oklahoma are individually owned and managed. The remaining fifty percent are owned by creamery companies, corporations, ice companies, or as private investments. The data gave no evidence of cooperatives throughout the state. This report differs from that of other states, particularly Iowa, where eighty-seven percent of the locker plants operate as private enterprises, and the remaining thirteen percent as cooperatives (11).

The manager was present in every plant during working hours to oversee renting of lockers, removals and additions of meat, keeping records, and processing operations. Plants operating in connection with ice companies usually stayed open longer than other plants, especially during summer months, when their ice business was heavy. Ice companies having over 250 lockers and having large estimated trade populations were among those having long working hours. The average working hours for all plants was from seven o'clock in the morning until seven o'clock in the evening.

Responsibility for Products in Lockers

Several plants reported they were responsible for stolen meat or other foods from their patron's lockers; others reported they did not stand responsible for either spoilage or stolen products. Plants operating with locker boxes made from hardware cloth or light wood were more liable to theft than those plants having all steel boxes. However, the plants using home made boxes were among those who did not assume responsibility. These two problems confront every locker plant manager and operator. It seems reasonable to believe the locker plant should be responsible for spoilage due to temperature fluctuations; however, if spoiled products are placed in the locker to begin with the plant is

justly not responsible.

Over ninty percent of the lockers reported their patrons were issued keys to their lockers when rented. Ten percent reported individual keys were not issued to their patrons. When keys are not given to the individual, more labor is required in handling the patrons' locker packages. However, if labor is not a problem, better records can be kept when the manager or employee in charge removes the packages from the locker box.

Complaints Due to Spoilage

A few plants reported complaints from customers due to spoiled meats. These plants were among those having an average locker room temperature above plus fifteen degrees fahrenheit. Spoilage was especially prevelant in plants reporting quick-freezing room temperatures as high as locker room temperatures, or in plants reporting no quick-freezing room. Also these plants did not keep a record of additions to the lockers in which case spoiled meat might have been placed in the lockers at the start of storage. The following factors were listed by plant operators as contributing to meat spoilage:

1. Locker room temperature too high.
2. Not quick-freezing before putting in lockers.
3. Too high humidity in locker room.
4. Meat allowed to age too long in chill room.
5. Too much fluctuation or variation in locker room temperature.
6. Meat left in lockers too long.

Inspection of the meat handled through freezer lockers is largely absent; however, there is definite talk about improving this situation

(21). Many states already have laws and regulations which must be obeyed in order to obtain a license to operate a cold storage locker plant. One of the regulations states that no article of food shall be cold stored unless it is in a proper condition for storage and meets all the requirements of the purefood and food sanitation laws, and such rules as may be established by the Department of Agriculture (4).

The following states report no legislation relating to installation or operation or regulation of cold storage warehouses and cold storage locker plants: Colorado; Idaho; Missouri; Oklahoma; and Wyoming.

Record Keeping

Approximately fifty percent of the locker plants reported some system of keeping records. Very few evidenced the fact that they kept an inventory record of the locker contents. Nearly fifty percent of the firms stated they kept no record of additions or removals whatsoever. Where the card system was used, a record of the rental of the locker was kept along with accounts of additions or removals. Where the cutting charge was assessed on the amount of meat weighed in, an inventory was kept of this amount. Where records were kept in this manner, the patron could figure his chill shrink, his cutting shrink, his quick-freezer, and his locker storage shrink. Accounts of removals were not kept in the above system. Where accounts were kept of removals a set charge for each package removed was made.

Length of Time Meat Can Be Kept in Lockers

A difference of opinion exists among locker plant operators regarding the length of time that meats, with the exception of pork, should be

kept in storage.

Very few locker plants reported meat could be kept in their lockers indefinitely, but, a few did. A majority reported meat could be held from six to twelve months. Plants maintaining a lower locker room temperature recommended storage periods longer than those with higher temperatures. Beef and lamb have been found to keep longer than pork. The recommended storage period for pork is six months or less (11).

Longer storage will be made possible when more knowledge is obtained about maintianing correct relative humidities (8), and preventing dehydration or locker room freezer-burn.

Service for Patrons

City regulations prohibited slaughtering in several of the plants. Many of the plants not slaughtering did not mention city regulations as a reason for not doing this service. Approximately twenty-five percent of the plants in Oklahoma are slaughtering animals for their patrons. These plants were among those reporting an average of over 350 lockers per plant.

Over seventy-five percent of the locker plants offered the services of cutting, wrapping, and processing for their patrons. The remaining twenty-five percent were plants with an average number of lockers below a hundred. This service is believed to be one of the more important services and is a means of increasing the income from plants; however, if only a few lockers are installed the equipment and labor required makes this practice impractical.

