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AUBURN

Harvesting and Storing Sweet Potatoes

By

J. C. C. PRICE

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HARVESTING AND STORING SWEET POTATOES

By

J. C. C. Price, Associate Horticulturist

INTRODUCTION

Storage has proved to be the most serious problem of sweet potato growing. Storage in banks, pits and trenches is not always satisfactory, because sweet potatoes require a warm, dry, rapidly changing atmosphere during the curing period, and a uniform temperature and humidity after curing. Such conditions are found only in a storage house. When the pit, bank or trench methods are used from 10 to 100 per cent rot and those that keep are not of as good quality as are the cured potatoes. Even if potatoes would keep as well in trenches or banks, these methods are not economical, because too much labor is required each year to make and use them. It costs ten to twelve cents per bushel to bank sweet potatoes, unbank and clean them for market. Potatoes cannot be removed conveniently from banks in rainy or cold weather without injuring the potatoes or causing decay; but they can be conveniently marketed from the storage house at any time without regard to weather conditions and without damaging the rest of the crop.

Uniformity of temperature and humidity are two of the most important factors in the storage of any perishable crop. The ability to control humidity and temperature is the most important factor in curing a perishable crop. It is also a well established principle of storage that a rapid rise or fall of either temperature or humidity is not desirable.

MAKING THE EXPERIMENTAL STORAGE ROOM

In order to make a thorough test of house curing and storage of sweet potatoes under Alabama conditions, one large room of a negro cabin (Fig. 3) standing on the Experiment Station grounds, was remodeled during the fall of 1914 as follows:

The cracks in the rough board walls were covered on the outside with one-half by three inch strips. The walls inside were covered with building paper. The rough board floor was covered with building paper and a tongue and grooved floor was laid over this and at right angles to the boards of the first floor. Care was taken to join the floor carefully to the outer walls so as to keep out rodents or air. Two by four inch scantlings were set vertically two feet apart around the walls and a layer of paper tacked upon these. This provided a four inch dead air space between the two by fours from floor to ceiling, thus giving excellent protection from sudden changes of temperature.

The walls were then ceiled with the same material as that used for the floor. The rough board ceiling was simply covered with building paper during the first season, but was also ceiled at the beginning of the second year. The effect of this change is clearly shown by the much more constant temperatures maintained the second year.

The windows on the north and east sides of the house were replaced by hinged doors, composed of two layers of matched boards with building paper between, so as to provide ventilation during the curing period. The door at the south-east corner of the house was remodeled by covering with paper and an extra layer of boards.

An eight by ten inch ventilator opening was cut in the floor at each of the four corners of the room as a part of the ventilating system. These openings could be closed at will by means of sliding covers. A flue, made by nailing four six inch boards together, extended through the ceiling in the center of the room and out through the roof. The top of this flue was roofed to keep out rain and the ceiling opening could be closed at will by a sliding board.

BUILDING THE BINS

The bins (see fig. 4) were constructed as follows: Two by fours were used for the uprights, or posts, which were toenailed to the floor and ceiling. One inch by three inch strips were nailed to the corner posts for the sides and backs, leaving a one inch space between the strips. The backs of the bins were made first and then set in place, since there is not room in the narrow space to work. Edging strips, (which may be had at the saw mill at a cost not exceeding fifty cents for a two-horse wagon load) were used for constructing the bins and were entirely satisfactory. The false bottoms were made by nailing stout edging strips on three pieces of two by fours cut two inches shorter than the width of each bin, placing the two by fours on edge, one near each end and one near the middle. The false bottoms were made detached so they could be removed easily when the house was to be cleaned. Both sides of the scantling between the bins were slatted so as to leave an air space between the potatoes in adjacent bins. When built as described above there was a four inch air space all around each bin. The bins varied in width, the general size being three feet wide, seven feet long and seven feet high.

An ordinary sheet iron, wood stove was installed in the center of the room and connected with the chimney at one end of the room. A coal stove of the hot blast type was used the third year. It gave a more satisfactory heat than the wood stove.

COST OF REMODELING THE ROOM

The total cost of remodeling the room, which had a capacity of about six hundred bushels, including all material, labor and stove was less than fifty dollars. It will serve our purpose indefinitely.

HARVESTING THE CROP

In order to make the experiment of practicable value, the principles of correct harvesting were carefully followed. The potatoes were allowed to mature in order to produce a maximum yield and develop high quality. An immature potato is difficult to cure. If a potato is broken and the surface turns white and dries within a few minutes, it is mature and ready to dig. Frozen potatoes or potatoes from frozen vines are dangerous for human food and will not keep in storage. Therefore, our crop was harvested as soon as mature and before there was serious danger of frost. (See chart for date of first killing frost in various parts of the State.) Bruised, cut and broken potatoes are difficult to cure and store. Hence care was exercised in the methods of removing the vines as well as in digging and hauling the potatoes. A six foot McCormick hay rake was used for removing the vines; (see Fig. 9) taking two rows at a time. This cleaned the vines off the rows and left them in heaps, thus facilitating their removal from the field. The rake rarely, if ever, injured a potato, as is so often done by a cultivator or a rolling coulter. The digging implement (Fig. 5) was easily run deep enough to prevent cutting and bruising the potatoes. The pronged mould board of this digger separated the potatoes from the soil, thus preventing unnecessary handling. Neither the common "scooter" or Dixie turning plow is satisfactory, as they bruise and cut too many of the potatoes found deep in the ground. In dry, hard ground, digging was made easier by barring off one side and then running the digger under the row.

