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Ice on the Farm

C. Larsen

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AGRICULTURAL EXPERIMENT STATION

South Dakota
**State College of Agriculture
and Mechanic Arts**

DAIRY HUSBANDRY DEPARTMENT

ICE ON THE FARM

BROOKINGS, SOUTH DAKOTA

ICE ON THE FARM

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ICE ON THE FARM

—by—

C. Larsen.**INTRODUCTION.**

Ice on the farm is not a luxury. It is of economic importance. Some are inclined to class it as an article without which we can get along, but if a rural home has once had a plentiful supply of ice during one season ice will henceforth be regarded as a necessity.

Homes in the various towns are supplied with ice from centralized storage, and the delivery company finds it possible to plan for and provide ice for the whole community. Such a plan cannot work on the farm. Homes are too scattered and too far apart, and besides the farmer needs more ice than the person living in town. The farmer needs ice to use in connection with the production and marketing of foods.

In the past many farmers have purchased ice from the ice man in town, brought it out to the farm and kept it over night and then used what was left. This method is wasteful and expensive for the farmer. Besides, it enables the farm home to have the many benefits of ice irregularly and usually only when the farmer goes to town.

At the present time ice is stored to a small extent on the farms of South Dakota. If the ease and inexpensiveness of storing ice and the comfort and handiness of having ice were realized, there would be ice on every farm.

Common Uses for Ice.

1. In hot weather, milk, cream and butter deteriorate rapidly. If the cream and butter offered for sale in South Dakota in 1918 had been kept cool and marketed in a fresh condition the farmers in the state of South Dakota would have realized an increased income of about \$400,000.00.

2. Although it is not desirable to keep cream too long on the farm before delivery, the cooling with ice will not necessitate so frequent delivery of dairy products. Keeping the cream in ice water constantly will also keep it sweet and in better marketable condition.

3. Where butter is made on the farm, control of temperature is important. The dull, smeary and mottled butter so often offered for sale at the grocery stores, is a direct result of improper temperature in the churning or in some other step of manufacture. During the summer, ice is the best, most common and practicable means by which the temperature can be regulated.

4. During the hot weather, ice cream and ice-cold drinks are refreshing and satisfying. There should be a small ice cream freezer on every farm. Iced tea, lemonade, ice-cold watermelon and cantaloupes may be had on the farm. It is not necessary to go to some city hotel or restaurant to obtain the same.

5. A refrigerator in the household for the keeping of butter, cream, milk, meat, fruit salad, and other victuals is a saving of food and a convenience for the housewife.

6. Ice is often needed for the sick room. When it is needed in this connection it is needed badly.

Obtaining the Ice.

In order to obtain a good pure supply of ice some forethought is important. There is not a farm in South Dakota located in such a place that ice is not obtainable. Water is essential to farm life and wherever there is a supply of water ice can be frozen, harvested and stored. The method of obtaining ice will vary according to the natural advantages and according to the cost.

In regard to the different conditions South Dakota divides itself into four more or less overlapping zones running parallel north and south as follows:

1. The western part, including the hills, valleys and mountains, has mountain streams and springs supplying the purest and best of water. In the smaller streams and where there is a naturally favorable spot for a reservoir, a dam may be built. In the larger streams where there is danger of floods it may be necessary to divert the water from the stream into a pond. Naturally low places can be selected. Relatively little work with team and scraper

will provide a good ice pond. In case the pond subsoil is gravelly and porous, cover the bottom with a layer of clay and let the horses pack well by tramping.

2. In the region immediately east of the Black Hills, running streams affording favorable conditions for ice harvesting are comparatively few. Besides, the few streams running during the fall and winter are usually quite muddy. Many farmers in this section obtain their water supply from wells and dams at the foot of draws. Most of these dams afford an excellent place from which to harvest a good supply of ice. Facilities for cooling with water in this part of the state are not common.

3. Immediately east of this is the zone where artesian wells are so numerous. These wells supply an abundance of pure water. Moreover the soil, generally speaking, is of such a character that when water is stored in an ice pond it will be retained. The lay of the land is level and there are relatively few running streams.

In this section it is of still greater importance that a supply of ice is on hand for cooling purposes during the summer. Although cold water from shallow wells is obtainable, most people depend on the artesian wells for their water supply. The water from these wells is usually of such temperature that it can do very little good as a cooling agency.

4. In the extreme eastern part of the state ice may be obtained from a nearby stream. In some instances it is necessary to haul the ice several miles. It will be necessary to obtain permission from the man who owns the land adjacent to the stream. In such instances a bonus may be required.

There are several places at lakes and rivers where ice may be purchased at a very low price. Where such a harvesting plant is within driving distance or on a direct railroad line it is usually cheaper and certainly much handier to purchase ice direct. The men who operate such an ice plant have all the necessary tools. They harvest the ice on a big scale and can sell it at a very low price.

Making an Ice Pond.

In planning an ice pond there are several things that should be considered:

1. The pond should be made in a place handy for getting water into it. This is true whether the pond is filled by pumping water from a well, whether it is supplied from a stream, or whether it is obtained from an overflowing artesian well.

2. If possible a naturally low place should be selected. This kind of ground holds the water well. It is usually of fine and firm texture, and therefore less porous. Further, less work is required to make the pond of sufficient depth.

