MP-172

Storing Flaxseed in Farm-type Bins in South Texas

June 1956

TEXAS AGRICULTURAL EXPERIMENT STATION

R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

SUMMARY

Research was conducted by the Texas Agricultural Experiment Station near Beeville to develop methods and procedures for maintaining the quality of flaxseed during storage. The study included drying tests with two types of batch dryers and a bin dryer.

The fastest time of drying in a column-type batch dryer was obtained with air volumes of 80 to 85 cubic feet per minute (cfm) per square foot of column area. The air temperatures found to be the most efficient for drying seed to 8 percent moisture were 150° F. for seed with an initial moisture content of 9 to 11 percent of 175° F. for seed with an initial moisture content of 15 to 18 percent.

A portable batch dryer was used to dry seed at 12 and 18-inch depths. Air volumes used ranged from 27 to 40 cfm per square foot of floor area. The highest capacity for drying seed from an average of 13.2 to 8 percent moisture was obtained with a drying air temperature of 175° F. and at a depth of 12 inches. The air temperature found to be most efficient for drying seed from an average of 10.4 to 8 percent moisture was 175° F. The rate of drying was about the same for an 18-inch depth as for a 12-inch depth.

Flaxseed were dried at a 3.5-foot depth in a round steel bin. Heated air was supplied at a rate of 6.7 cfm per bushel. These tests indicate that the most economical drying can be obtained when the drying air temperature does not exceed 7 to 10° above the outside air temperature and the depth of the seed is 3 to 4 feet.

A good, tight structure is essential to protect seed from the weather, insects and rodents. Conventional wood and steel bins of proper construction were satisfactory for storing flaxseed.

With mechanical aeration, clean flaxseed, with an initial moisture content of 8 percent or less, stored in farm-type bins did not change in grade after 10 months' storage. No significant decrease in germination or increase in acid number occurred during storage.

The difference in temperatures in bins used in these tests was not great enough to have any important effect on quality as measured by germination and acid number.

Flaxseed with a maximum moisture content of 8 percent were stored in burlap bags under normal farm conditions for as long as 9 months without loss in germination or serious increase in acid number.

Flaxseed with initial moisture as high as 9.2 percent were kept in a cold storage room 8 to 9 months without loss in germination or increase in acid number. Air temperature and relative humidity in the room averaged 40 to 48° F. and 78 to 95 percent, respectively. For longer periods of storage, a maximum relative humidity of 60 percent is recommended.

Few insects were found in low-moisture-content flaxseed that was of good quality and free from "trash." In some instances, however, insects were a problem and their control should be considered when storing flaxseed.

Rats and mice were difficult to control and no doubt were responsible for considerable losses. Effective control can be obtained through approved rodent control procedures.

Losses in weight during storage were 2.1 to 3.8 percent.

A 21-foot auger operated by a 3-horsepower electric motor was used for loading and unloading the bins. The loader handled an average of 30,000 pounds of flaxseed per hour in moving seed from trucks to storage bins.

Storing Flaxseed in Farm-type Bins in South Texas

J. W. SORENSON, M. G. DAVENPORT and G. L. KLINE*

THE MAIN FLAX-GROWING AREA OF TEXAS EXTENDS roughly from San Antonio east to Houston and south to Brownsville. Over 2 million acres in this section are well suited for flax production. Flax also has been grown in recent years in the Austin-Waco-Brady-Abilene area. The harvested acreage increased from 1,000 in 1938 to 329,000 in 1949. A severe drouth since 1950 has caused considerable reduction in acreage.

Flax harvest in South Texas usually starts the last week of April or the first week of May. This is a period of high humidity and of rising temperatures. Excessive moisture at the time of harvest and lack of satisfactory methods of storing the crop often lead to serious deterioration in quality.

Research on the storage of flaxseed was started by the Texas Agricultural Experiment Station near Beeville in 1950. The objectives were: (1) to develop practical methods for drying; (2) to determine types of structures suitable for maintaining the quality of flaxseed during storage; (3) to determine the maximum moisture content at which flaxseed could be stored safely in bulk and in sacks; (4) to determine the effect of storage during the summer on the oil content of the seed; (5) to develop methods and procedures for preventing loss in quality during storage; and (6) to determine the extent of insect infestation during storage and find effective methods of control.

GENERAL PLAN

This study included two phases—drying high-moisture flaxseed and storing the dry seed. Results were obtained for 4 crop years.

Drying

Drying tests were conducted with two types of batch dryers and a bin dryer.

Batch drying means drying seed in layers 10 to 18 inches thick. This method requires large volumes of heated air and is used when high drying capacities are desired. Seed dried by this method must be transferred to another bin for storage.

Bin drying means drying seed in storage bins at depths of 3 to 8 feet. The seed usually are dried in the same bin in which they are stored. Drying can be done with heated or unheated air. Heated air was used in these tests.

*Respectively, associate professor and assistant professor, Department of Agricultural Engineering, College Station, Texas; and formerly agricultural engineer, U. S. Department of Agriculture, Beeville, Texas.

Bulk Storage

Flaxseed were stored at different moisture contents at Substation No. 1 near Beeville to determine the best procedure to follow for successful storage. Eight farm-type bins were used. The bins had capacities of 500 to 1,000 bushels and were constructed of wood and steel. Shapes were round and rectangular. Seed depths ranged from 6 to 10 feet. Air distribution systems were installed in some of the bins to provide a means of cooling the seed by mechanical aeration during storage.

Temperature observations were made at regular intervals during the storage period. Samples for moisture content, grade, acid number, iodine number and germination were taken as the seed were stored and at intervals during the storage period. Acid number is a measure of the quality

CONTENTS

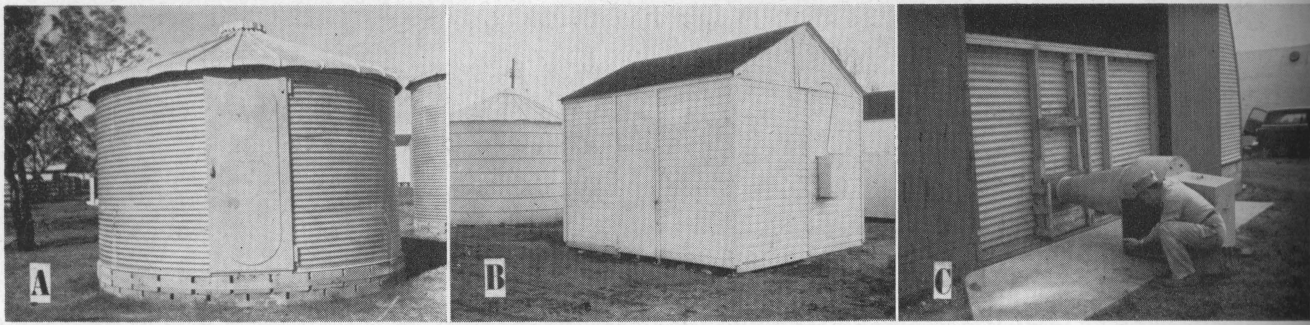

Figure 1. Types of bins used in the flaxseed drying and storage tests. A. Two 625-bushel and two 1,000-bushel capacity round steel bins, such as shown, were included. B. A bin of 500-bushel capacity was constructed in each end of this 14 x 16-foot wooden building. A separate 1,500-bushel capacity bin also was used. C. Pulling air through this 900-bushel capacity bin, constructed in a 32 x 60-foot Quonset, provided a means of checking the temperature of the seed and of detecting any "off" odor that may have developed.