Baskets lined with old sacks were used in gathering as they prevented bruising and breaking the skin. Hay was placed in the wagon bed in lieu of springs and the potatoes were hauled to the storage house in the baskets to reduce handling to a minimum.

TIME OF HARVESTING

Table I. shows the average date of the first killing frost for Alabama for four years, prior to the date of the beginning of these experiments. The date of the first killing frost for 1914 at Auburn was November 20th; for 1915, November 16th; and for 1916, November 16th. This shows conclusively that it is not safe to wait later than November 1st to begin harvesting a large crop.

TABLE I.

Huntsville, Alabama	October 25th
Birmingham, Alabama	November 1st
Montgomery, Alabama	November 10th
Mobile, Alabama	November 20th

FILLING THE BINS

A fire was started in the storage house and doors, windows, and ventilators opened the day before digging was begun, to raise the temperature and expel excess moisture. The potatoes were hauled in each day as soon as dry. No sorting or grading was done in the field. (But should be done for best results.) The workmen filled the back of the bins first and all to the same depth when possible rather than filling one bin at a time, since the potatoes would cure slowest at the bottom where the cold moist air would naturally settle. A slatted partition was put across the middle of the long bins, thus permitting the back of the bins to be filled without walking over the potatoes in front. The partition was made in sections and set in against the cleats as the bins were filled. The partition across the middle of the bins and the gates at the ends had one inch space (see Fig. 4) between the slats to give good ventilation.

THE CURING PERIOD

In storage house, the curing required was from ten days to two weeks, depending upon weather conditions. When the weather was cool or rainy, or both, curing was retarded as the air was already saturated with moisture. It was harder to keep the temperature up to the desired degree on cold days. Moisture is given off from the potatoes much more slowly when the temperature is low and the air is more nearly saturated with moisture.

Some varieties of potatoes cured more easily than did others. The wet, juicy or sugary varieties cured much more slowly than the dry varieties. It required from three to five days longer to cure the Dooley Yam than the Triumph and Nancy Hall. The curing in these experiments was timed for Triumph. Good results were secured, however, with Nancy Hall and Porto Rico. Many other varieties were stored in the same room but the proper curing period for each variety could not be ascertained. There was consequently a greater loss from dry or soft rot among the other varieties. The cultural and other experiments seem to show that Triumph, Nancy Hall and Porto Rico are the three most valuable varieties, so no record of other varieties is given.

The curing process was considered complete when the tubers felt dry and spongy to the touch and the cut or skinned surface had formed a dry, white callous.

CURING TEMPERATURE

The air inside the storing house was kept warmer than the air outside through the curing period. If it was impossible to keep the temperature up to 80 to 85 F. during the curing period, the ventilators, door and window were kept open so as to expel the moisture and prevent it being deposited on the walls. On cool nights the house was closed.

As the storage house was not ready until after the potatoes had been dug in 1914, they were stored in the greenhouse laboratory until the house was sufficiently completed for them to be removed into it. Many of the cut and bruised potatoes had begun to decay due to this delay. The potatoes showing signs of rot were thrown out, but sound potatoes that came in contact with those already decayed were infected with spores. Hence, rotting continued to a degree in the storage house.

This, with the uncompleted overhead ceiling, largely accounts for the higher loss record for the first year. During that season unfavorable weather conditions prevailed after the digging season and the loss among potatoes stored in banks was complete in many cases through the State.

STORAGE TEMPERATURE

At the end of the curing period the house was closed tight. The temperature inside the house responded slowly to the outside temperature and was usually between fifty and sixty Fahrenheit at Auburn. During cold weather the temperature was not allowed to fall below forty degrees Fahrenheit, a fire being built and maintained as long as needed. At such times care was taken not to raise the temperature above sixty-five degrees Fahrenheit.

COMMENTS ON STORAGE RESULTS

The potatoes stored at Auburn in banks as a part of this experiment, were taken immediately from the field and banked as practiced by farmers near Auburn. Therefore, for that reason in 1914 the banked potatoes had an advantage in prompt handling over the house-stored potatoes. The records for 1915-1916 and 1916-1917 show a more accurate comparison between house and bank storage because the house once completed was ready each year and potatoes were stored as soon as dug, and cured promptly.

In addition to the work done at Auburn, Table II, part 1, arrangements were made with three farmers to cooperate on storing sweet potatoes in banks and in houses. The results of these storage tests are also shown in this table.

Note the results of the experiment in cooperation with Mrs. Bellamy, Table II, Part 2. In 1915-16 the percent of loss in banks was a little more than double that in the house, while in 1916-17 the loss in banks was nearly eighteen times that in the house. The room used by Mrs. Bellamy was one room of the servants' cottage, without floor or ceiling ventilators. A grate fire was used to secure heat for curing. The only loss

TABLE II: *Results of Storage Tests.*
Part I: Auburn Experiments.