3. If there is any difference in the kind of soil, select a place having a clay subsoil. Water stored on the top of gravel will drain away too rapidly. In case the subsoil is of a porous nature it is well to cover the bottom of the pond with a layer of clay. This clay soil can be packed in by having a boy ride a horse back and forth until thoroughly puddled.

The size of the pond will vary with the amount of ice to be harvested and also the thickness of the ice. The depth of the ice will again vary with the climate and the depth of the pond. In some winters ice may be frozen to a depth of two feet, while during other winters the weather is mild and the ice would not freeze to a depth of more than one foot.

Generally speaking, the pond should not be too deep. If too deep freezing is retarded. Also if the water does not come to the top or near the edge of the pond snow will drift in and freezing will be much retarded. About three feet is sufficient for depth. The pond should be deep enough so that when the cakes of ice are cut they will float in the water.

Speaking in round numbers 53 square feet will produce one ton of ice 8 inches thick; 35 square feet will contain one ton of ice 12 inches thick. If the ice is 14 inches thick, 30 square feet will be required to produce one ton; if the ice is 16 inches in thickness, then 26 square feet will

be required; if the ice is 18 inches thick, then $23\frac{1}{2}$ square feet of pond area will be required to contain one ton of ice.

SIZE OF ICE POND AND AMOUNT OF ICE.

Square feet of Pond Area	Thickness of Ice	Tons of Ice
83 square feet	8 inches	1 ton
35 square feet	12 inches	1 ton
30 square feet	14 inches	1 ton
26 square feet	16 inches	1 ton
23.5 square feet	18 inches	1 ton

In this climate it is safe to calculate the size of the ice pond on the basis of the ice being 12 inches in thickness.

The amount of ice used on the average farm can hardly be estimated. The various uses to which ice is put are numerous. It will also depend on the kind of ice house, method of storing the ice and the manner of usage. This much is sure, it is better to have too much than not enough ice. With this in view the pond should be big enough to produce about 40 tons of ice.

Considering that 35 square feet of ice, which is one foot in depth, will make one ton of ice, then to produce 40 tons of ice would require a pond having an inside area of 1400 square feet, or one having dimensions of 40 feet in length and 35 feet in width. Such a pond can easily be made by the use of a plow, team and scraper. The dirt scraped from the pond should be placed on the side and in this way used as an embankment. This to a large extent eliminates trouble of drifting snow.

During the freezing one should carefully watch that the pond is kept full of water. If the water settles the ice will also settle. This will cause the ice to freeze to the bottom and make the harvest more difficult and the bottom of the ice cakes will be covered with dirt.

Freezing Ice in Cans.

During the last nine winters the author has been experimenting with methods of freezing and storing ice under farm conditions. One of the methods consisted of freezing ice into blocks in cans made of galvanized sheet iron. In many ways this proved to be a good method of obtaining ice.

Cans of various sizes were used. The larger size

proved most satisfactory. These cans can be made by any local tinner. The size and dimensions of the can are based upon the manner on which the iron sheets will cut without waste rather than upon cans containing an even number of pounds of ice. Galvanized iron comes in sheets 30 inches wide by 96 inches long.

The accompanying illustration shows how the sheets of iron are cut. Figure I. illustrates the total size of the sheet necessary to make one can, 30x61 inches and illustrates how it is cut to obtain the least waste. After this amount is cut from the full sheet as it comes from the factory (30x96) a piece will be left that is 30x35 inches. This will make four end pieces by cutting close. The next new sheet of iron will cut two pieces 43x30 for sides and bottom, so two new sheets of metal 30x96 will make three tanks with very little waste.

Figure II. shows how the sides and bottom of the tank is made.

Figure III. gives the construction details of the ends of the can. The top of the tank should be one inch wider than the bottom to permit the ice to come out easily.

Figure IV. shows the side view. Notice the top is reinforced with $\frac{3}{8}$ inch rod.

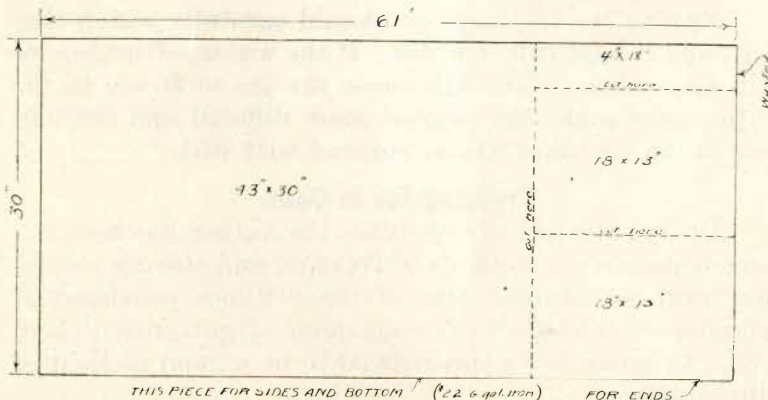


FIGURE I. Showing size of sheet iron for tank, and showing also how it is cut to obtain least amount of waste.