With over fifty percent rural patronage, and a large trade territory it is almost impossible for plants to make deliveries to customers.

In spite of this fact, from ten to fifteen percent of the plants reported deliveries of some kind were made. Creameries reported free delivery to milk customers, ice plants reported making occasional deliveries to ice customers, but generally it was not a custom to make deliveries. All deliveries reported were made without charge. It is believed to be impractical to make deliveries in this business.

The labor required in a cold storage locker business varies with the size of the plant, the amount of meat or other products handled, and the number of locker boxes. The services of four men were reported by several of the larger plants. These plants had an average of over 350 lockers, were slaughtering for patrons, and were cutting, wrapping, and processing meats. All plants with over a hundred lockers reported the employment of from one to two persons. Plants with less than a hundred lockers did not employ additional help.

Foods Stored Other Than Meats

Many foods other than pork, beef, and mutton were reported stored in the cold storage lockers. Vegetables ranked next to meats, and some fruits were reported successfully stored. Peas, sweet corn (roasting ears), green (snap) beans, and lima beans were reported stored. Fruits stored included strawberries, raspberries, cherries, and peaches. Other foods named were poultry, fish, and frog legs.

Vegetables for freezing should be carefully selected. Variety, maturity, and freshness must be considered if a first class product is desired (19). Peas were the most popular of all frozen vegetables and the one most commonly packed. The screened peas were washed in clean cold water and then blanched (scalded) for one minute by immersion in a large amount of rapidly boiling water. At least one gallon of boiling

water was required for each pound of peas. Immediately after scalding, the peas were cooled in the coldest clean water available (preferrably not over sixty degrees fahrenheit) and packed in heavy paraffined paperboard cartons holding about one quart and frozen quickly at zero degrees fahrenheit or below.

All other vegetables were handled in practically the same manner. Corn was selected for freezing when in the proper maturity for cooking as corn on the cob. If corn has passed through the milk stage, the frozen product was found to be starchy and undesirable. Blanching of corn was done in boiling water; however, a steam chamber gave better products where plenty of live steam was available. Corn was cooled to seventy degrees fahrenheit or below, packaged in cartons, and frozen. A cleaver was used to cut it into the proper size to fit the cartons.

The preparation of fruits was somewhat different from that of vegetables. Strawberries were mixed with one-third their weight of sugar and slowly stirred with a large spoon until most of the sugar was dissolved in the juice drawn out of the berries. They were then packed in heavy cartons and frozen at zero degrees fahrenheit or below.

Raspberries were mixed with one part of sugar and four parts of berries by weight. After mixing well by stirring they were packaged and frozen at zero degrees fahrenheit or below.

Cherries which had been previously pitted were mixed with granulated sugar in proportions of three parts of cherries to one part of sugar. They were packaged in cartons and frozen the same as other fruits.

Peaches were found to be the most difficult of all the common fruits to freeze. They oxidize readily, thus turning dark. Clean peeled peaches were sliced into a heavy paraffin paperboard carton to which a seventy-five percent sugar syrup was added to within three-fourths of an inch

from the top. They were immediately frozen at zero degrees fahrenheit or below. Peaches had to be stored in low temperature rooms to prevent oxidation. The seventy-five percent sugar syrup was made by dissolving seven parts by weight of sugar in three parts by weight of boiling water, and stirring constantly over a fire until completely dissolved.

Patronage of Plants

The average estimated population of the trade territory of all the plants reporting was 19,240. The size of the trade territory usually indicates whether the plant is located in or near a city. Plants located in the larger trade territories did not have a higher percentage of urban customers. Although the trade territory was large for several of the plants reporting, they did not have any more lockers rented than plants reporting from smaller trade territories (Table II); however, they did report more lockers per plant. A few plants reported over ninty percent of their patronage was urban. These plants were located in large cities or in college towns. Many of the plants having large trade territories reported as high as seventy-five percent rural patronage. Plants reporting less than a hundred lockers had fifty percent rural and fifty percent urban patronage. Plants with 100 and less than 200 lockers reported 48 percent rural and 52 percent urban, while those with over 200 lockers reported 55 percent rural and 45 percent urban. (Table II) Plants with over 200 lockers represented trade territories of from 3,100 to 100,000 population.