Year	Variety Stored	Bushels in Storage House	Percent of loss by decay in house March 1st	Percent of loss by decay in house May 1st	Bushels stored in bank	Percent of loss by decay in bank March 1st
1914–15	Triumph	24	5.5	None in Storage	20	100
	Nancy Hall	35	11	None in Storage	20	100
1915–16	Triumph	107	4	7	16	11
	Nancy Hall	74	5.8	7.4	10	9
1916–17	Triumph	60	.5	1.7	9	10
	Nancy Hall	26	2	5	9	10
	Porto Rico	8 3-4	2.8	3.5	This Variety Not Banked	

Part II: Storage at Montgomery in cooperation with Mrs. Bellamy.

1915–16	Triumph	427	3	3.5	450	7.5
1916–17	Triumph	347	4.5	None in Storage	10	80

Part III. Storage at Greenville in cooperation with J. E. Helms.

1915–16	Triumph	200	2.5	Reported average of community loss by decay in banks 45%
1916–17	Triumph	300	1.5	

Part IV. Storage near Auburn in cooperation with J. A. Cullars.

1914–15	Nancy Hall	Did not have house			50	100
1915–16	Nancy Hall	100	10	None in Storage	15	80
1916–17	Nancy Hall	60	2	Would not bank		

was in the lower corners of the bins farthest from the grate, which indicates that the potatoes in that portion of the bins may not have been properly cured.

The storage at Greenville, Table II, Part 3, in cooperation with Mr. J. E. Helms, gave excellent results with an average loss of only 2 percent for the two years. The house used by Mr. Helms was a worked-over outhouse as shown in Fig. 8. Mr. Helms very kindly secured data on losses in his community from storing in banks, which was an average of 45 percent for the two years. He stated that his average loss by banking his potatoes for the past twenty-five years had been 75 per cent and that he had saved more than enough the first year in the storage house to pay for it. He also stated that the house was worth its cost because of the increased richness and sweetness of the cured potatoes.

The results of the cooperative experiments with Mr. J. A. Cullars of Auburn, as recorded in Table II, Part 4, show a total loss of banked potatoes in 1914-15. In 1915-16 he built a small house holding one hundred bushels. The house was not properly ventilated for the first few days during curing, and this probably accounts for a part of his loss of ten percent from decay. However, this loss is small when compared with the loss of 80 percent occurring in banks. His average loss for two years by banking was 90 percent as compared with 6 percent loss in his storage house. Mr. Cullars stated that even if the percent of loss were the same, the house was worth its cost because of the better quality of the cured potatoes.

STORAGE ROT

Sweet potatoes are subject to at least two types of decay in the storage house; Soft Rot (Rhizopus nigricans Ehr.) and Dry Rot (Diaporthe batatis (E. & H.) Hart and Field). If the potatoes are properly cured there is practically no danger of decay from Soft Rot. If they are over-cured there is danger of Dry Rot.

It should be stated at this time that the potatoes stored in these experiments were not sorted at gathering time. The small tubers and cut and bruised tubers were all stored together without sorting. If the small tubers and strings had been discarded, the decay would probably have been reduced to a mere fraction of that recorded, because in no instance was decay found on a tuber that did not show a cut or a bruise. If only sound marketable potatoes are put in a bin and they are properly cured, the loss from rots will be negligible.

LOSS OF WEIGHT IN CURING

One hundred and twenty (120) pounds of Triumph potatoes were selected from the field when dug November 10th, 1915, placed in the storage house and a careful record was kept of their loss in weight.

TABLE III. *Loss in Weight.*

Date	Weight in Pounds.	Weight Lost	Percent of Loss
1915			
Nov. 10	120.		
Nov. 11	118.2	1.8	1.5
Nov. 12	117.	3.	2.5
Nov. 13	116.1	3.9	3.25
Nov. 15	114.5	5.5	4.58
Nov. 16	113.85	6.15	5.12
Nov. 17	113.25	6.75	5.62
Nov. 18	112.86	7.14	5.95
Nov. 19	112.28	7.72	6.43
Nov. 20	111.95	8.05	6.70
Nov. 22	111.25	8.75	7.29
Nov. 23	110.74	9.26	7.71
Nov. 24	110.53	9.47	7.89
Nov. 25	110.16	9.84	8.2
Nov. 26	109.82	10.18	8.48
Nov. 27	109.45	10.55	8.79
Nov. 29	108.85	11.15	9.29
Nov. 30	108.65	11.35	9.45
Dec. 1	108.40	11.60	9.66
Dec. 2	108.20	11.80	9.83
Dec. 3	108.	12.	10.
Dec. 4	107.70	12.30	10.23
Dec. 6	107.20	12.80	10.66
Dec. 7	107.	13.	10.83
Dec. 8	106.85	13.15	10.96
Dec. 9	106.40	13.60	11.33
Dec. 10	106.10	13.90	11.5
Dec. 11	105.80	14.20	11.83
Dec. 13	105.55	14.45	12.04
Dec. 14	105.10	14.90	12.41
Dec. 16	104.80	15.20	12.66
Dec. 20	103.80	16.20	13.5
Dec. 21	103.30	16.70	13.91
Dec. 23	103.15	16.85	14.04
Dec. 24	103.	17.	14.16
Dec. 25	102.85	17.15	14.29
Dec. 27	102.35	17.65	14.7
Dec. 30	102.	18.	15.
1916			
Jan. 1	101.	19.	15.83
Jan. 14	99.	21.	17.66
Feb. 1	95.	25.	19.83
Feb. 14	93.80	26.20	21.83
Mar. 13	90.10	29.90	24.92

A set of standard scales weighing to the one-hundredth of a pound, was used to secure the above data. The package which was of slatted construction, was placed on the scales in the storage room and was not removed until the end of the experiment.