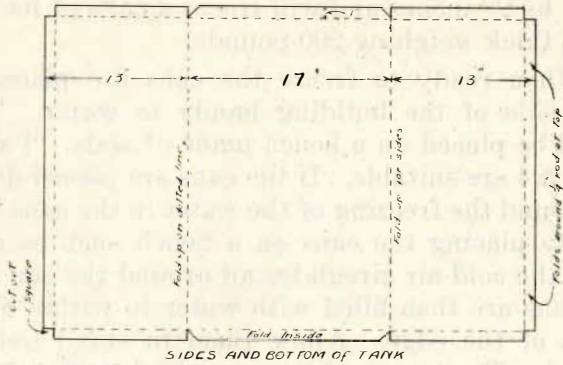


FIGURE II. Showing how sides and bottom are folded.

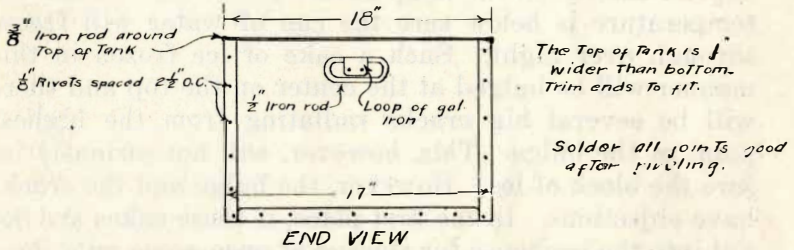
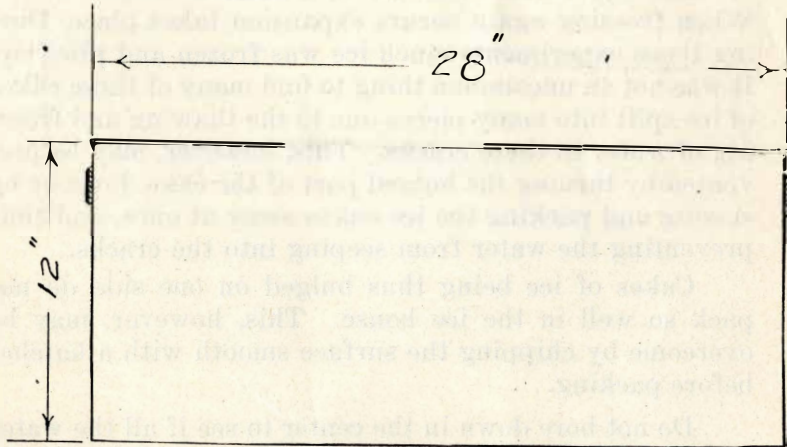


FIGURE III. Showing end view of tank.



SIDE VIEW.

FIGURE IV. Showing side view of tank.

The dimensions of such a can are 12 inches by 18

inches by 28 inches and will freeze a cake of ice about 10 inches thick weighing 200 pounds.

When ready to freeze the cans are placed on the north side of the building handy to water. The cans should be placed on a bench made of slats. Two stringers of 2x4 are suitable. If the cans are placed directly on the ground the freezing of the water in the cans is retarded. By placing the cans on a bench such as described above the cold air circulates all around the can of water. The cans are then filled with water to within about two inches of the edge. Allow them to stand until frozen through. The length of time required to thus freeze will depend chiefly on the temperature of the air. When the temperature is below zero the can of water will freeze through over night. Such a cake of ice frozen in this manner will be bulged at the center on the top and there will be several big cracks radiating from the highest point of the bulge. This, however, will not seriously injure the block of ice. However, the bulge and the cracks have objections. In the first place, if these cakes are not put into the ice house for storage at once, some mild days or rain will cause moisture to collect in these cracks. When freezing again occurs expansion takes place. During these experiments much ice was frozen and piled up. It was not an uncommon thing to find many of these cakes of ice split into many pieces due to the thawing and freezing of water in these cracks. This, however, may be prevented by turning the bulged part of the cake down or by storing and packing the ice cakes away at once, and thus preventing the water from seeping into the cracks.

Cakes of ice being thus bulged on one side do not pack so well in the ice house. This, however, may be overcome by chipping the surface smooth with a hatchet before packing.

Do not bore down in the center to see if all the water is frozen. This makes the water rise up into the hole. When it freezes expansion takes place and the cake of ice is split.

When the cake of ice is frozen turn the can over,

mouth down, on the bench, pouring a little hot water over the bottom, taking hold of the handles and slightly hitting the cans on the bottom. By not having the cans entirely full the block of ice readily falls out. Remove the ice, turn the can over and repeat the operation.

Several ways have been tried with the view of overcoming the bulging and expansion of the ice during freezing. Porous substances of various kinds were inserted in the water with the lower end reaching to the center of the can and the other end above the water. There is an old saying that a broom handle inserted into a barrel of water will prevent the barrel from bursting. No substance was found which would adequately take care of the expansion on this principle.

Airtight waterproof inflated rubber bags were placed in the center of the can of water. The end of this inflated rubber reached above the surface of the water. This contrivance replaced sufficient water to take care of the expansion during freezing. From the above description it will be seen that a block of ice freezes from the outside first leaving unfrozen water in the center to freeze last. When this finally freezes it expands. This expansion is equal on all sides. On the bottom and sides the can furnishes a resistance. There is no resistance from the top and therefore the ice expands upward.