of seed. It refers to the number of milligrams of alkali that are necessary to neutralize the free fatty acids that are present in 1 gram of oil. Flaxseed with an acid number of 4 or less are considered sound and satisfactory for obtaining high quality oil. Iodine number is a measure of the drying ability of an oil. Oil with a high iodine number will dry faster than an oil with a low iodine number.

Sack Storage

Flaxseed were stored in burlap bags at Beeville and College Station. Seed were stored under normal farm conditions and in a cold storage room.

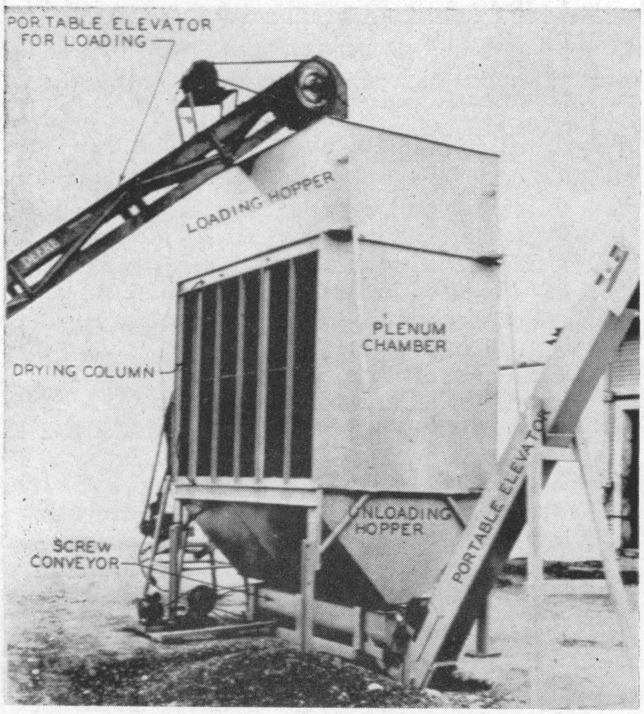

Figure 2. This column-type dryer was used to dry high-moisture flaxseed. The drying unit consisted of two vertical columns separated by an air chamber. Each column was 6 feet high, 9 feet long and 10 inches thick. The holding capacity of the dryer was about 4,400 pounds, dry basis.

Instruments

A portable potentiometer and copper-constantan thermocouples were used to determine temperatures at various locations in the seed in both bulk and sack storage tests. A Steinlite moisture tester was used for all moisture determinations. A deep bin drier was used to obtain samples for moisture content, grade, germination and chemical analysis. Recording instruments were used to obtain continuous records of atmospheric temperatures and relative humidities. Manometers were used to measure air pressures.

Flaxseed

Approximately 415,000 pounds of brown and golden seed were used during the 4-year period the tests were conducted. Usually the two kinds were mixed when received for the tests. Initial moisture contents varied from 6 to 18 percent, wet basis.

Flaxseed used during the first 3 years were furnished by Archer-Daniels-Midland Company,

Figure 3. This portable batch dryer, used in the studies, consisted of a drying bin 7 by 14 feet with walls 6 feet high. A perforated steel floor separated the drying bin from an air chamber. Seed were loaded to the desired depth on the drying floor and heated air was forced into the air chamber and through the seed until the moisture content was reduced to a safe limit.