The first five days show a loss of 5.5 pounds moisture with an average temperature of 84 F., while during the next five days under an average temperature of 62 F., there was an additional loss of only 2.22 lbs., or only 40 percent of the rate during the first five days at the higher temperature. Notice chart of November, 1915, when the temperature was low and the humidity high, the loss of moisture was lowest, as shown November 20, 24, 30, December 34 and 27 to 30.

The evaporation of excess water immediately following storage constitutes curing. The rate of evaporation is evidently influenced by the percentage of excess moisture in the potato and also by the temperature and percent of moisture in the air at any time.

HEATING AND VENTILATING

For the first two years a large, sheet-iron wood stove was used for producing heat. This type of stove is very hard to regulate. If too much draft is given, the stove is soon red-hot; if too little draft is given, combustion ceases and the room cools rapidly. These facts are evidenced by the extreme high and low temperatures as shown by records during the first year and a similar temperature record for the second year, except that, apparently due to the repair made to the ceiling, the room did not cool quite as much at night. There was greater uniformity of both temperature nd humidity for the third period due to better construction, to the use of the coal stove and to the less frequent opening of the storage room. The superior results secured during the third year indicate that it is better not to open the house or to build fires as often as had been done during the previous two years. In the third year after the curing period fires were built but twice as a protection against freezing temperature and the room was rarely ventilated except for the few moments when visitors were shown into the building and when the temperature and humidity records were made at the end of each week.

The cost of fuel for heat the third year to cure the potatoes stored in house shown in Fig. 3 was about two dollars.

HUMIDITY

The humidity records show that the degree of humidity at no time passed the ninety degree mark and that during the third year, when the crop kept better than at any other period, the degree of humidity was almost constantly at or between 80 and 90 degrees. It is entirely likely that if the curing has been perfectly done at the curing period, a lower degree of humidity would cause a constant loss of moisture in the potatoes to a greater degree than would be desirable. Therefore, the practice of opening the house on warm, dry days during the first two seasons, thus admitting the dry air from the outside, was of doubtful value.

The atmosphere in the bank often reaches the point of saturation as shown by sweating. But our records show that in the house the air is usually twenty percent short of saturation. And the weight table shows a gradual loss of moisture in cured stored potatoes throughout the storage period.

Practical growers claim that potatoes stored in banks are inclined to become "watery" during the warm, late winter weather, thus not only lowering the quality of the potato for use as food, but increasing the probability of decay.

TEMPERATURE AND HUMIDITY RECORDS

In order to secure an accurate record of the temperature and humidity in the house during the curing and storage period, a recording standard Thermo-hygrograph was installed. These records for three years are shown in Table IV. It is noticeable that the fluctuation in temperature was much more sudden and extreme during the curing period the first and second years, when a wood stove was used, than during the third year when a coal stove was used and the humidity records also vary in consequence. The curing was most satisfactory during the third year when the most uniform temperature and humidity conditions were maintained inside the house. It is noticeable that the temperature in the house for all practicable purposes is a mean or average between the daily extremes of temperature prevailing outside. Abrupt changes in temperature, shown for various dates after the curing was complete, were due to opening the house when ventilation was supposed to be needed or to the building of fires when the outside temperature seemed to indicate a freeze.