The inflated rubber bladder of an ordinary football is of sufficient size to take care of this expansion and it responds as the expansion of the water occurs during the freezing. The air in the bladder is pushed up and when the cake is completely frozen the air has all been pushed out of the bladder in the water into the part of the bladder that is above the surface of the water. This method leaves the cake of ice entirely smooth on the surface.

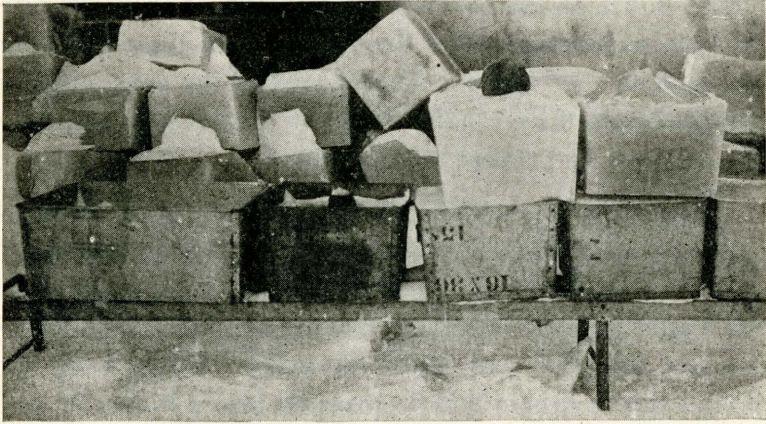
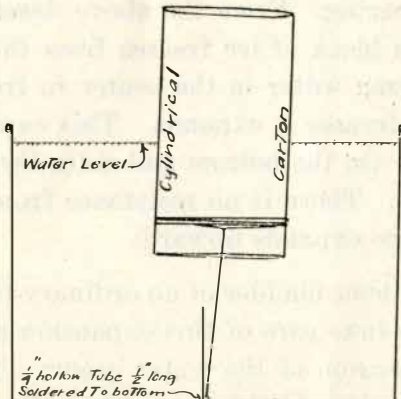


FIGURE V. Showing ice freezin in tanks. In the right field may be seen a bulged cake of ice. Next to it on the left may be seen a cake of ice without the bulge, but this ice block shows the inflated rubber bladder at the top due to the expansion during freezing.

The one great objection to this method is that these rubber bladders are too expensive to use. It is not practical to remove the rubber bag from each cake of ice.

Cheaper substances were also used. Round cartons used for packing oatmeal were used. These cartons meas-



CROSS SECTION OF TANK Showing empty carton submerged in water ready for freezing After running string thru eyelet at bottom it is tied down to one of the handles on the end of tank.

FIGURE VI.

ure $5\frac{1}{4}$ inches in diameter and $9\frac{1}{2}$ inches in height. They are a trifle small to take care of the expansion. The amount of expansion is about equal to one-ninth of the volume of water. However, they work successfully.

Before these cartons were used they were painted on the outside with melted hot paraffin. The lids were all left on. These paraffin-coated cartons were pushed down to the center of the tank of water and held in that position by means of a stout cord tied around the carton, run through a small eye soldered in the bottom of the can as illustrated in Figure VI., and tied down to the handle on one end of the tank. These paraffin-coated paper cartons do not take care of the expansion in the same manner as do the rubber bags. Whenever the pressure on the cartons due to expansion become sufficiently great the cartons burst and water escapes to the inside of the carton. As the water in the center of the tank freezes the force of expansion forces water up into the portion of the carton above the water level and if the carton is large enough for the depth of the water in the tank the ice will not bulge or crack. If a smooth block of ice is desired this is probably the cheapest way of preventing the bulging. However, considering the work necessary to prevent this bulging of the ice, and considering that the bulging is not serious to the success of ice freezing in cans, it is doubtful whether it is practical to use any of these bulging preventive measures.

The author experimented with cans made from different weights of sheet iron (18 gauge, 22 gauge, and 26 gauge). Generally speaking, sheet iron of 22 gauge is most suitable.

The bulging of the ice cake may also be prevented by freezing a few inches of water at a time. It will require about five separate fillings to freeze a cake of ice without bulging. This method requires more attention than the average person is willing to give it. A longer time is also required to freeze a block of ice in this manner. However, if only a small supply is wanted and a person is around the place to attend to this gradual filling of the cans, this method is practical.

Storing the Ice.

During the winter 1910-1911 two lots of ice each of 15 tons were stored. One lot was stored in a 12x12 ft. pile on the top of the ground, and the other lot was stored in a 12x12 ft. pit in the ground. No packing material between the blocks of ice was used. The blocks of ice were put in and snow was used for filling up the cracks. Previous to piling the ice a heavy layer of straw was spread on the ground. The sides and top of the ice piles were covered with a layer of straw at least a foot in depth. The tops were covered with rough boards so that no rain penetrated from the top.

These two lots of ice did not keep well. The month of March was unusually warm. The top part of the straw dried rapidly. The ice pile above the ground gradually melted. Although much straw was used and it was well packed all around and on top of the ice it was not sufficient to keep the air out. The dryness on the outside loosened the straw. The wet from the ice on the inside and on the sides of the ice caused the straw to form manure and to shrink.