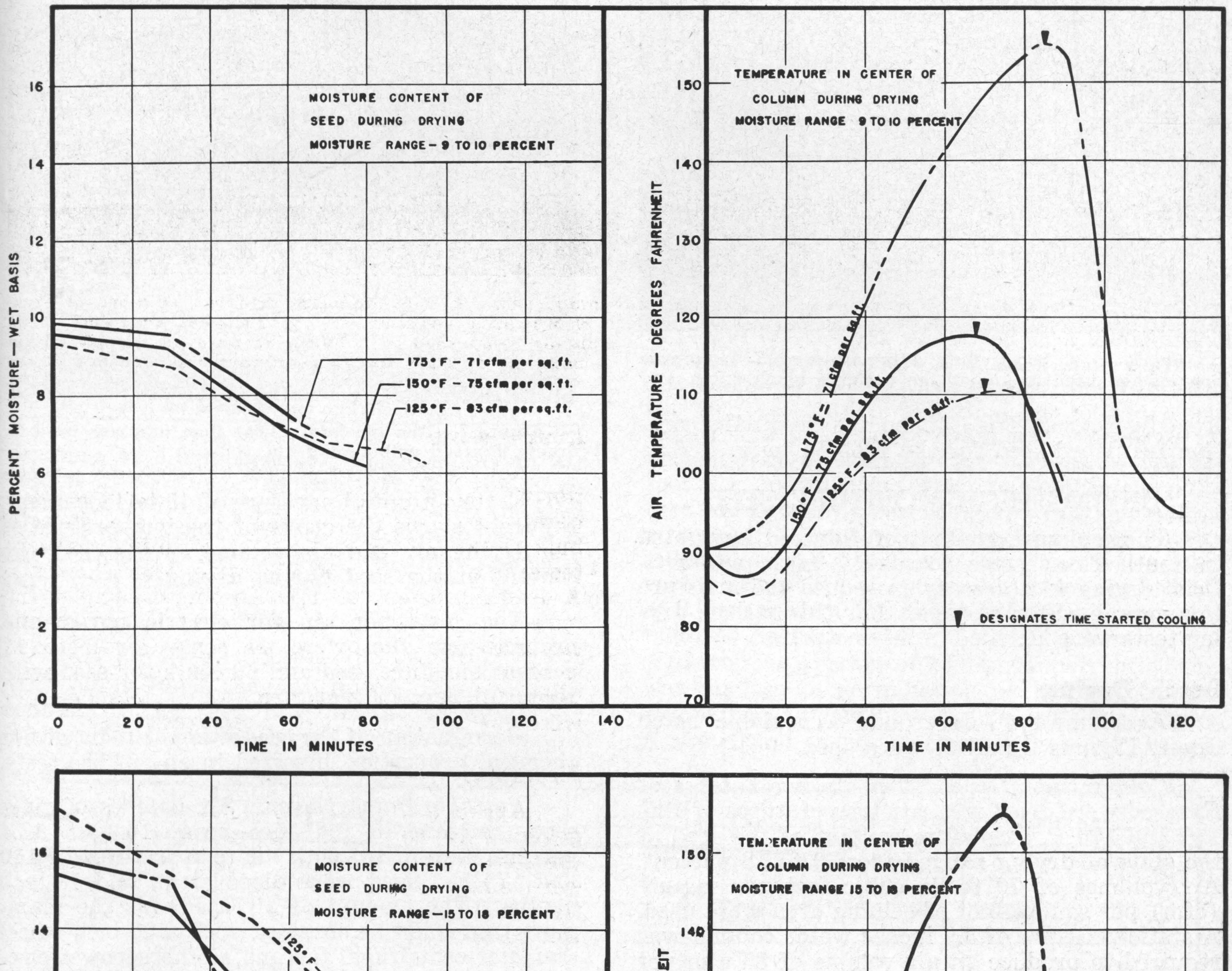

Figure 4. Air temperatures found to be most efficient for drying flaxseed below 8 percent moisture in a column-type dryer were 150° F. for seed with an initial moisture content of 9 to 11 percent (top) and 175° F. for seed with an initial moisture content of 15 to 18 percent (bottom).

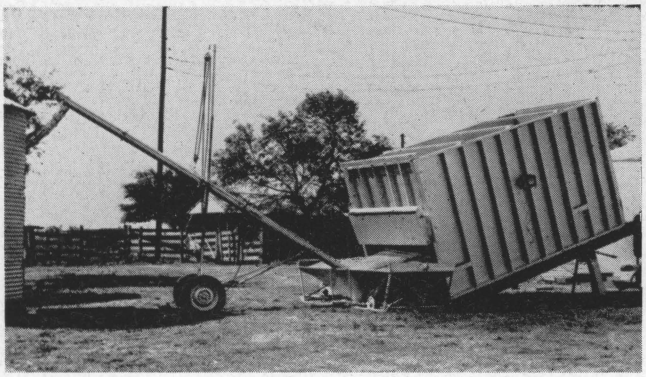

Figure 5. A heavy duty hydraulic wagon dump was one method used to unload the portable batch dryer.

Kenedy, Texas. The Commodity Credit Corporation furnished seed for the 1953-54 tests.

DRYING HIGH-MOISTURE SEED

The moisture content of flaxseed harvested in South Texas some seasons is high, and artificial drying is necessary to reduce the moisture to a safe level for storage. For this reason, drying tests were included in these studies.

Batch Drying

A column-type dryer and a portable batch dryer, Figures 2 and 3, were used.

Column-type Dryer. Twenty-two batches of flaxseed were dried with air temperatures of 125, 150 and 175°F. Moisture content of the seed at the start of drying ranged from 9 to 18 percent. Air volumes of 70 to 85 cubic feet per minute (cfm) per square foot of column area were used. A static pressure of 3.9 inches water column was required to produce an air volume of 85 cfm per square foot.

The fastest time of drying was obtained with air volumes of 80 to 85 cfm per square foot. The most efficient air temperatures for drying seed below 8 percent moisture were 150°F. for an initial moisture content of 9 to 11 percent and

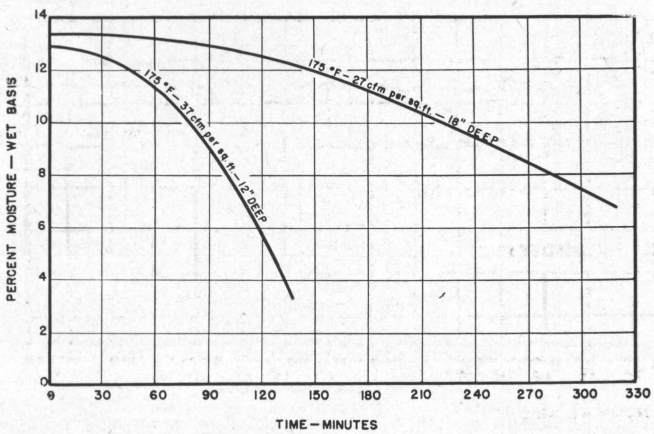

Figure 6. With a portable batch dryer, flaxseed were dried at a 12-inch depth in about one-third the time required to dry seed 18 inches deep.

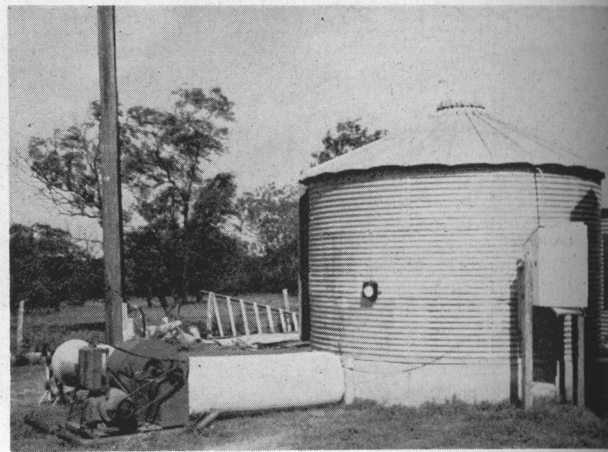

Figure 7. This bin had a false floor and was used for drying flaxseed with heated air.

175°F. for an initial moisture of 15 to 18 percent. Figure 4 shows the effect of the temperature of the drying air and air volume on the moisture content of the seed during drying.

The costs per ton for electric power and propane gas fuel were 44 cents for 9 to 11 percent moisture seed and 60 cents for seed with 15 to 18 percent moisture.

Germination of the seed was not reduced nor chemical properties impaired in any of the tests.

Portable Batch Dryer. Six batches of flaxseed, ranging in moisture from 10.3 to 13.4 percent, were dried with air temperatures of 150 and 175°F. Seed were dried at 12 and 18-inch depths. The amount of air used was the maximum that could be obtained with a 30-inch wheel diameter centrifugal fan and a 5 horsepower electric motor. Air volumes obtained ranged from 27 cfm per square foot of floor area for an 18-inch depth of seed to 40 cfm per square foot for a 12-inch depth. The fan operated against a static pressure of 4.6 inches water column.