TABLE IV. *Temperature and Humidity Records in Storage House at Auburn.*

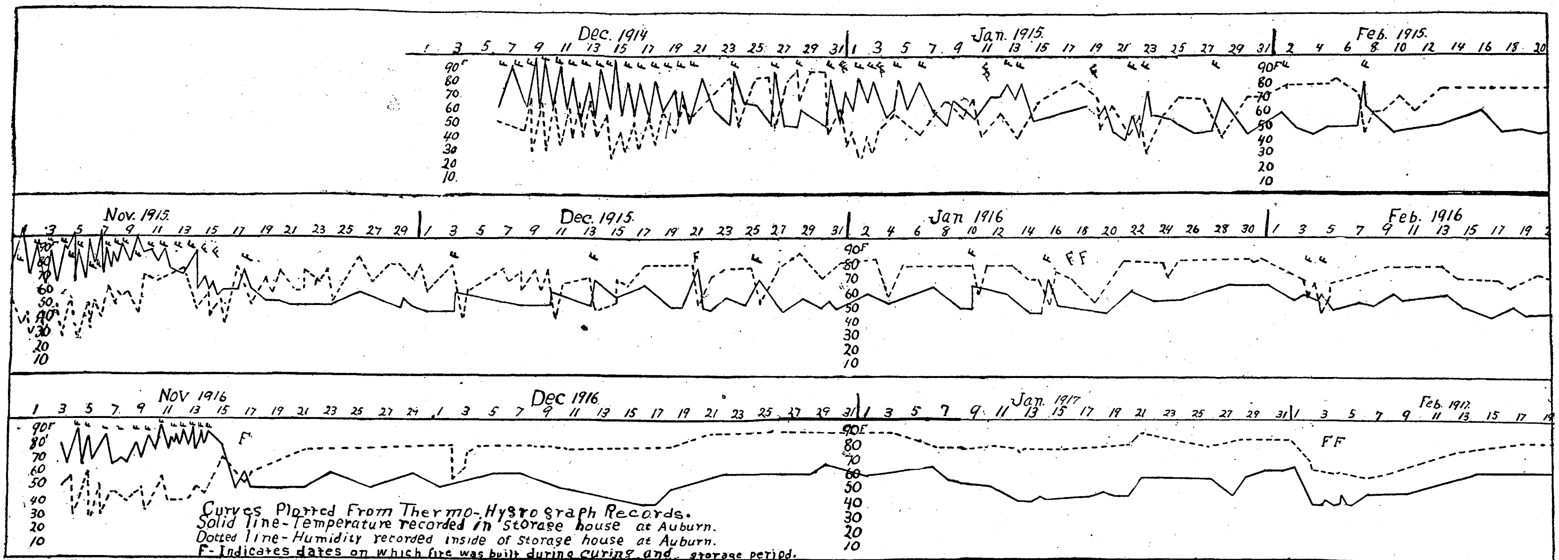
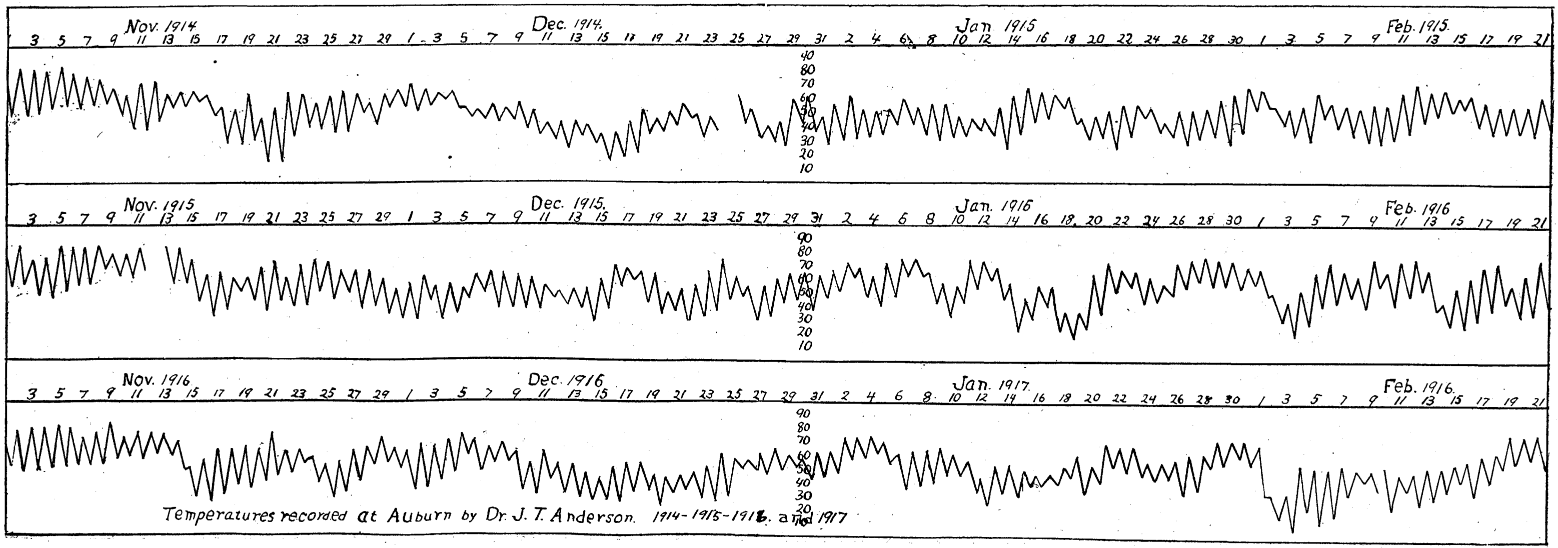


TABLE V. *Temperature Records Outside of Storage House at Auburn.*



SUMMARY

The results of these experiments seem to show that potatoes can be cured sufficiently in ten days to two weeks, but there is a continuous loss of moisture even when the humidity is from eighty to ninety degrees.

There is a vast difference between a banked potato and a cured potato stored in a dry room. The latter is sweeter and firmer and will undoubtedly ship to any reasonable distance by freight. Potatoes cured at Auburn the past winter were mailed to Honolulu,Hawaiian Islands, a distance of three thousand miles by rail and two thousand miles by boat, and requiring nearly a month for the trip, arrived in good condition and were bedded for plants with excellent results. A Triumph potato of the 1915 crop is lying in the office on this date, August 25th, 1917, and sending out good sprouts. There are many of the 1916 crop on hand in perfect condition for food or bedding.

A part of the 1916 crop was canned in February and made a fair canned product, although not as clear in color as the freshly dug potatoes.

Storage potatoes, because of their excellent condition and freedom from decay, are superior for bedding to those kept in banks.