FIGURE VII. Pile of ice stored on top of ground from which only 10 per cent of ice stored was recovered for actual use.

The ice pile on top of the ground was used first in the College creamery refrigerator. The refrigerator was filled about once each week. The first ice was taken April 26th. On May 5th the last ice was taken from the pile on the top of the ground. A total of 2845 pounds of clean ice was made use of, or an amount equal to about ten per cent of the original amount stored.

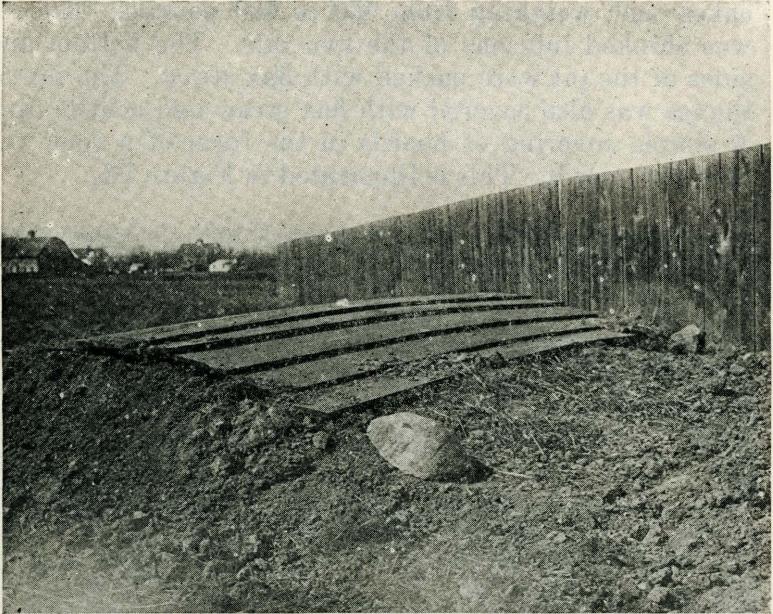


FIGURE VIII. Ice stored in a pit and from which 30 per cent was recovered for actual use.

The ice stored in the pit was then used in a similar manner. On August 4, the last of this ice had been used. The total recovered from this pile was 8880 pounds, or about thirty per cent of the total amount stored. This showed that ice stored in the ground kept better than the ice stored on the top of the ground. About three times as much was obtained from the ground storage as the surface storage.

During the winter 1911-1912 two square holes were dug in the ground. Each one of them was five feet in

depth, twelve feet wide and twelve feet long. About one foot on the sides of the ice was used for insulating material. This would leave a space for storing the ice equal to 10 feet in width, 10 feet in length and 5 feet in depth or 500 cubic feet. Inasmuch as a cubic foot of ice weighs about 58 pounds each hole in the ground would contain about 15 tons of ice.

This amount of ice was purchased in the form of cakes each weighing from 400 to 600 pounds. The ice was chinked into one of the two pits. The bottom and sides of the pit were packed with flax straw. The top of the ice was also covered with flax straw and a little dirt. A simple covering of boards in the form of a roof was then put over it. This is illustrated in Figure IX.

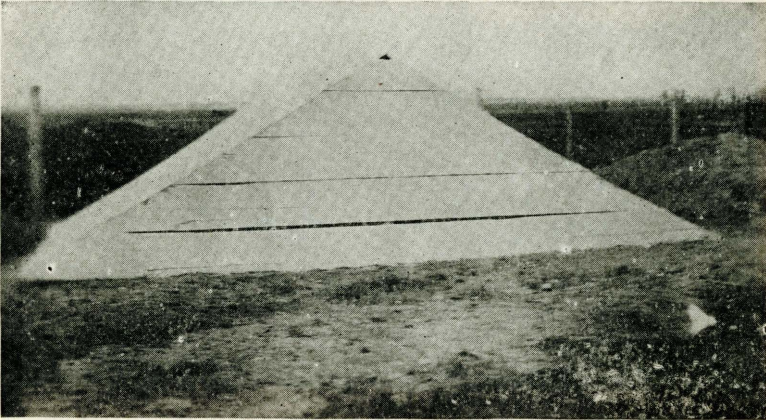


FIGURE IX. Showing an ice storage pit with cheap covering. From this ice 36 per cent of original amount stored was recovered.

It was the intention to fill the second pit with ice by gradually running water into it and freezing it little by little until the hole in the ground was filled with one solid block of ice. The intention was to allow the bottom and sides of the pit to become thoroughly frozen, and then allow an inch or two of water to run in daily and thus gradually freeze it full.

This latter plan, however, did not materialize. The bottom of the pit did not freeze solid until late in Janu-

uary. The first few inches of water in the pit froze into ice very slowly. A little later in the winter the sun became so strong that the sides of the pit facing to the south thawed and a portion of the dirt caved into the pit. A portion of the ice also melted during the day. This part of the plan was a failure. If ice is to be frozen into one solid chunk it should be accomplished in a shallow pit or above ground, or else in a pit having a large area so as to permit circulation of the cold air.

The 15 tons purchased and stored in the other pile were used for cooling milk in the creamery and also used in the creamery refrigerator and for other sundry purposes. Some ice was taken out daily. All of the ice was carefully weighed after it had been washed and was ready for use. The first ice was taken out June 1 and the last September 29.