When seed with initial moisture contents of 13.0 to 13.4 percent were dried with an air temperature of 175°F., the highest capacity was obtained when the seed were 12 inches deep. As shown by Figure 6, seed at a 12-inch depth dried in about one-third of the time required to dry seed 18 inches deep. The costs for fuel and power were about the same for both depths. The highest capacity for drying seed with initial moisture contents of 10.3 to 10.5 percent was obtained with a drying air temperature of 175°F. The rate of drying was about the same for an 18-inch depth as for a 12-inch depth. Operating costs per ton for propane fuel and electricity were 39 cents for a 12-inch depth and 43 cents for an 18-inch depth. There was no indication of loss in germination or increase in acid number from any of the treatments used.

An attempt was made to dry a 10-inch depth of seed testing 10.5 percent moisture. A static

TABLE 1. BIN DRYING WITH HEATED AIR

Weight before drying, pounds	23,350
Weight after drying, pounds	21,600
Bushels, dry seed	390
Depth of seed at start, feet	3.5
Average moisture content, wet basis, percent	
Before drying	13.2
After drying	7.1
Average air temperature, deg. F.	
Plenum chamber	110
Outside	73
Average relative humidity, percent	
Plenum chamber	23
Outside	72
Calculated air volume, cubic feet per minute	
Total	2,600
Per square foot of floor area	17
Static pressure in plenum chamber, inches of water	6.0
Total hours fan operation	55
Total time air heated, hours	31
Cost per bushel for propane fuel and electricity, cents	4.1

pressure of 4.0 inches, corresponding to an air volume of 43 cfm per square foot, was the maximum that could be used without blowing the seed off the dryer floor. From this standpoint, it is not practical to dry flaxseed less than 12 inches deep with this type of dryer.

Bin Drying

In a bin dryer, seed usually are dried in the same bin in which they are stored. The moisture content of the seed next to the incoming air changes first, and the drying progresses in stages according to the direction of air flow through the seed. There usually is greater variation in moisture from the bottom to the top with heated air than with unheated air. Less variation in moisture is obtained when the drying air temperature does not exceed 7 to 10° above the outside air temperature. This results in slow drying rates, but this method should not be used when the time of drying is important. When high capacities are desired, a dryer similar to the column-type dryer or the portable batch dryer, described previously, should be used.

One lot of seed was dried in a 1,000-bushel capacity bin equipped with a false floor, Figure 7. Air heated to 110°F. was forced through the seed for 36 hours. After that time, the moisture content of the seed varied from 3.6 percent in the bottom foot of seed to 12.8 percent in the top foot. An attempt was made to equalize the moisture in the bin by reversing the fan and pulling atmospheric air down through the seed. After pulling air for 29 hours, the moisture content varied from 5.0 percent in the bottom of the bin to 8.0 percent in the top. Fifty-five hours were required to reduce the moisture content of the seed from an average of 13.2 to 6.5 percent. There was no loss in germination or increase in acid number in samples taken before and after drying. A significant increase occurred, however, in acid

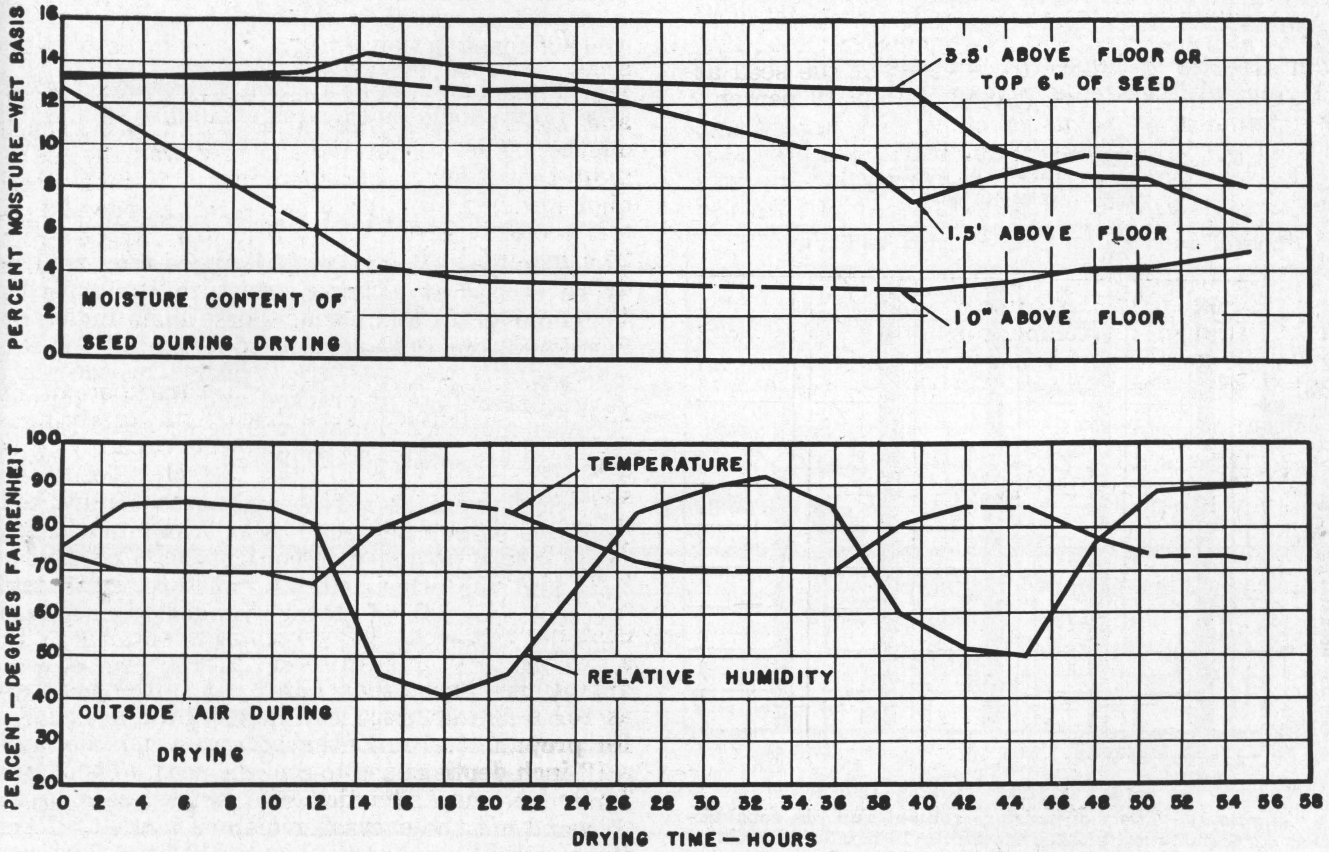

Figure 8. Flaxseed were dried at a 3.5-foot depth in a round steel bin. Heated air was forced through the seed for the first 36 hours. Drying was completed by pulling unheated air through the seed. Top graph shows moisture content at different levels during drying. Note wide variation in moisture caused by the use of heated air. Bottom graph shows the outside temperature and relative humidity during the test.