PLANS AND SPECIFICATIONS FOR A HOUSE, 20x20 FEET WITH 1250 BUSHELS CAPACITY

The following suggestion for the building of a new storage house will prove valuable to those who have no house that can be remodeled.

Plans for constructing a new house are shown in Figs. 1 and 2. Good material should be used in building the frame work of the house as it must support considerable weight when the house is filled. A row of brick, or cement, pillars should be placed ten feet apart under each side and under the middle of the house. These pillars should be at least eighteen inches high so as to give good ventilation under the building. The sills should be six by eight inches and the joists two by eight inches, or two by ten inches and free of knots. If the house is to be weather boarded the studding should be placed two feet apart, while if the house is planked up and down, the studding may be further apart with two lines of purlins running around the house, properly spaced between sill and plate. In Alabama, except in the Northern portion, a house built with building paper tacked on the studding inside and out and ceiled inside with flooring and planked up and down on the outside with cracks stripped, will be sufficiently warm. Those preferring a warmer house should put on storm sheeting on the outside of the two by fours, building paper and weather boarding.

The floor and ceiling should be double, with paper between. The first floor may be made of six or eight inch boards with edges fitting close together. The second floor should be of matched lumber, tongued and grooved and laid at right angles to the first. If the roof is constructed by using boards, with edges close for sheeting and covered with rubber roofing so as to prevent the air coming in, a single ceiling with paper is sufficient.

The floor should extend out against the outside wall in order to make a perfect dead air space and prevent rats getting between the walls. Do not fill the space between the walls with sawdust, or other materials, as the dead air space is better.

The plan as shown in Fig. 1 should have a door at one end and a window at the other. If a larger house is built a door should be placed at either end. The bins should be placed four inches from the walls at the back of the bins and six inches at the side of the bins, so as to allow circulation of air. A little more room is required at the sides so as to open and close the floor ventilators. Some plans call for eighteen inches of space at the end of the house between walls and bins so that the ventilators may be opened and closed by hand. By making a long handle of one inch by one inch strip and attaching to ventilator, the ventilators may be opened and closed from the passage way, thus giving bin space for one hundred and eighty bushels of potatoes.

In a twenty by twenty foot house there should be a ventilator in each corner of the house, as shown in Fig. 1. These ventilators should be six inches wide and twelve to fifteen inches long and fit with a sliding lid that may be opened or closed at will. An eight by eight inch or ten by ten inch ventilator should be placed overhead in center of room, as shown in Fig. 3, and covered to keep out the rain. These are easily made by nailing together in box fashion and extending the box through the ceiling and roof. The lower end of the box should be provided with a closely fitting door or shutter which may be closed when desired.

The following is a list of material necessary to build a sweet potato storage house as shown in Figs. 1 and 2:

8	pieces	4x4 x10	posts	100 ft.
74	pieces	2x4 x10	studding	493 ft.
5	pieces	6x8 x20	sills	400 ft.
11	pieces	2x8 x20	floor joists	294 ft.
11	pieces	2x6 x20	ceiling joists	220 ft.
32	pieces	2x4 x12	rafters and purlins	256 ft.
90	pieces	1x12x10	outside boards	900 ft.
90	pieces	1x3 x10	strips for outside wall	225 ft.
90	pieces	1x6 x20	rough floor and ceiling boards	900 ft.
30	pieces	1x12x20	sheeting for roof	600 ft.
			*Ceiling and flooring	2000 ft.

2400 sq. ft. of building paper.
5 squares of rubber roofing.
1 stove.
Hinges for doors and windows.
400 brick for flues and pillars.
50 pounds of nails.
1 flue hanger.
2 loads of edging strips for bins.
Approximate cost of material, $145.00.

*For ceiling and flooring use second grade flooring as it is cheaper and much more satisfactory. Cut out all unsound knots.

