THE COSTS AND RETURNS ASSOCIATED WITH ON-FARM STORAGE OF WHEAT IN OKLAHOMA

By

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INTRODUCTION

Current Situation

On-farm storage of wheat is not new to Oklahoma wheat farmers. Many farmers have, in the past, utilized on-farm storage facilities to store feed and seed wheat. However, in the last few years new emphasis has been placed on the use of on-farm storage as a possible alternative in solving some of the problems within the wheat marketing channel. The purpose of this study is to examine the economic feasibility of on-farm wheat storage as such an alternative.

A Measure of On-Farm Wheat Storage Capacity

Although the exact amount of on-farm storage capacity in Oklahoma is not known, the relative change in on-farm storage capacity over the last few years can be analyzed by examining on-farm wheat stocks. On-farm wheat stocks are reported by the Statistical Reporting Service of the United States Department of Agriculture on January 1, April 1, June 1 (July 1 prior to 1976), and October 1 of each year. Of the four reporting dates, on-farm wheat stocks are at their highest level as of October 1 of each year. For this reason, the October 1 on-farm stock level of wheat is used to discuss the changing role over time

of on-farm storage of wheat in Oklahoma. It should be remembered that on-farm stock levels on any one reporting date will represent a static storage figure. The exact amount of wheat that is stored on-farm depends upon many factors and is constantly changing. In short, on-farm stock levels indicate the amount of wheat that is being stored on farms as of each reporting date. Furthermore, the October 1 on-farm stock level yields no information concerning the exact amount of storage space available on farms, nor does it tell anything about the type and quality of storage facilities available.

During the period 1960 to 1972, October 1 farm stocks of wheat average 14.63 million bushels, whereas, October 1 farm stocks averaged 29.30 million bushels during the period 1973 to 1979, as shown in Table I. This increase is due, in part, to the increasing level of wheat production. Wheat production for the period 1973 to 1979 averaged 163.19 million bushels, about 62.61 percent greater than the average production of 1960 to 1972. Included in Table I is a ratio showing October 1 on-farm stocks of wheat as a percentage of total wheat production in Oklahoma. This calculation is a way to detrend the data with respect to the increasing level of wheat production, thus allowing for a better comparison of production years. For the period 1960 through 1972, the ratio of October 1 farm stocks to wheat production ranged from 13 to 16 percent, with an average of 14.46 percent. Since 1972, on-farm wheat stocks as a proportion of total wheat production has only twice been within the range of 13 to 16 percent, in 1973 and 1976. For the period 1973 to 1979, October 1 on-farm wheat stocks averaged 18 percent of Oklahoma's total wheat production.

The most dramatic change in on-farm storage capacity occurred in

TABLE I

ACRES PLANTED, ACRES HARVESTED, TOTAL WHEAT PRODUCTION, OCTOBER 1 FARM STOCKS OF WHEAT AND OCTOBER 1 FARM STOCKS OF WHEAT EXPRESSED AS A PERCENTAGE OF TOTAL WHEAT PRODUCTION, OKLAHOMA, 1960-79

Year	Acres Planted	Acres Harvested	Wheat Production	October 1 Farm Stocks of Wheat	October 1 Farm Stocks Awarded by Wheat Prod.
	Thousand Acres		Thousand Bushels		Percentage
1960	4,887	4,665	121,290	18,194	15.00
1961	4,887	4,618	110,822	17,733	16.00
1962	4,349	3,741	71,079	10,073	14.17
1963	4,740	3,591	75,411	10,497	13.92
1964	4,882	4,201	96,623	12,561	13.00
1965	5,321	4,747	132,916	21,267	16.00
1966	5,268	4,700	98,700	14,805	15.00
1967	6,480	5,217	88,689	11,530	13.00
1968	6,091	5,321	124,200	17,134	13.80
1969	5,450	4,350	121,800	20,107	16.51
1970	5,024	3,900	101,400	13,748	13.56
1971	5,050	3,600	72,000	10,842	15.06
1972	5,700	3,900	89,700	11,664	13.00
Mean	5,240.69	4,350.08	100,356.15	14,627.31	14.46
S.D.	579.43	583.26	20,791.02	3,855.10	1.22
1973	6,000	5,260	157,800	22,092	14.00
1974	7,000	6,400	134,400	22,848	17.00
1975	7,400	6,700	160,800	27,336	17.00
1976	7,800	6,300	151,200	22,684	15.00
1977	7,800	6,500	175,500	36,855	21.00
1978	7,000	5,400	145,800	36,450	25.00
1979	7,000	5,600	216,800	36,822	17.00
Mean	7,142.86	6,022.86	163,135.71	29,298.14	18.00
S.D.	618.75	535.08	26,880.50	7,141.35	3.79

Source: Oklahoma Agricultural Statistics, Oklahoma Crop and Livestock Reporting Service, USDA - ESCA, 1960 to 1979.