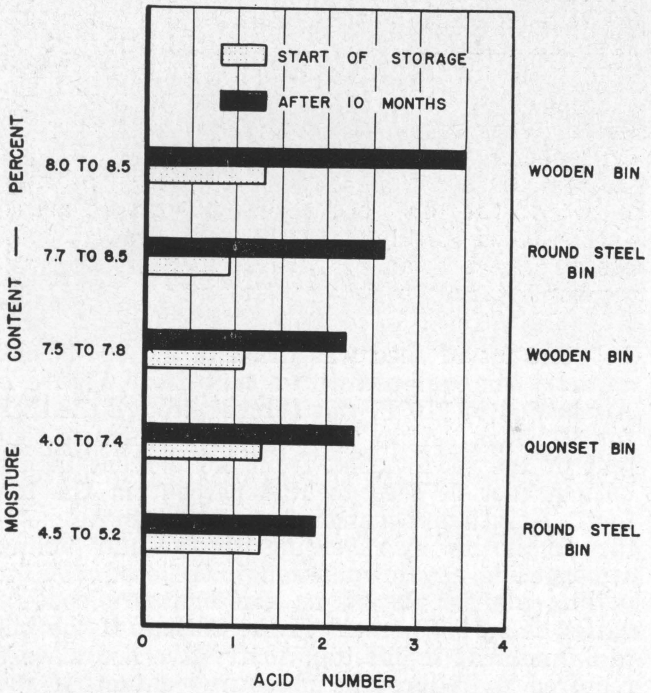

Figure 9. Effect of moisture content and bin construction on the acid number of seed stored for 10 months in 1952-53.

number in the top portion of the bin during the first 2 months storage. Results of this test are summarized in Table 1.

Greater volumes of air are required for drying with heated air than with unheated air.

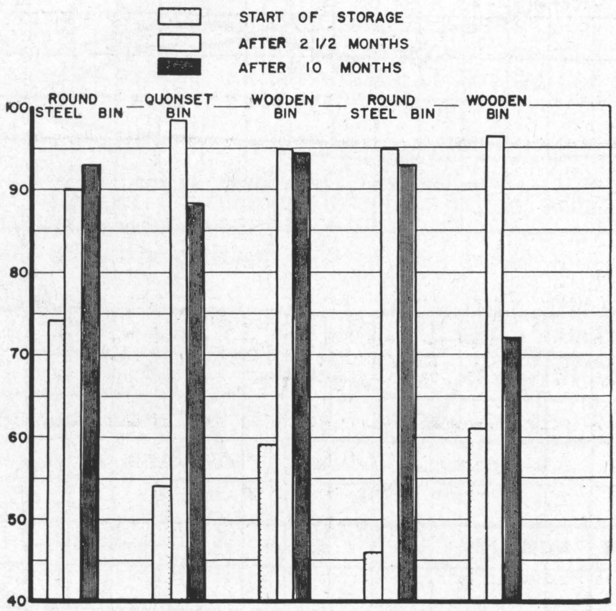

Figure 10. Effect of moisture content and bin construction on germination of seed stored for 10 months in 1952-53. Loss in germination in the Quonset bin was caused by leakage of outside moisture. High temperature areas developed in the wooden bin filled with 8.0 to 8.5 percent moisture seed. Mechanical aeration was effective in reducing temperatures, but did not prevent loss in germination.

In this test, heated air was supplied at a rate of 6.7 cfm per bushel through a 3.5-foot depth of seed. With this high rate of air flow, it usually is necessary to limit the depth to 3 to 4 feet in order to do the most economical drying. As the depth of seed is increased, the power requirements and equipment costs increase rapidly.

STORING FLAXSEED IN BULK

Most losses during storage were caused by high moisture conditions—either from leakage of outside moisture through bin walls or from storing high moisture seed.

Bin Construction

A good, tight structure is essential to protect seed from the weather, insects and rodents. Conventional wood and steel bins provide good storage if they are kept tight.

Wooden bins with single walls usually are not tight enough to exclude moisture or prevent loss of fumigants. Single-wall bins can be made tight by lining the walls with reinforced paper or roofing felt. It usually must be repaired before each filling of the bin.

Serious damage to the seed in steel bins can be caused by leaks around bolt heads and around the wall joints. All joints between roof sections and wall sheets require careful caulking at the time of construction.

Bins should be located on well-drained areas. The floor should be elevated enough so that water cannot collect and leak through the floor-wall joint.

Moisture Content of Seed

The high oil content of flaxseed requires that it be stored at a lower moisture content than sorghum grain and corn. These tests indicate a maximum moisture content of 8 percent for safe storage. If the seed are "trashy" or contain a large percentage of cracked and broken kernels, a lower moisture content will be required than if the seed are clean and sound.

Seed were stored at average moisture contents of 5 to 9 percent. About half of the lots were stored at moisture contents of 8 percent or less and the other half at moistures of 8 to 9 percent. Length of storage ranged from 4 to 10 months.

Eight Percent or Less. At initial moisture of 8 percent or less, clean flaxseed did not change in grade after 10 months' storage when mechanical aeration was used to cool the seed. This 8 percent maximum should be the wettest seed in the bin and not the average moisture content. Moisture content usually was lowered 0.5 to 1.0 percent during storage because of the slow rate of moisture loss during aeration. No significant decrease in germination or increase in acid number occurred during storage. The iodine number usually was above 180 at the start of storage and showed no significant change during storage. The changes in test weight were commercially negligible.

Eight to 9 Percent. Flaxseed stored 7 to 10 months with moisture contents of 8 to 9 percent heated 1 to 2 weeks after storage. Frequent aeration was necessary during the summer and fall to reduce high temperature areas. Mechanical aeration during storage caused average moistures to decrease 1.0 to 1.5 percent. No loss in grade occurred in any of the tests, but there was a considerable decrease in germination and increase in acid number. No significant change occurred in iodine number and test weight.

Temperature

The temperature of low-moisture seed during storage is a good indication of its condition. Low temperatures are desirable to prevent loss in germination and increase in acid number.

Variation during Storage. Typical temperatures of flaxseed with low moisture content for different types of storages are shown in Figure 11. Mechanical aeration was used to cool the seed in the metal and Quonset bins. Seed in the wooden bin were not aerated during storage. Average moisture contents were 5.0 to 7.4 percent. Seed temperatures were not reduced below 85 to 90°F. in any of the bins during the summer. They dropped below this level the last part of September when there was a corresponding drop in atmospheric temperature. Moisture leakage through the bin walls caused temporary heating in two of the bins, but high temperature areas were reduced quickly by mechanical aeration. No loss in germination or serious increase in acid number occurred in any of the bins.