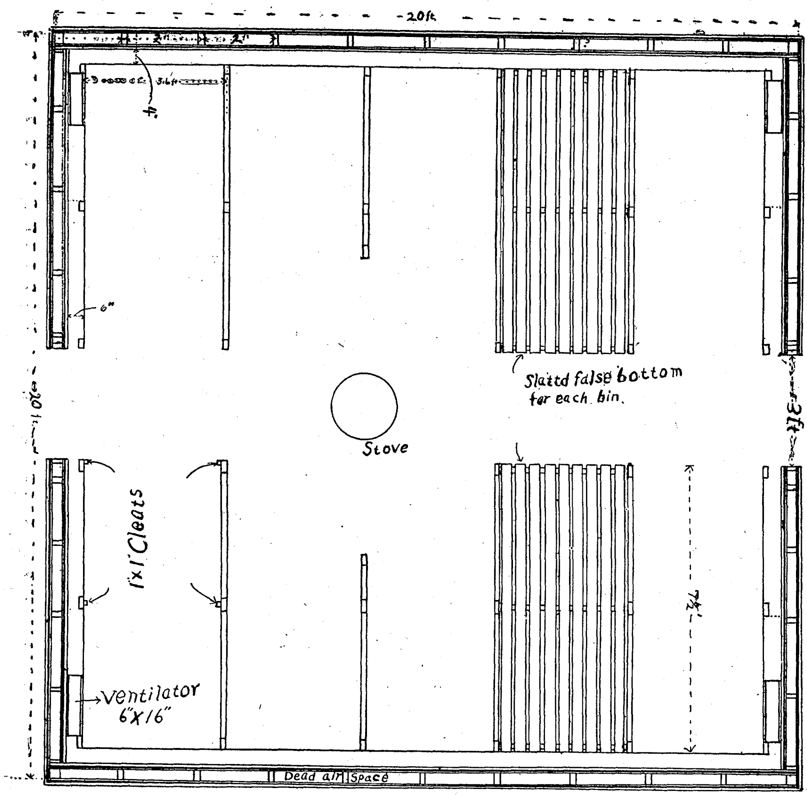


Fig. 1. Floor plan, 20x20 curing and storage house. Capacity, 1250 bushels.

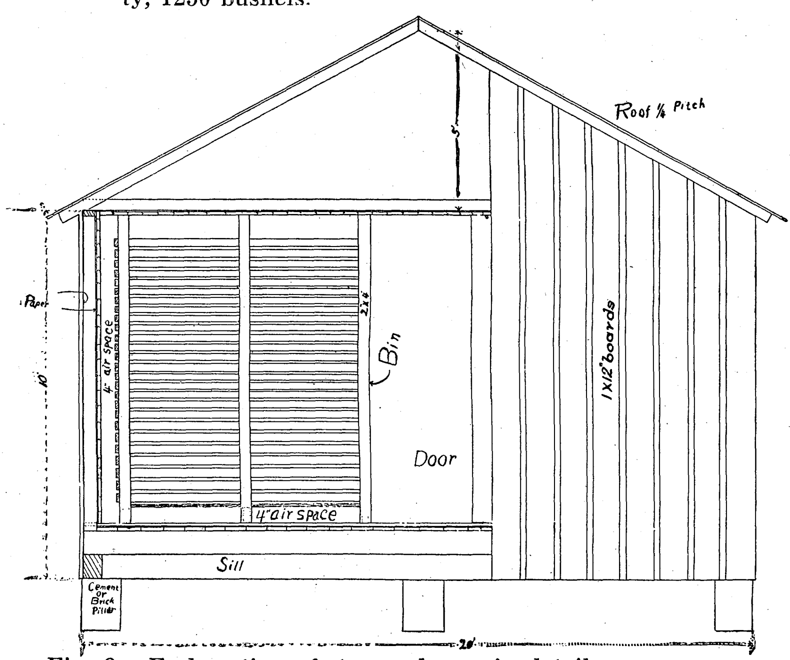


Fig. 2. End section of storage house in detail.

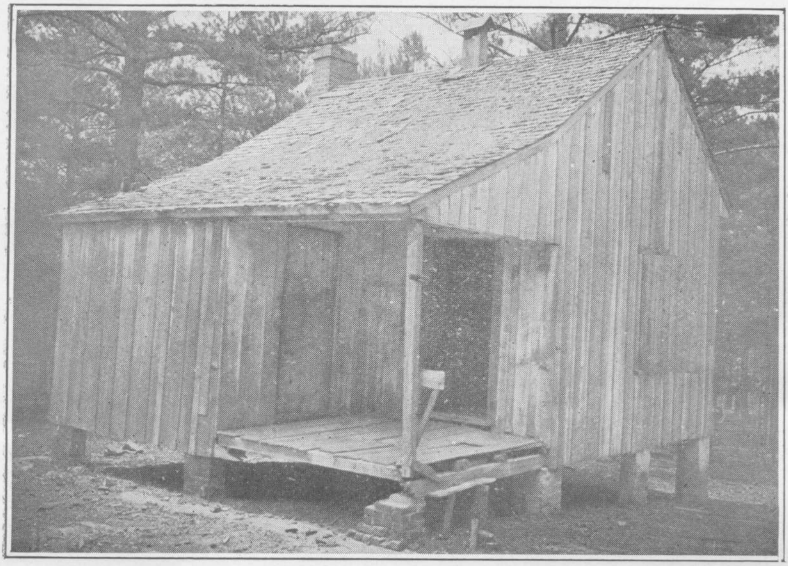


Fig. 3. Negro cabin on Station farm converted into storage house for experimental storage. Chimney used instead of building a new flue over the stove. Total cost, including stove, $42.00.

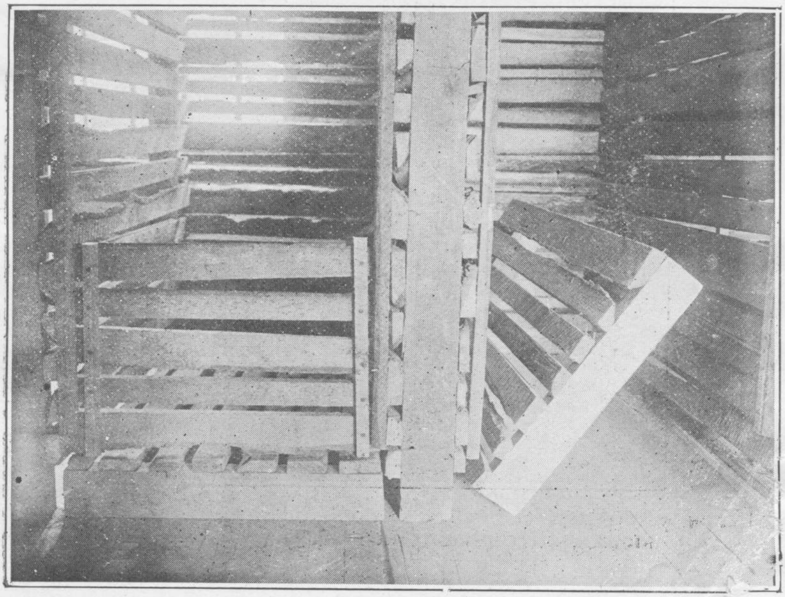
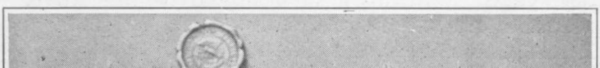