1977. On-farm wheat stocks for October 1, of that year, exceeded 36 million bushels, some 10 million bushels greater than any other recorded stock level. October 1 on-farm wheat stocks jumped to over 20 percent of total wheat production for the first time. Even though total wheat production in Oklahoma fell nearly 30 million bushels from the 1977 level in 1978, the amount of wheat stored on farm has remained about the same, as indicated by October 1 on-farm wheat stocks. In 1979, Oklahoma reported a record wheat harvest of 216.8 million bushels, some 23.63 percent larger than the record 1977 harvest. Even with the bumper wheat harvest, October 1 on-farm stock level remained at about 36 million bushels.

Table I is segmented with accordance to changes that have occurred in United States agricultural policies toward wheat production. The Agricultural and Consumer Protection Act of 1973 marked a major turning point in agricultural programs. The 1973 act emphasized maintaining and increasing production rather than curtailing production, as did agricultural programs prior to 1973.

Factors Influencing the Change in On-Farm Storage

The dramatic increase in on-farm storage of wheat in Oklahoma seen in the last few years can be attributed mainly to the allocation of commercial storage space, which occurred in 1977. Other factors, such as: 1) the A.S.C.S. facility loan program, 2) the reserve grain program, 3) the increasing level of wheat production within the state, 4) the price variability of wheat, and 5) the increasing costs of commercial storage, have also encouraged producers to use on-farm

storage facilities as well.

The allocation of commercial storage space became a reality to Oklahoma wheat producers going into the 1977 wheat harvest. Allocation was needed because of the substantial increase in carryover stocks, caused by 1) a low export demand, and 2) a high content of yellow wheat in the 1976 wheat crop. Oklahoma went into the 1977 wheat harvest with 66.86 million bushels of carryover stocks, some 37.41 percent higher than the previous year. Intensifying the storage problem facing wheat producers going into the 1977 wheat harvest, was a bumper wheat harvest of 175.5 million bushels. Figure 1 and Table II illustrate the problem facing Oklahoma's wheat producers going into the 1977 wheat harvest. Wheat production in 1977 exceeded the total available commercial storage capacity by over 47.05 million bushels. Total available commercial storage capacity equals total rated commercial storage capacity minus June 1 off-farm wheat stocks. Table II and Figure 1 show the commercial storage capacity available for receiving a new wheat crop for the years 1960 to 1979. Note, the figures shown in Table II are static capacity figures and they should be interpreted as such. If wheat is moving out of commercial storage facilities to market, no real problems arise from having production exceed available storage space. However, if the demand for wheat is off and grain is not moving out of the storage systems very quickly, production exceeding the available storage capacity can be costly not only for producers but also elevator operators. The incoming wheat must be placed somewhere so the harvest can continue. If producers do not have on-farm storage bins this means dumping wheat on the ground because of the lack of commercial storage space to meet