Cooling Seed During Storage

Mechanical aeration was a practical and economical method of cooling seed during storage. These tests show that: (1) it is desirable to aerate the seed as soon as possible after the bin is filled until the temperatures in the seed are reduced to 85 to 90°F.; (2) aeration during the summer should be as often as necessary to keep temperatures below 90°F.; and (3) the seed should be aerated during the winter until all the temperatures in the bin are reduced to 60°F. or less. More cooling usually can be done in the summer when the fans are operated at night.

Effective cooling was obtained with an air flow rate of 3/4 cfm per bushel. The aeration

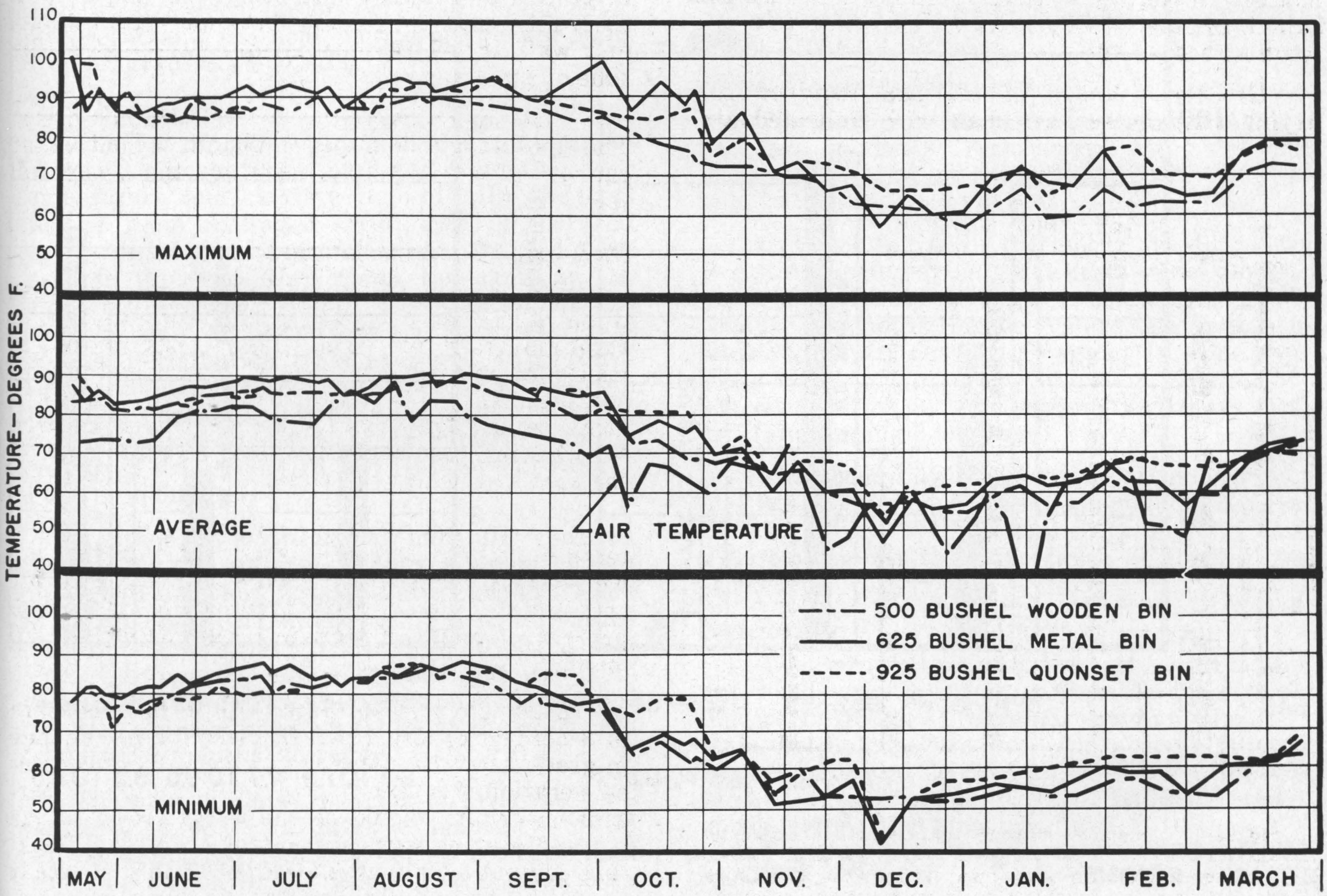

Figure 11. Maximum, average and minimum seed temperatures in three types of bins from May 1952 to March 1953. Average outside air temperature during the same period is shown on the center graph.

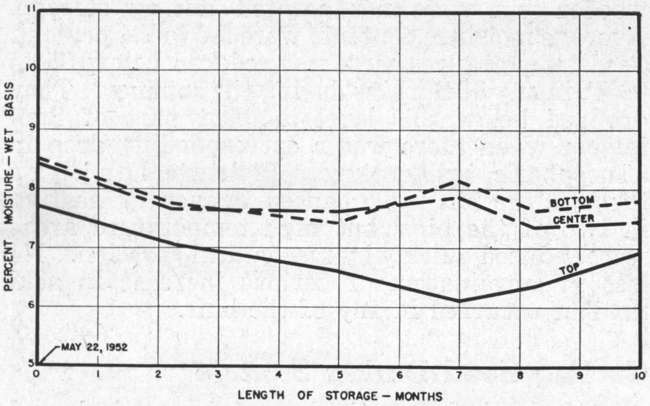

Figure 12. Flaxseed with initial moisture contents below 8 percent and cooled by mechanical aeration usually decreased 0.5 to 1.0 percent in moisture during storage. Since air was pulled through the seed, the greatest loss was in the top portion of the bin.

equipment required depends on the volume of air used and the size of the storage bin. A centrifugal fan of 13½ inches diameter driven by a 1½ horsepower electric motor will deliver air at a rate of ¾ cfm per bushel through a 10-foot depth of flaxseed in a 2,200-bushel capacity bin. As the depth of seed is increased, power and equipment costs increase rapidly. For this reason, an air flow rate of ¾ cfm per bushel is not practical for deep depths. Based on research with sorghum grain and other crops, effective cooling can be obtained with an air flow rate as low as 0.1 cfm per bushel. This amount of air usually can be supplied economically through the depths encountered in commercial storage.