Fig. 4. Bins, showing end of gates and removable slatted bottom. Note saw mill edging strips used for constructing these bins.

PLATE II.

Fig. 5. A good digging outfit.



Note perfect healing of cuts and bruises. Photo eight months after placing in storage.

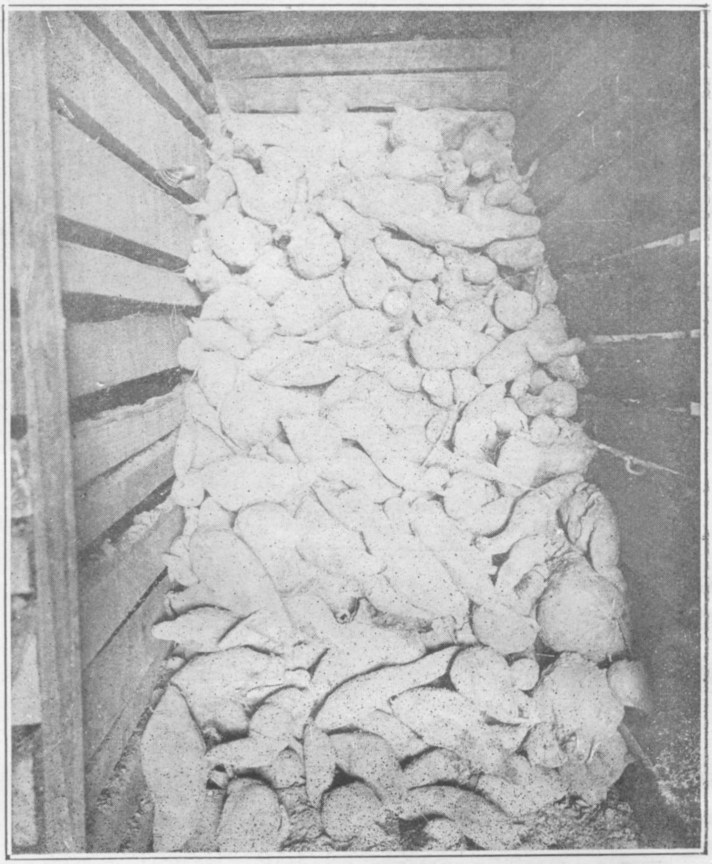


Fig. 7. Triumph potatoes in bin June 1st, 1916. Note cut ends which healed perfectly. Photo eight months af- ter storing. This bin of potatoes was marketed in perfect condition in June.

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nstruct-

PLATE IV.

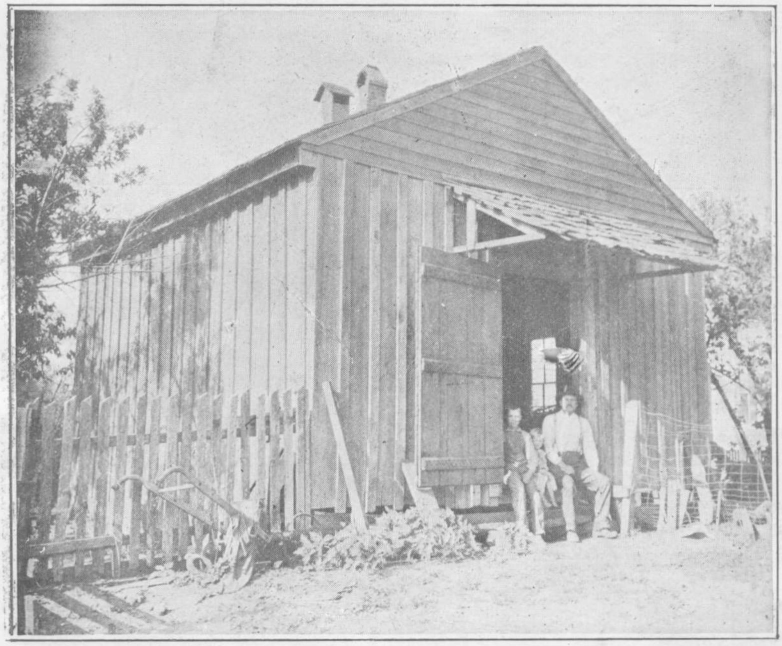

Fig. 8. Storage house used by J. E. Helms, Greenville, Ala. Note double door, flue and ventilator.

Fig. 9. Hay rake method used at Auburn to remove vines.