Many of the plants have not had an opportunity to observe the percentage patronage during the winter months or summer months, because they have not been in operation one year. The plants that have been in operation over one year reported an average of 65.5 percent of their

patronage was during the winter months; the remaining 34.5 percent was through the summer months. There is a tendency for the patronage to become equally distributed throughout the year in the larger trade areas as the public becomes more familiar with the benefits to be derived from locker plants. (Table II)

Packaging

Five different kinds of paper were reported used in wrapping meat. The kinds reported were vegetable parchment, Model Wrap, special wax paper, ordinary wrapping paper, and vapor proof paper. The greatest number used "Model Wrap" purchased from a paper company in Oklahoma City. All cuts should be well wrapped in tough, moisture proof paper, preferrably before freezing. Cheap oiled paper or ordinary wrapping paper will not prevent undesirable drying (21). A majority of the locker plants mark their packages by stamping them. Others allowed the customer to mark their own packages. Some were marked with pencil, others by tags, and a few were stenciled. Stamping with a rubber stamper seems to be the most popular as writing is very difficult on parchment or moisture proof paper.

The Costs and Income From Cold Storage Locker Plants

Financing of Business

Five different methods of financing were reported. These methods are as follows:

1. Cash
2. Loan
3. R.F.C. Loan
4. Partnership investment
5. Sale of stock (corporation)

The renting of the locker boxes in advance of installation or construction is thought to be a factor in removing the risk of the investment; however, the number of signed patrons before construction of the plants or installation of locker boxes in Oklahoma was small. Only a few firms reported having any great number of signed patrons before construction of their plant. The data did not indicate that signing before construction was of special benefit.

Cost of Plant

The operating costs of cold storage locker plants varied among the different plants. This variation was usually due to difference in labor, difference in utility charges and other factors such as interest. From the data received the larger plants or the ones with the most lockers did not show the highest operating costs. A few plants operating with from 350 to 500 lockers reported an average operating cost of $312.00 per month. In general locker plants operated in connection with other businesses had a lower overhead per locker than did single unit plants. The data showed that single unit plants cost from $15,000.00 to $25,000.00 depending upon their size and their completeness. Other plants built for a dual purpose cost from $4,000.00 to $40,000.00. These plants represented businesses from 100 to 516 lockers. The connecting business, in most cases, was ice manufacture. Approximately one-third of the initial cost of the entire plant was charged to the locker service, especially in plants reporting installation of lockers in their present operating plant. The larger plants spent more for equipment, thus increasing their initial cost. The data showed the initial cost to be greatest in plants having a large number of lockers. Several plants stated they did not

have records to show the cost charged to the locker service, because the installation was over a period of time.

The amount and kind of equipment used in the cold storage locker plants varied according to the size of the plant and the amount of services offered to patrons. Plants with less than 100 lockers, in which no services whatsoever were offered, did not list any equipment. Plants operating over 100 and less than 200 lockers reported the use of a meat grinder, a cutting table and block, a meat slicer, scales, baskets commonly known as butter trays, and a complete set of butcher and cutting equipment. Approximately the same amount and kind of equipment was used by plants having 200 and less than 300 lockers as was used in plants housing 100 to 200 lockers. The larger plants reported the use of an electric meat saw, display pans and counter, and a meat truck in addition to the equipment listed by the smaller plants.

The cost of the equipment was not given, but can be had by inquiry at places where such equipment is sold.

Charges for Lockers

Some authorities (3) state much variation is shown in operating costs due to varying local conditions, utility, and interest rates. However, in other respects, such as charges for lockers and the services of the butcher, there is a remarkable similarity. Particularly in reference to the charge for lockers there appears to be a recognition of the necessity of adequate rates which are considerbly higher than some of the pioneer plants charged. By some it is pointed out that the minimum charge should be more than the customary $1.00 a month or $10.00 a year.

The maximum charge per month for a locker was $1.25, the minimum

$0.50. The maximum charge per year was $12.50, the minimum $6.00. The average monthly charge for all plants reporting was approximately $1.00, the average yearly charge $10.00. (Table III) Many plants rented different size lockers at different price levels. The larger boxes costing a trifle more. In every instance yearly rates were lower than monthly rates. A few plants also ranted on the six months basis. This charge averaged approximately $5.00.

Table III

Averages for Different Size Plants

Number of lockers	0 - 99	100 - 199	200 - 299	300 - up
Number of additional men employed	---	1 - 2	1 - 2	1 - 2
Per month:				
Charges for lockers	$1.00 - $1.25	$0.85	$1.00	$1.00
Per year:	$10.00	$9.00	$10.50	$10.00
Charge for cutting and wrapping	---	$0.015	$0.017	$0.015
Charge for processing	---	$0.01	$0.015	$0.02

Processing Charges

Nearly all the plants reported a charge of $0.015 per pound for cutting and wrapping meat for customers. A few reported a charge of $0.02 per pound, and one plant charged $0.01 per pound. Another plant charges approximately $1.35 per cut. These cuts included quarters of beef and halves of hog carcasses. The average charge of all the locker plants reporting was slightly more than $0.015 per pound. (Table III) This charge is one of the charges found to be quite uniform in all plants

not only in Oklahoma, but in other states as well. Plants having less than 100 lockers did not cut or wrap for their patrons. No locker plant cured meat, or rendered lard. The charge for grinding meat ranged from $0.01 to $0.02 per pound as shown in table III. Plants with less than 100 lockers did not process for their patrons.