Out of the 15 tons stored 10,881 pounds or about $5\frac{1}{2}$ tons were recovered. This means that a little more than 36 per cent of the total amount stored was put to actual use. On an average 90 pounds of ice were used daily for 121 consecutive days. A shrinkage of 64 per cent appears large. The conveniences and benefits of having ice daily more than repays this shrinkage. This experience reaffirmed by the previous year shows that ice keeps well in the ground.

The following three winters ice was stored in an ice house. This building was not insulated; the studdings were merely covered with one layer of building paper; and the siding and the inside of the studdings were covered with matched lumber. A ventilator was put into the roof. The ice stored in this building was manufactured in cans. The first winter, 1912-1913, 8 tons of ice were stored. Flax straw was used as a covering on the top and also for insulating all around on the sides. During the summer the flax straw on the sides and on the top seemed to heat more or less causing unnecessary shrinkage of the ice.

Some ice was used daily between June 1 and July 29. From the total amount stored 4,790 pounds of clean ice

were used, or about 30 per cent of the total amount stored.

In the winter 1913-1914, 10 tons of ice were frozen in molds as during the previous winter. Instead of using flax straw for a covering and for insulation, sawdust was used.

From the 10 tons stored 8,480 pounds were recovered for cooling purposes. This is equal to 47 per cent.

During the winter 1914-1915, 15½ tons were frozen in the cans or molds and stored in the same ice house. Sawdust was again used for covering and for insulation. The amount of ice recovered or actually used was 12,330 pounds, or almost 40 per cent of the ice stored.

Year	Amount Stored	How Stored	Amount Used	Per Cent used of Amount Stored
1910-1911	15 tons	Top of ground	2,845 lbs.	10
1910-1911	15 tons	In pit	8,880 lbs.	30
1911-1912	15 tons	In pit	10,881 lbs.	36
1911-1912		By running water into pit		
1912-1913	8 tons	In ice house	4,790 lbs.	30
1913-1914	10 tons	Straw used for packing		
1913-1914	10 tons	Sawdust used for packing	8,480 lbs.	47
1914-1915	15½ tons	Ice house	12,330 lbs.	40

These experiments indicate that a basement plan of an ice house stores ice economically. Such an ice house can also be built at a relatively small cost and permanency and efficiency obtained.

These experiments also indicate straw is not a first class material for insulation on the sides and for covering the top. Sawdust is more effective. Wherever sawdust is not obtainable flax straw or any other straw may be used.

A Good Farm Ice House.

A farm ice house, sections of which are shown in the accompanying diagrams, may be built at a very low cost. This ice house was designed and drawn by R. L. Patty, farm engineer in the Extension Division. Such an ice house will hold about 21 tons of ice. A space of about one foot for sawdust insulation on all four sides is allowed. This is all the insulation necessary.

Such an ice house made of concrete is permanent. It will not rot and bulge as is the case with many of the ice houses built from wood. Such an ice house is of good appearance and will add to the attractiveness of the group of farm buildings.

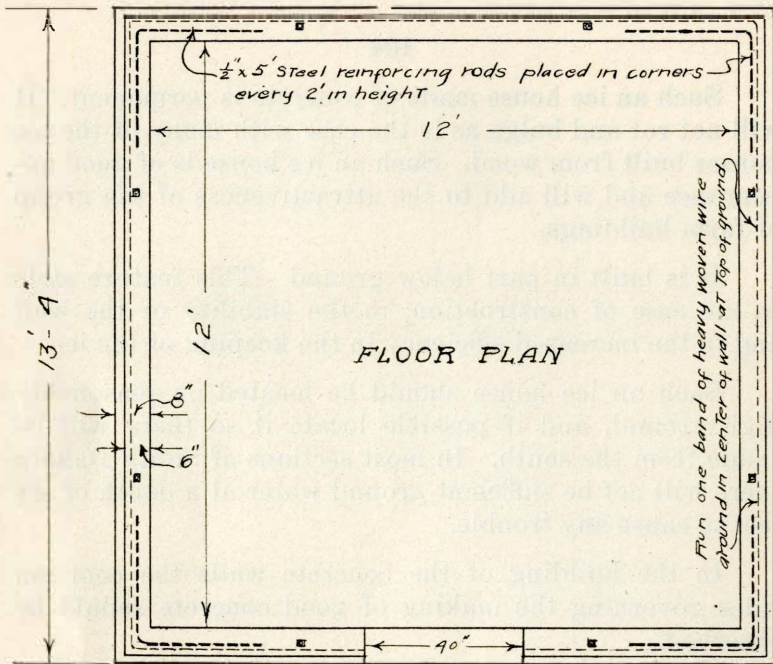
It is built in part below ground. This feature adds to the ease of construction, to the stability of the wall and to the increased efficiency in the keeping of the ice.

Such an ice house should be located on reasonably high ground, and if possible locate it so there will be shade from the south. In most sections of South Dakota there will not be sufficient ground water at a depth of six feet to cause any trouble.

In the building of the concrete walls the common rules governing the making of good concrete should be observed.