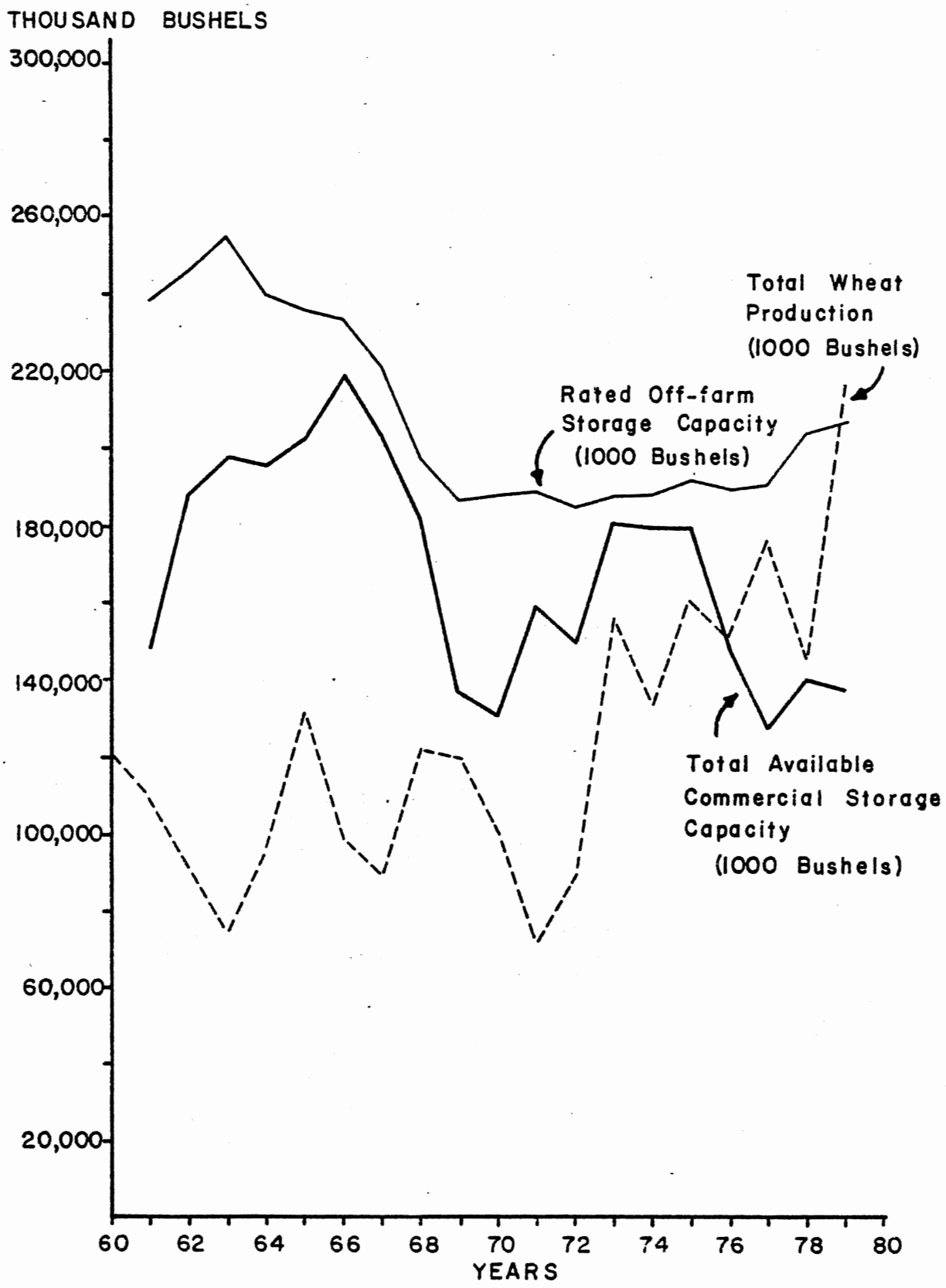


Figure 1. Oklahoma's Total Wheat Production, Rated Off-Farm Storage Capacity and Total Storage Capacity Available for a New Wheat Crop.

TABLE II

COMPUTATION OF STORAGE SPACE AVAILABLE IN OKLAHOMA FOR A NEW WHEAT CROP, OKLAHOMA

1960 to 1979

Year	Col 1 Rated Off-Farm Storage Capacity[b]	Col 2 June 1 Off-Farm Wheat Stocks[a]	Col 1-Col 2=Col 3 Total Available Commercial Storage Capacity	Col 4 Wheat Production[a]	Col 3-Col 4 Available Capacity Minus Wheat Production
	Thousand Bushels				
1960	*	89,057	N/C	121,290	N/C
1961	238,700	92,677	146,023	110,832	35,191
1962	246,100	67,823	188,277	71,079	117,198
1963	255,000	57,340	197,660	75,411	122,249
1964	240,000	44,214	195,786	96,623	99,163
1965	236,000	32,736	203,264	132,916	70,348
1966	234,000	15,160	218,840	98,700	120,140
1967	222,000	17,850	204,150	88,689	115,461
1968	198,400	15,424	182,976	122,383	60,593
1969	186,810	49,782	137,028	121,800	15,228
1970	187,570	56,447	131,123	101,400	29,723
1971	189,050	29,892	159,158	72,000	87,158
1972	184,880	34,835	150,045	89,700	60,345
1973	187,650	6,736	180,914	156,800	23,114
1974	188,160	7,656	180,514	134,400	46,114
1975	191,790	11,836	179,954	160,800	19,154
1976	190,200	44,639	145,561	151,200	(5,639)
1977	190,780	62,328	128,454	175,500	(47,046)
1978	203,520	63,394	140,126	145,800	(5,674)
1979	207,330	70,414	136,916	216,800	(79,884)

*Data not available

N/C Not Computable

[a]Oklahoma Agricultural Statistics, Oklahoma Crop and Livestock Reporting USDA, ESCS, 1960 to 1979.

[b]Grain Stocks, USDA-ERS, January 24, 1961 to April 24, 1980

harvest needs.

The allocation program allowed each producer a specified amount of storage for his 1977 wheat crop. If the producer's crop exceeded his allocated storage space, he had two options available, 1) he could sell his crop at harvest to the commercial facility, or 2) find additional storage for his crop. Because wheat prices were low at the time of harvest and since most commercial facilities had limited storage space and allocated available space to past patrons, many producers decided to take advantage of the farm storage facility loan program provided by the Commodity Credit Corporation and build their own on-farm storage facilities.

The C.C.C. facility loan program is designed to encourage the storage of grain on-farm by making secured storage facility loans to producers of wheat and other grains. Although the program was enacted in 1933, the 1977 Agricultural Adjustment Act changed the loan program so producers could secure loans for not only the storage facility itself, but the total construction cost of the facility including, but not limited to, the cost of structural and equipment foundation, electrical systems, grain handling systems, drying equipment and site preparation. The farm storage facility loan program is part of the overall grain reserve program which is designed to stabilize prices through the acquisition of stocks during years of excess supply and releasing of stocks during years of excess demand. Under the grain reserve program producers have the option of storing wheat in either on-farm or commercial facilities. If the producer chooses to store grain in commercial facilities, he assumes the costs of storage during the loan period. Then when the loan is called, the

producer is paid an amount specified by the Act to cover the cost of storage. On the other hand, if the producer chooses to store wheat on-farm, he receives the full support price although, of course, he assumes costs of storage on the farm. Producers will receive the same payment to cover storage costs whether grain is stored in on-farm or commercial storage facilities. Thus, the program does, to some degree, encourage the storage of wheat on-farm.