Air was pushed upward and pulled downward through the seed. Both methods seemed equally effective for cooling the seed; however, pulling air downward avoids condensation since the humid air leaving the seed does not come in contact with the cool bin roof. It also gives an opportunity to smell the air coming out of the bin to detect any "off" odor which may have developed.

Effect of Structure on Seed Temperatures

Very little variation in temperatures occurred in the bins used in these tests. Although temperatures were slightly higher in the steel bins than in the wooden bins, the difference was not great

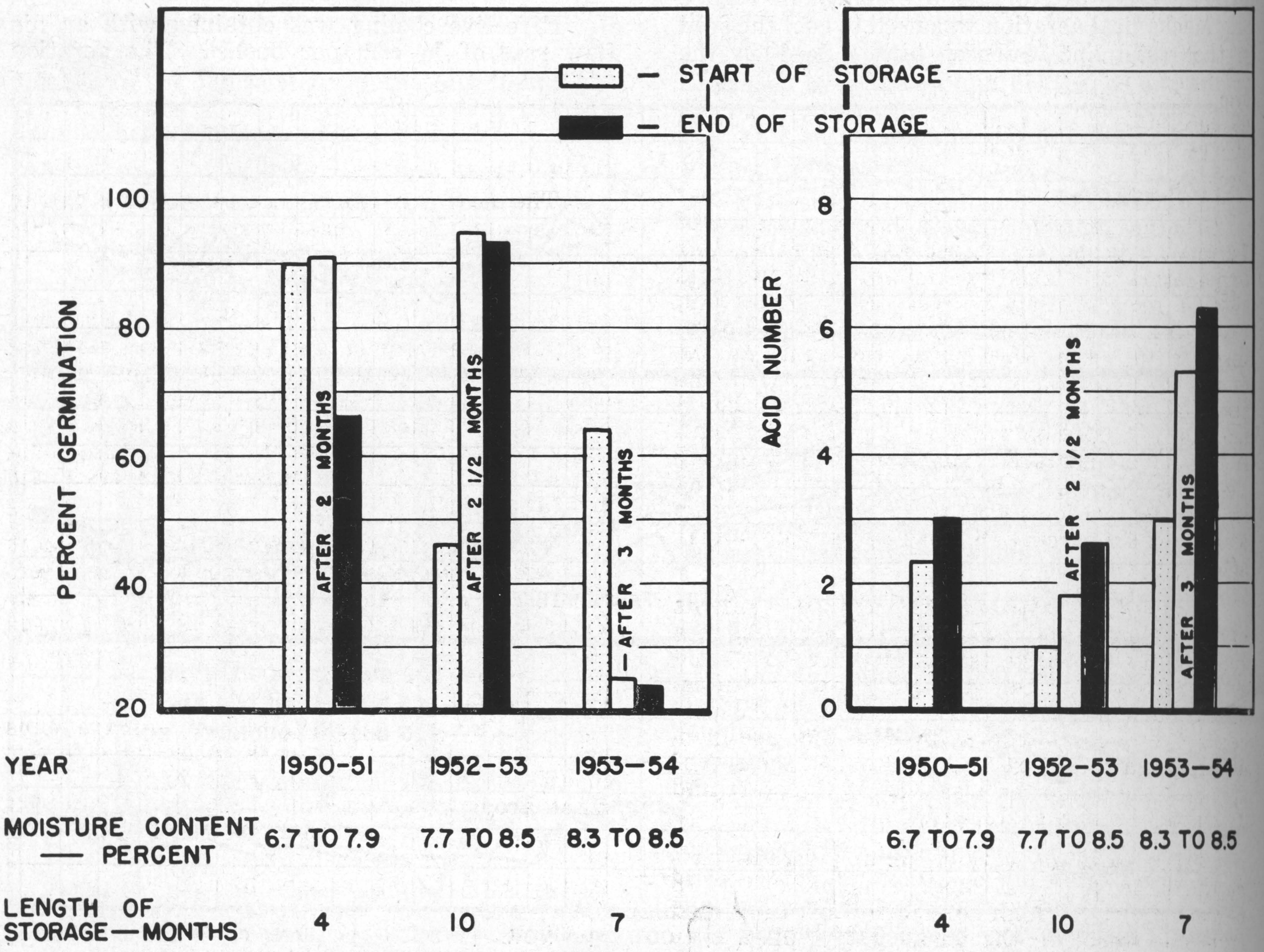

Figure 13. Percent germination (left) and acid number of seed stored in a 625-bushel capacity round steel bin for 3 crop years. The seed were cooled in 1950-51 by transferring from one bin to another. Mechanical aeration was used the other 2 years.

enough to have an important effect on germination and acid number. Temperatures in bins of small diameter and narrow width responded to changes in atmospheric temperature more readily than larger bins.

STORING FLAXSEED IN SACKS

Seed were stored in burlap bags under normal farm conditions and in a cold storage room. Initial moisture contents were 6.3 to 10.5 percent and length of storage was 4 to 9 months.

Farm Storage

Seed with a maximum moisture content of 8 percent were stored 4 to 9 months without loss in germination or serious increase in acid number. The average moisture content increased slightly during storage. Temperatures in the seed fluctuated greatly and generally followed the same pattern as the average atmospheric temperature. The seed were stored in locations with good air circulation in and around the sacks. Lots stored in poorly ventilated locations showed considerable loss in germination and an increase in acid number.

Flaxseed with initial moisture contents of 10.2 to 10.4 percent were stored in a well-ventilated location for 6 months. No loss in grade occurred but germination decreased from 86 to 58 percent and the acid number increased from an average of 3.47 to 4.00.

Cold Storage

One lot of seed with moisture contents of 7.1 to 9.2 percent was stored for 8 months. Air temperature and relative humidity in the cold storage room averaged 40°F. and 95 percent, respectively. One week after storage, temperatures in the seed were about the same as the temperature in the room. Germination of the seed was only 42 percent at the start. After 8 months, germination tests averaged 46 percent. Acid number increased from 3.04 to 3.63 during the same period. The high humidity during storage caused an increase in moisture to an average of 9.9 percent (9.2 to 10.4 percent range) after 8 months.

Another lot with initial moisture contents of 7.8 to 8.0 percent was stored for 9 months in a room with an average temperature of 48°F. and an average relative humidity of 78 percent. Moisture content increased to a maximum of 8.8 percent. Germination tests showed an increase from 48 percent at the start to 90 percent at the end of storage. Acid number was 2.80 at the start and 2.30 after 9 months' storage.

These tests show that for an average temperature of 48°F., a relative humidity of 78 percent is not too high for storing planting seed from one season to the next. For storage over 1 year, however, a maximum relative humidity of 60 percent is recommended.