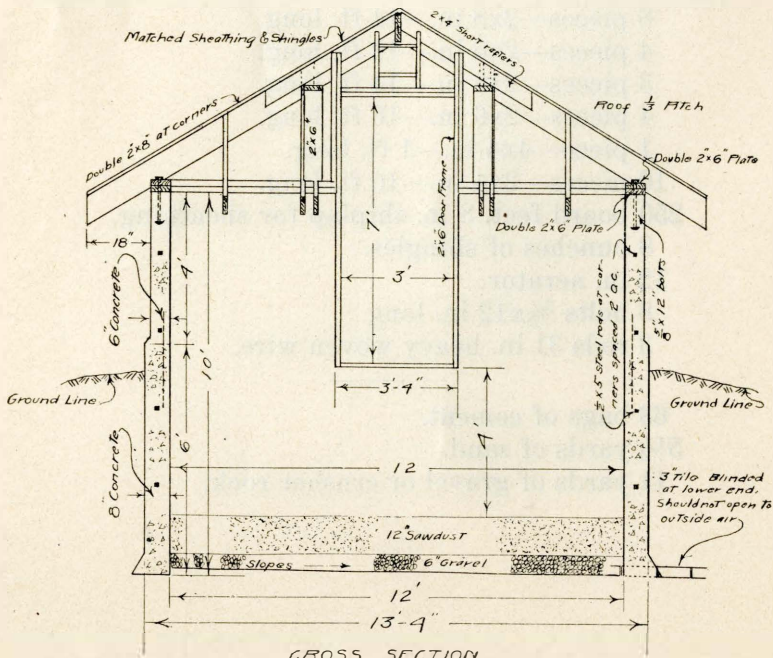
The following is a bill of material for the ice house holding 21 tons:

- 8 pieces—2x8 in.—14 ft. long.
 - 4 pieces—2x6 in.—12 ft. long.
 - 3 pieces—2x6 in.—14 ft. long.
 - 4 pieces—2x6 in.—16 ft. long.
 - 1 piece—4x4 in.—1 ft. long.
 - 10 pieces—2x4 in.—16 ft. long.
 - 250 board feet. 8 in. shiplap for sheathing.
 - 8 bunches of shingles.
 - 12 in. aerator.
 - 8 bolts $\frac{5}{8}$ x12 in. long.
 - 3 rods 31 in. heavy woven wire.
-
- 63 bags of cement.
 - 5½ yards of sand.
 - 11 yards of gravel or crusher rock.



SHOWING REINFORCING IN WALLS

FIGURE X. Floor plan of re-enforced concrete basement ice house.



CROSS SECTION

FIGURE XI.

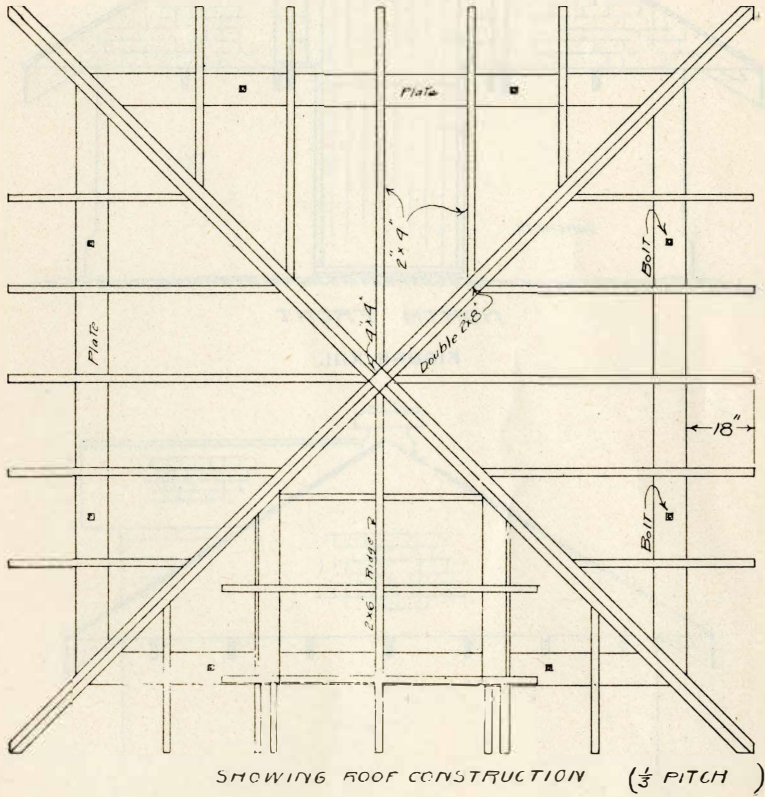
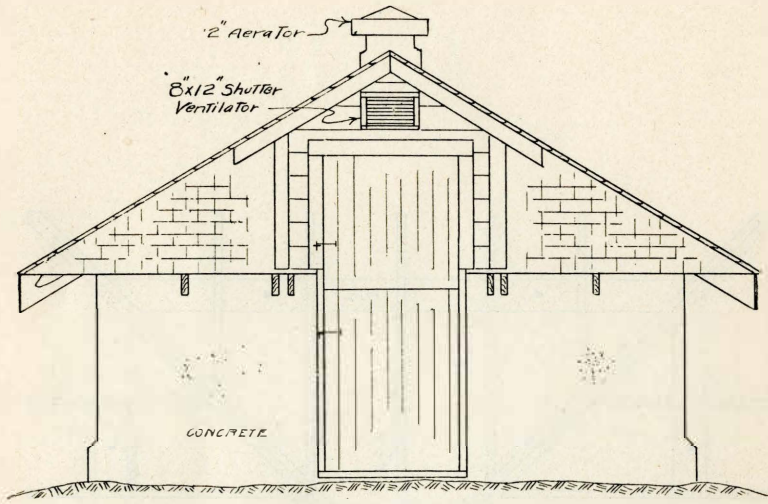
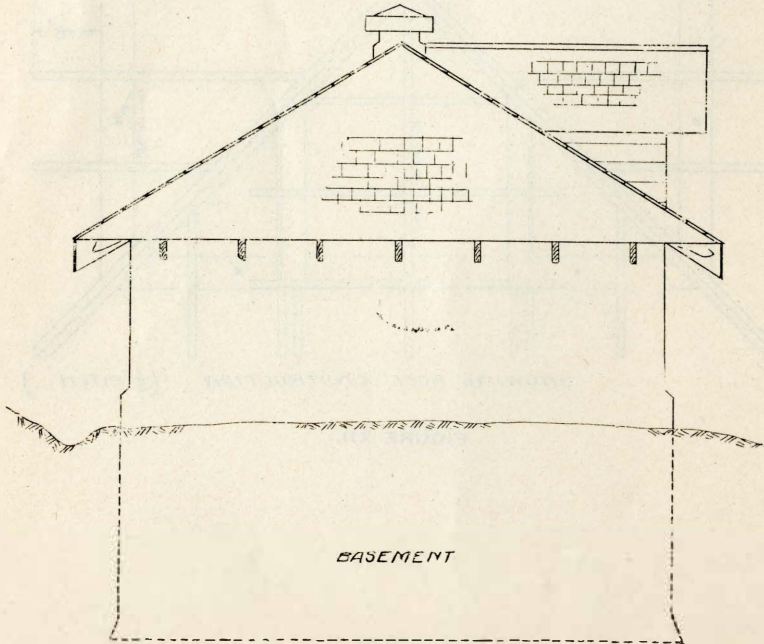