Sources of Income Other Than Lockers

With approximately two-thirds of the cold storage locker plants operating in connection with ice plants, the sale of ice was the biggest source of income other than from the lockers. Income from creameries ranked next to that of ice. Approximately fourteen percent of the plants were in connection with creameries. Several plants reported income from storage of perishable products, the chilling of beef, and from electric and water utilities.

A few of the larger frozen food companies reported income from retail of fast frozen meats, fish, poultry, fruits, and vegetables; and also from wholesale to hotels, restaurants, and small stores.

Problems in Plant Operation

Although oil and gas are quite plentiful in many sections of Oklahoma, few cold storage locker plants reported the use of gas engines as a source of power for their refrigeration units. A few plants reported the use of gasoline motors, a few automobile motors, but the majority reported the use of mechanical refrigerating machines powered with electric motors. Many of the larger plants reported the use of several machines. The use of either a York, a Frick, or both was reported by

several plants. The size of the machines and the number required varied with the size of the plant and the number of lockers. A few plants having 200 or more lockers reported the use of two York four by four inch compressors having a capacity of four tons each, operated by electricity. Other plants having equally as many lockers reported the use of a Frick five by five inch self-contained unit operated by an electric motor.

Oklahoma has many different types of water (8). Sometimes alkaline and hard water cause corrosion in the cooling systems of the engines and refrigeration coils. However, only one cold storage locker plant reported any trouble from hard water in their refrigeration machinery. This plant was located in the Northwestern part of the state. The trouble caused in this instance was corrosion.

SUMMARY

1. The cold storage locker business is relatively new in the state of Oklahoma. All the plants started operating during or after 1935. There has been considerable interest shown in this new business by the number of inquiries sent to the Meats Division of the Oklahoma Agricultural and Mechanical College.

2. Of the 31 cold storage locker plants throughout the state, 66.7 percent operated in connection with ice plants, 14.3 percent in connection with creameries, and 19.0 percent as single units.

3. The average dimensions for all plants was 50.25 feet by 87.75 feet. (Table I) The approximate number of locker boxes for this size plant was 209. There was little difference in the dimensions of the freezing rooms.

4. The average freezing-room size was 7 feet by 10.6 feet. The average temperature was minus fifteen degrees fahrenheit. (Table I)

5. Locker room dimensions averaged 18 feet by 30 feet and had an average capacity of 200 locker boxes. The temperature average was plus 11.25 degrees fahrenheit. (Table I)

6. The average cutting room size was eleven feet by nineteen feet and was reported too small for the larger plants.

7. Very few plants offered the service of processing for patrons. Plants operating between 200 and 300 lockers reported a processing room 12 feet by 18 feet.

8. Corkboard was the most commonly used insulator. Locker rooms required six inches, chill rooms four inches, and quick-freezer rooms eight inches.

9. The estimated trade territory had little to do with the percentage

of urban patronage. A slightly higher rural patronage was found in the larger trade areas. (Table II)

10. There was a tendency toward equal distribution of patronage in summer and winter months in the larger trade territories. (Table II)

11. Plants with less than 200 lockers had slightly higher rental percentages than those with over 200 lockers. (Table II)

12. The average locker box size was sixteen by eighteen by thirty inches. A few plants reported two sizes.

13. Approximately fifty percent of the cold storage locker plants in Oklahoma are individually owned and managed. The remaining fifty percent are owned by creamery companies, corporations, ice companies, or as private investments. No cooperatives were reported in the state.

14. Locker plants reporting complaints due to spoilage had a locker room temperature above fifteen degrees fahrenheit.

15. Plants maintaining a lower locker room temperature recommended longer storage periods than those with higher temperatures.

16. Vegetables and fruits were stored successfully in several plants where proper preparatory practices were carried out.

17. Packaging in tough moisture proof paper prior to freezing aided materially in the keeping of a more nearly perfect product.

18. The average monthly charge for standard size locker boxes was $1.00. The average yearly charge was $10.00. (Table III)

19. Processing and cutting and wrapping charges were quite uniform for all size plants averaging a little over $0.015 per pound. (Table III)

20. The data evidenced the fact that the cold storage locker business has a definite place in the Southwest and that the larger "complete service" plants in connection with ice companies or operating

as single units were more successful than smaller plants with less services.

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