Wheat producers, like all other agricultural producers, are faced with many critical decisions during the production process of their commodity. From the time of planting to selling, the profitability of production depends upon the accuracy and timeliness of the producer's decision. At the time of harvest, producers must decide whether to sell their wheat immediately or store it for sale at a later date. A wrong decision about grain storage could lead to a loss in income. With the decision of whether to store or not also comes a decision of whether to use on-farm or commercial storage facilities. To make the most profitable decision, producers must have information and guidelines about each storage alternative. The purpose of this study is to provide wheat producers with information concerning on-farm wheat storage. Specific objectives of this study are listed below.

Objectives

The objective of this study is:

1. To develop the costs and returns of on-farm wheat storage in Oklahoma. Specific sub-objectives are to provide:

    a. Technical input-output data for various sizes and types of storage systems;

b. Capital investment requirements, annual operating costs, and a monthly cost equation for the various systems understudy;

c. Potential returns associated with storing wheat in various time periods will be examined; and

d. Expected rate of return on the storage investment will be determined.

This study will be organized in the following format. First there will be a review of literature, then procedures of analyses, data employed, empirical results, summary, and conclusions and recommendations for further research.

CHAPTER II

REVIEW OF LITERATURE

Introduction to Storage

The Function of Storage

Storage is broadly defined as the time period between production and consumption of goods. Storage bridges the gap between production and consumption, allowing goods to be consumed in time periods other than those when production takes place. Most products, whether manufactured or grown, require some form of storage. Storage is extremely important to agriculture because of the seasonality of agricultural production. The length of storage depends upon the good's production and consumption pattern, plus the good's parishability, and the feasibility and costs of storage.

Storage and its' function within the marketing system has been the topic of discussion in many marketing textbooks. Kohls and Downey (1974) emphasize storage as a necessary part of the marketing system because of the time lag between production and utilization of goods. These authors feel storage is the function of matching a good's production pattern with its' consumption patterns in reference to time. For this reason, Kohls and Downey (1974) feel storage creates time utility. These authors stress two general types of storage. First, there is storage which equalizes seasonal

production to the pattern of demand. This type of storage is undertaken by elevators, warehouses, and other places of mass accumulation. Second, there is the storage which is necessary to keep the marketing channel operating efficiently. This type of storage is generally thought of as operating inventories.

Stewart and Britton (1973) suggest storage is necessary to provide, 1) a supply consistant with demand, 2) a surplus storage with which to carry over supplies into years of low productivity, and 3) for the adjustment and maintenance of grain quality consistant with the intended use of the grain. These authors state grains can be stored either in on-farm or off-farm (terminal or country) storage facilities. Each storage system has its' own advantages and disadvantages which each producer must consider with reference to his own particular storage needs. Stewart and Britton (1973) indicate that producers choose to store on-farm because it gives them the ability to: 1) harvest and store grains at the producers' convenience, 2) store grains under federal loan programs without worrying about the availability of commercial storage space, and 3) market grain either for cash or through livestock at the producers' convenience.

The discussion of storage and its' function within the marketing system, thus far, has been in broad framework. Moore (1974) however, discusses the role of wheat storage specifically. Moore (1974) believes wheat is stored not only because of the time lag between production and utilization, but also because arrangements are being made for sale, for milling, and for transportation. For this reason, Moore (1974) feels storage is a result of conditions of time lapse, rather than time lag. Moore (1974) stresses time lag as being an

inappropriate definition of storage because it implies storage as merely filling the gap between production and utilization. Whereas, time lapse indicates the presence of other activities, such as transportation and processing, occurring between the period wheat is produced and consumed.

Storage in Oklahoma

Grain storage in Oklahoma consists of commercial storage (terminal and country elevators) and on-farm storage facilities. As of January 1, 1979, Oklahoma's total grain storage capacity was estimated at 207.3 million bushels that was distributed among 397 commercial storage facilities. Of the total 207.3 million bushels, approximately 142.3 million bushels are country elevator storage and the remainder, 65 million bushels, are terminal elevator storage. According to a study conducted in 1977-78 by two U.S.D.A. agencies, the Agricultural Stabilization and Conservation Service (A.S.C.S.) and Economics, Statistics, and Cooperative Service (E.S.C.S.), approximately 71 percent of Oklahoma's total grain storage capacity was off-farm commercial storage. The remaining capacity was attributed to on-farm storage. The study estimates Oklahoma's total grain storage capacity to be 287.7 million bushels (205 million bushels of off-farm storage). It should be noted that the A.S.C.S. study included storage of all grains, not just wheat storage. On-farm storage data were gathered by county A.S.C.S. offices through the use of mail questionnaires sent to grain producers. Producers where asked to estimate their total usable on-farm storage space available for storing all grains.