FIGURE XII.



NORTH FRONT

FIGURE XIII.



EAST SIDE

FIGURE XIV.

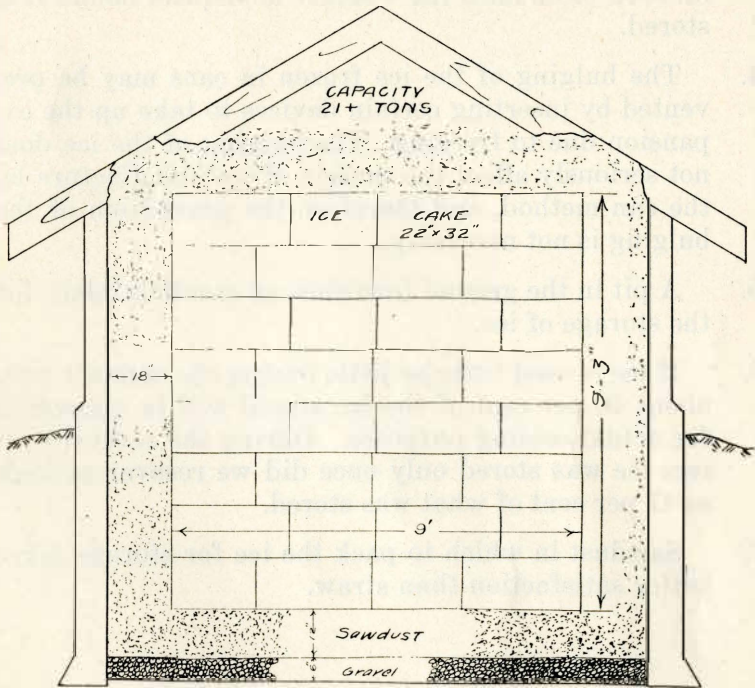


FIGURE XV. Showing how ice is packed in the basement of re-enforced concrete ice house.

SUMMARY

1. Every farmer in South Dakota may have ice during the whole summer for cooling dairy products, for the house refrigerator, for the various kinds of cooling drinks, for ice cream and other frozen delicacies, and for cases of sickness should such occur.
2. Ice may be frozen in cans. Such ice has the advantage that the water from which it is frozen is usually well water and is pure. Ice obtained from lakes, and streams, is not always of known purity.
3. Weather at zero or below is most favorable for the freezing of ice in cans. Ice should be stored while at this low temperature. Such ice keeps better than if

allowed to lie until the weather moderates before it is stored.

4. The bulging of the ice frozen in cans may be prevented by inserting certain devices to take up the expansion due to freezing. The bulging of the ice does not seriously affect the success of ice manufacture by the can method, and therefore the prevention of the bulging is not necessary.
5. A pit in the ground furnishes an excellent place for the storage of ice.
6. If ice is used little by little during the summer only about 40 per cent of the ice stored will be recovered for actual cooling purposes. During the several winters ice was stored only once did we recover as high as 47 per cent of what was stored.
7. Sawdust in which to pack the ice for storage gives better satisfaction than straw.