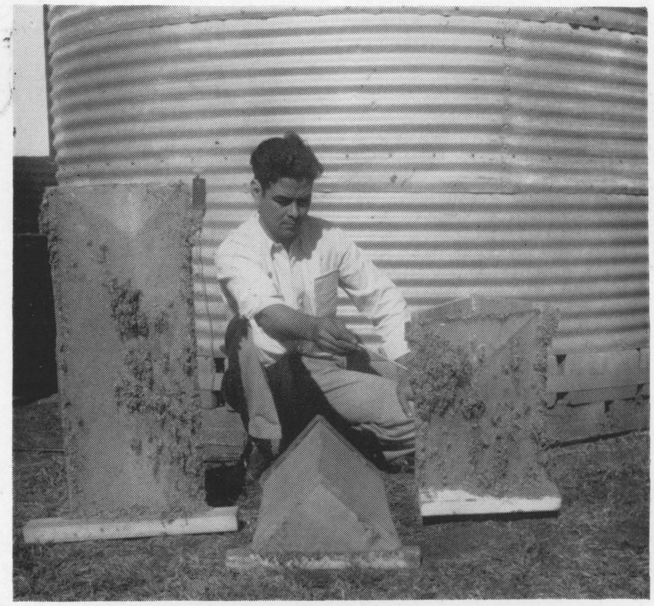

Figure 14. Moth webbing on bottom of aeration ducts used in flax storage bins.

INSECT CONTROL

Few insects were found in low-moisture-content flaxseed that was of good quality and free from "trash." In some instances insects were a problem and their control should be considered when storing flaxseed.

Most Common Insects

The most common insect pests found in stored flaxseed in South Texas were the rice moth, Indian meal moth and the flour beetle or "bran bug."

Only the larvae of the moths are destructive to grain. Injury from these pests seldom extends more than 12 to 18 inches below the surface because the moths themselves are unable to penetrate the grain mass to lay eggs. In some cases, these insects formed a webbing or matting over the screen wire on duct systems which restricted air flow through the seed.

The "bran bugs" and larvae of the rice moth and Indian meal moth are primarily surface feeders and usually feed on broken grains and trash. This emphasizes the importance of storing clean seed.

Sanitation

The proper preparation of storage bins before the crop is stored is essential for effective insect control. A thorough cleanup should be made around the premises and accumulations of waste grain and seed removed from around the bins. Bin walls should be sprayed with a residual spray before the bins are filled.

Control

Insecticidal sprays applied to the surface of flaxseed were effective in controlling moths.

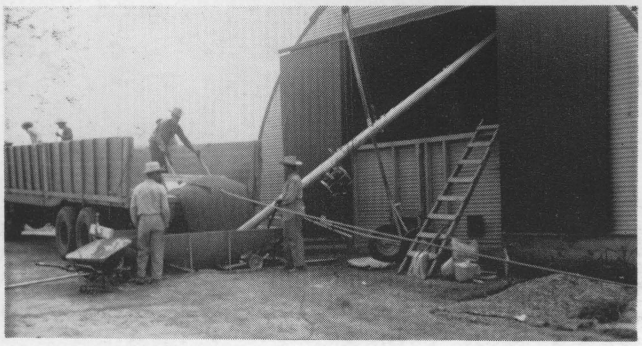

Figure 15. This auger loader and grain tow board were used to move seed from trucks to storage bins.

The highest infestation occurred during the summer and fall. Cooling the seed with mechanical aeration during cool weather was helpful in reducing infestations.

RODENT CONTROL

Rats and mice were difficult to control and no doubt were responsible for considerable losses.

Effective control can be obtained through approved rodent control procedures. Areas surrounding bins should be free from rat-harboring places. A tight structure should be used. Outside openings in aeration ducts should be sealed tightly when not in use to prevent entrance of rats and mice.

Information on the control of rodents can be obtained from the local county agricultural agent, or from the Rodent Control Service, Box 1941, San Antonio 6, Texas.

LOSSES DURING STORAGE

Records were kept on the weight of flaxseed loaded into bins at the beginning of storage and the weight of seed unloaded at the end of storage.

TABLE 2. LOSSES IN WEIGHT DURING STORAGE

Item	1950-51	1952-53	1953-54
Length of storage, months	4	10	8
Weight at start of storage, pounds	129,210	149,230	121,390
Calculated moisture loss in drying, pounds	5,000	3,800	2,550
Total amount dry seed stored, pounds	124,210	145,430	118,840
Weight at end of storage, pounds	119,410	140,988	116,350
Total weight loss from sampling, decrease in moisture, rodents, insects, and handling, pounds	4,800	4,442	2,490
Percentage loss during storage	3.8	3.1	2.1

Losses occurring over a 3-year period are shown in Table 2. The highest loss occurred during the 1950-51 storage year. This was the first year of the tests and facilities were not available to cool the seed by mechanical aeration. As a result, it was necessary to transfer the seed from one bin to another to keep them in condition. Losses shown for the other 2 years are probably more representative.

HANDLING SEED IN AND OUT OF STORAGE

A 21-foot auger loader operated by a 3-horsepower electric motor was used for loading and unloading bins. The loader handled an average of 30,000 pounds of flaxseed per hour in moving seed from trucks to storage bins. This capacity was obtained by using a grain tow board, as shown in Figure 15.

Records also were kept on different methods of unloading bins. Metal bins 9 feet-10 inches in diameter were unloaded by shoveling seed through an 8-inch diameter unloading spout in the bin door. Two men unloaded seed at a rate of 23,000 pounds per hour. Seed were handled at a rate of 16,400 pounds per hour by 2 men shoveling through an unloading spout in the bin wall of a 6 by 16-foot wooden bin. Three men unloaded seed through a spout in the bin wall of a 12 by 16-foot bin in a Quonset building at a rate of 20,200 pounds per hour. Seed were shoveled through the door of a 14-foot diameter metal bin by 3 men at a rate of 25,200 pounds per hour. In all cases, the seed were allowed to flow by gravity as long as possible.

ACKNOWLEDGMENTS

The following cooperators contributed materials, equipment and funds for these tests: Archer-Daniels-Midland Company, Kenedy, Texas; Stran-Steel Corporation, Detroit, Michigan; and Agricultural Stabilization and Conservation, U. S. Department of Agriculture.

The authors express their appreciation for the cooperation of the following individuals: J. M. McNabb, manager, A-D-M Company, Kenedy, Texas; L. M. Redlinger, entomologist, U. S. Department of Agriculture, Houston, Texas; R. A. Hall, superintendent, Substation No. 1, Beeville, Texas; Jack Bradshaw, State ASC Office, College Station, Texas; and M. M. Garcia, formerly of the Beeville station.