Other estimates of on-farm grain storage in Oklahoma have been

made by looking at quarterly on-farm grain stock figures for the primary crops grown in Oklahoma. Bloome, Parks, Mennem, and Kletke (1977) used this method to estimate Oklahoma's total on-farm storage capacity in a study conducted in 1977. Their study consisted of two phases of analysis. In Phase One of their study, these authors felt s simple summation of each grains highest on-farm stock level would give an approximation of the total on-farm grain storage capacity in Oklahoma. Given the four stock reporting dates of January 1, April 1, June 1, and October 1, these authors found that on-farm stocks of wheat, barley, and oats were the highest on the October 1 reporting date, while on-farm stocks of sorghum and corn were the highest on the January reporting date. These authors also pointed out that this method of estimation could overestimate total on-farm grain storage capacity if more than one crop is stored in a single facility during the year. This method could also underestimate the actual level of on-farm grain storage capacity if stocks peak at some date other than a reporting date, or if unused capacity remains in the storage facility during the year. Using this method of estimation, the authors estimated Oklahoma's total on-farm grain storage capacity for 1977 at 49.22 million bushels, some 33.5 million bushels below the A.S.C.S. (1977) estimate of 82.7 million bushels. Excluding permanent ear corn storage and wet storage of high moisture grains from the A.S.C.S. on-farm storage capacity figures places Oklahoma's on-farm grain storage capacity at 76.7 million bushels, only 27.5 million bushels higher than the estimate made by looking at grain stocks.

Johnson, Mennem and Oehrtman (1978) used on-farm stocks of wheat

to estimate Oklahoma's on-farm wheat storage capacity. The authors found the largest October 1 on-farm stock level of wheat occurred in 1977 when on-farm wheat stocks reached 36.9 million bushels. This implies that Oklahoma's minimum on-farm storage capacity devoted to storing wheat, for October 1, 1977, was 36.9 million bushels. Johnson, et al (1978) stress that this method of estimating on-farm wheat storage capacity would likely underestimate the actual storage capacity because on-farm stocks peak prior to October 1. Generally, by October 1 producers have already removed seed wheat from storage.

To date, little research work has been conducted on the economics of on-farm wheat storage in Oklahoma. The Farmer Stockman ("Do We Need More On-Farm Storage?" March, 1979; "On-Farm Grain Storage: Is it for Your Farm? Ask Yourself 8 Questions." April, 1979; "Storing Grain On the Farm; You'll Need to Watch It." June, 1979) has run a series of short articles discussing various economic and physical aspects of on-farm storage. These articles in general expressed the need for additional information concerning the storage of wheat and other grains in on-farm storage facilities. Johnson, et al (1978) stress the use of on-farm storage as a possible means of reducing pressures resulting from rapid harvesting upon commercial storage and transportation facilities. Phase Two of the study conducted by Bloome, et al (1977) consisted of sending a mail questionnaire to a selected sample of farmers who stored cash grains on-farm. The questionnaire was designed to determine: 1) why farmers have invested in on-farm storage; 2) the kinds and capacities of storages they have selected; 3) the quality of their management; and 4) their differences in marketing strategy with farm stored grain as compared

to commercially stored grain. Each questionnaire recipient was asked to respond to questions concerning types and sizes of their storage facilities; advantages and disadvantages of on-farm storage; management and marketing practices; and other specific problems related to on-farm storage of grain. In analyzing the returned questionnaires, Bloome, et al (1978) found the majority of respondents had round metal storage bins and an average on-farm storage capacity of 14,200 bushels. Grains were generally handled through the use of portable augers and only 19 percent of the respondents had some type of drying system. The respondents listed insect and rodent damage as a persistent problem associated with on-farm storage of grains. When asked to rank the advantages and disadvantages of on-farm storage, the respondents ranked increased market flexibility as the greatest advantage, with shrink and risk of spoilage being the greatest disadvantage. In response to questions concerning marketing practices, 71 percent of the respondents said they had a tendency to hold farm-stored grains longer than commercially stored grains. Seventy-one percent of the respondents also indicated that they usually held some farm stored grain into the next tax year. Of the 182 responses only 43 (24 percent) routinely insured their on-farm stored grains. Only 11 percent of the respondents inspected their grain as frequently as recommended for safe storage practices.

On-Farm Storage Facility Design

An important aspect of any on-farm storage system is its' design. The systems design is important in determining the usefulness and efficiency of the on-farm storage system. Although the study does

not concern itself with facility design per se, the author feels it is important to discuss some of the factors which producers should consider when planning an on-farm grain storage system.

The primary concern of any on-farm storage system design should be to maintain grain quality and to provide a useful and efficient means of storing grain for the producer. Stewart and Britton (p. 274, 1973) feel the following factors should be considered when designing an on-farm grain storage system:

> Whether the producer wants temporary or permanent storage facilities;
>
> Types and quantities of grain to be stored;
>
> Location, size and number of bins;
>
> Handling equipment and methods;
>
> Conditioning methods and requirements;
>
> Structural requirements;
>
> Producers future plans.

The design of an on-farm grain storage system must suit the purpose which it is to serve. If producers intend to store grain only on a temporary basis, a detailed study of alternative facility designs need not be made, says Stewart and Britton (1973). However, a permanent storage system requires careful consideration by producers so that the facility will meet not only his current needs, but his future needs as well.

The type of grain(s) to be stored is a major determinant in the design of a storage system. Each grain has its' own special characteristics which must be considered in designing of the storage system. If the producer plans to store more than one crop annually, the storage system should be designed to meet the needs of the grain which is

the most difficult to store and handle. The number of different grains to be stored annually and the length of time they are to be stored is important in determining the number and capacity of bins for your on-farm storage system. A general rule of thumb suggested by Stewart and Britton (p. 273, 1973) to determine the amount of storage capacity needed in an on-farm grain storage system is to "provide enough total storage space to store your entire crop for one year". Jim Baxter (1979), on the other hand, feels this hard and fast rule of thumb of providing enough storage for one year's crop is an over simplification of a more complex issue. Baxter suggests using the three M's; Market, Money and Management, to determine the amount of storage a producer should provide. The market provides information concerning the localized basis of each crop. If traditionally the basis is narrow at harvest, little or no on-farm storage capacity is needed, whereby a traditionally wide harvest basis favors enough on-farm storage capacity to hold 100 percent of the producer's crop. The second M, which stands for money or equity position of an individual dictates the amount of storage capacity the producer can afford to provide. A producer with a weak equity position or high capital requirements in other parts of his business would be better off not worrying about on-farm grain storage. The third M in determining the amount of storage capacity to provide stands for management. This element of the decision process involves the idea of risk and how management views risk. Management's philosophy toward risk dictates the amount of storage management is willing to provide. A risk oriented manager may be willing to provide enough storage for 100 percent of his crop, whereas a risk averting manager may not be

willing to provide any on-farm storage for his crop. These methods suggested by Jim Baxter are general guidelines to help producers make storage capacity decisions. As always the final decision of how much on-farm grain storage capacity to provide remains with the individual producer and his particular needs.

The grain handling system would be adequate enough to prevent bottlenecks from occurring during the harvest period. Stewart and Britton (1973) suggest designing the handling system to fit the expected inmovement of grains during harvest. A poorly designed handling system effects the efficiency of the entire harvesting system.

Beyond certain fundamental decisions on size and arrangement, producers have little say in the engineering or structural specifications of components in an on-farm storage facility. Producers should recognize that storage facility should be structurally sound enough to withstand wind, rain, snow and internal pressures created by the grain. If the storage structure fails to withstand any one of these forces, losses will occur in the stored grain. The location of an on-farm storage facility depends upon, 1) the intended use of the stored grain, 2) the availability of electricity, 3) security, 4) wind direction and other weather conditions, and 5) the accessability during good and bad weather. The on-farm storage facility should also be located where it is easy for the producer to periodically inspect the grain.

Conditioning of wheat and other grains is required to maintain good grain quality. High moisture grains such as corn, grain sorghum, rice and soybeans are generally harvested at a moisture content considered high for safe storage. Such grains require drying to a specified moisture content before being placed in storage. On the other

hand, low moisture grains such as wheat, barley and oats are generally harvested at a moisture content considered safe for storage. Table III shows the moisture content at which grains are harvested, as-well-as, the minimum moisture content and relative humidity in growth of common storage fungi on various grains. Wheat and corn can be stored safely at moisture contents below 13.5 percent, while a safe moisture content for grain sorhum and soybeans is 14.0 and 12.0 percent, respectively. Barre (1954) indicates that the maximum moisture content at which grains can be stored safely not only depends upon the kind of grain, but also on the geographical location of storage, the method of conditioning, and the length of time the grain is to be stored. Grains which are harvested at moisture contents higher than the recommended safe storage level require drying before being placed in storage. All grains, whether they are considered high moisure or low moisture grains, require aeration during the storage period to insure safe storage. Aeration is the process by which air is forced through the grain mass to help cool the grain to a temperature which prevents the growth of microflora. Aeration also helps prevent spot spoilage in the stored grain by maintaining a uniform temperature within the storage facility. Included with, but not required in an aeration system is a grain stirring device. This device mixes the grain to help eliminate hot spots within the grain mass.

Finally, on-farm storage facilities should be designed such that future expansion can take place easily. Even if expansion is not foreseen in the near future, it is to the producer's advantage to plan his initial storage system as if expansion was going to take place. By doing so the producer will save himself both time and money when he finally decides to expand his existing storage facility.

TABLE III

MINIMUM RELATIVE HUMIDITY AND MOISTURE CONTENTS FOR GROWTH OF COMMON STORAGE FUNGI IN CORN, WHEAT, SORGHUM AND SOYBEANS[a]

Fungus	Minimum Relative Humidity (%)	Minimum Moisture Content		
		Corn and Wheat (%)	Grain Sorghum (%)	Soybeans (%)
A. restrictus	70	13.5	14.0	12.0
A. glaucus	73	14.0	14.5	12.5
A. candidus	80	15.0	16.0	14.5
A. ochraceus	80	15.0	16.0	15.4
A. flavus	85	18.0	19.0	17.0
Penicillin, depending on species	80 - 90	16.5 - 19.0	17.0 - 19.5	16.0 - 18.5

Source: OSU Factsheet #1100, Oklahoma State University, 1974.

A) For more information on controlling micro flora and insects, the interested reader should refer to C.M. Christensent, Storage of Cereal Grains and their Products, 1974.

On-Farm Storage of Grains

The topic of on-farm grain storage has been a widely discussed issue over the last few years. Numerous agricultural trade magazines, professional journals, industry publications and research projects have dealt directly with this issue. Although no current empirical studies concerning the issue of on-farm storage in Oklahoma have been conducted, numerous short articles and factsheets have been written on this issue.

For three consecutive months in early 1979, the Farmer Stockman published articles concerning on-farm grain storage in Oklahoma. The first article appeared in the March 1979 issue and addressed the topic of whether or not more on-farm storage was needed in Oklahoma ("Do We Need More On-Farm Storage?", March, 1979). Although the article never fully answered this question, it did present a short historic overview of grain storage in Oklahoma. The article also discussed the 1977 A.S.C.S. grain storage survey which placed Oklahoma's total grain storage capacity at 285.78 million bushels (205 million bushels of commercial and 80.78 million bushels of on-farm storage). According to this 1977 A.S.C.S. survey, approximately 72 percent of Oklahoma's total storage capacity is commercial, whereas, states like Nebraska and Iowa have 70 percent of their total storage capacity in on-farm storage facilities. This Farmer Stockman article stated that climatic conditions, availability of commercial storage and the kind and uses of stored grains, were some of the reasons why less emphasis has been placed on on-farm storage of grains in Oklahoma. The second article in this series provided a short list of questions which could help producers decide whether or not they should use on-farm

on-farm storage ("On-Farm Grain Storage: Is It for Your Farm? Ask Yourself 8 Questions.", April, 1979). The article also included an interview with a producer who had 40,000 bushels of on-farm storage capacity. In this interview, the producer stressed quality maintenance of grains through careful monthly inspection and good managerial practices both before the grain is placed in storage and afterwards. The article ended with a brief discussion of the current A.S.C.S. storage loan program, how it works and how to apply for it. The third and final article in this series discussed the problem of grain spoilage and what measures producers can take to avoid such losses ("Storing Grain On the Farm; You'll Need to Watch It.", June, 1979). A major portion of the article was directed toward the topic of insect infestations of stored grains, and what producers should do to prevent and control such infestations.

An earlier article published July 1977 in the Farmer Stockman discussed the problem of inadequate commercial storage space during the 1977 wheat harvest ("On-the-Farm Storage.", July, 1977). The article cited the record wheat carryover, the wheat harvest and slow out-movement of grain from commercial facilities as the reasons for inadequate commercial storage space. To insure adequate storage for their crop, producers began constructing on-farm storage facilities. Storage bin manufacturers and dealers in Oklahoma were reporting that they were anywhere from three weeks to three months behind schedule in filling orders for new storage facilities. The article labeled this period as, "the on-farm storage building boom" (p. 8).

Peter D. Bloome was the senior author of a series of OSU Fact-sheets discussing the issues of, 1) quality maintenance of stored grain,

2) the equipment needed to properly maintain grain quality, 3) the types and sizes of grain handling systems to use, and 4) the idea of temporary grain storage. The above mentioned Factsheets are numbers 1100-1103, 1105, 1106 and Current Report number 1107, respectively. Factsheet number 1100 entitled, "Maintaining Quality of Stored Grain" (Bloome and Brusewitz, 1974), wherein the authors emphasize the role that moisture and temperature conditions have in the maintenance of grain qualtiy. In this Factsheet, the authors stress the need of maintaining a uniform moisture content and temperature level to discourage the growth of microflora, a fungi or mold which causes grain spoilage. The authors present safe storage guidelines and management practices which producers should follow when storing grains. Factsheet number 1101 entitled, "Aerating and Cooling of Stored Grains" (Bloome, Brusewitz and Harp, 1974), presents guidelines to help choose air flow rates to obtain proper aeration and cooling of stored grains. Aeration and cooling of stored grain is a vital component in maintaining grain quality. Factsheet numbers 1102 and 1103 entitled, "Aeration Systems for Flat-Bottom Round Bins" (Bloome, Harp, Brusewitz and Garton, 1977) and "Aeration System Design for Cone Bottom Round Bins" (Bloome, Harp, Brusewitz and Garton, 1975), cover the design and selection of aeration system components in flat-bottom round bins and cone-bottom round bins, respectively. Factsheet number 1105 entitled, "Auger Conveyers" (Bloome, Harp and Garton, 1976), discusses the various types and uses of auger conveyers in grain handling systems. This factsheet provides information concerning the power requirements and capacities of various size auger systems. Also included in this Factsheet are guidelines to help producers select the proper augers, motors, and drives to fit their specific needs. Factsheet

number 1106 entitled, "Bucket Elevators" (Bloome, Harp and Garton, 1978), provides very much the same information as Factsheet 1105 except for former concerns itself with the use of bucket elevators while the latter is concerned with auger conveyer handling systems. Current Report number 1107, "Temporary Storage of Wheat Using Plastic Sheets" (Bloome, 1977), provides information concerning the use of plastic sheets to provide temporary storage for wheat. This report provides a cost breakdown on 1,000 to 9,000 bushels of temporary wheat storage. Also included in the report is information regarding, 1) the size of fan needed to properly aerate the various size facilities, 2) the type and thickness of plastic to use, 3) the length of time grains can be stored safely, 4) the approximate costs of the various size fans and the approximate cost of operating them, and 5) where the best site would be to set up a temporary storage facility. Although no current cost studies have been developed for Oklahoma, some studies were found for other states. The following section of literature review will review some of these current articles.

Review of Cost and Return Studies

Review of the Development Process of Each Study

Nichols and Updaw (1978) analyzed the costs and returns associated with drying and storing corn on-farm in North Carolina. The objective of their study was to provide guidelines to North Carolina producers interested in building new grain storage and drying systems or for expanding existing systems. This study provides information to

interested producers concerning the costs and returns associated with seven different sizes of storage systems and four different types of grain dryers. The study also provided information on the costs and returns associated with just the drying facility for producers only interested in drying corn on-farm.

Grain storage systems studied ranged in capacity from 6,000 bushels to 100,000 bushels. In the appendix of their study, Nichols and Updaw (1978) give a detailed breakdown of each facility, its' components and handling equipment. For this study the authors only considered the use of medium and high temperature drying systems because of the problems associated with the use of low-temperature degrees. The four drying systems considered were: 1) batch-in-bin dryer; 2) batch-in-bin dryer with stirrer; 3) automatic batch dryer; and 4) continuous-flow dryer. These dryers are designed to remove ten percentage points of moisture from the corn in a 16 hour period. Dryers were designed to efficiently handle a day's harvest.

To determine the total cost of investing in drying and storage facilities, the following assumption and specifications were made. Five storage bins ranging in capacity from 3,400 to 25,000 bushels each were used to make up the seven storage systems under study. Each storage bin had a concrete base, roof vents and aeration fan and motor. The cost of each bin and its' corresponding equipment was determined from price quotation from North Carolina dealers during the slack season. Construction cost for each bin was calculated to be eight cents per bushel of storage capacity. Two drying bins with capacities of 1,000 and 1,700 bushels per 16 hour day were selected for use with the batch-in-bin and batch-in-bin with stirrer dryers. The study used three automatic batch dryers and three

continuous-flow dryers ranging in capacities from 115 to 388 bushels per hour and 183 to 435 bushels per hour, respectively. Storage facilities of sizes 6,000, 12,000, and 24,000 bushels were assumed to use portable augers while bucket elevators were used to move grain in the 40,000, 60,000, 80,000 and 100,000 bushel storage systems. Each elevator and its' components (drives, motors, turnheads, and downspouting) were computed at 80 percent of list price. Construction cost of the elevator was approximated at 40 percent of the elevator's costs. Construction costs for the elevator was supplied by experienced millwrights. The 40 percent cost figure is a general rule of thumb applied by the millwrights when bidding construction jobs. The cost of each complete system was determined by summing the price of each component in the system. For producers interested in drying corn without storing it, the authors provided the investment costs for each drying system separately.

Annual operating costs consisted of fixed and variable costs. Fixed costs included depreciation on storage bins and equipment, property taxes, interest expense on the source of money used to purchase equipment, and insurance on grain storage and handling system. Variable costs included labor costs to load and unload dryers and moving grain to and from storage, liquified petroleum gas used in dryers, electricity used to power fans, augers and elevators, tractor power used to operate portable augers, interest expense on grain inventory, and maintenance of the storage facility, equipment and dryers. The author again determined both the annual operating costs in both storage with dryer and drying without storage.

Nichols and Updaw (1978) determined the gross returns on investment in drying equipment and the gross returns on investment in storage

equipment. Gross returns on investment in drying equipment consist of the value of the reduction in field losses attributable to on-farm drying plus the increased market value earned through the removal of moisture. To estimate returns on investment in drying equipment, the authors assume drying equipment will allow producers to reduce field loss by up to 4 percent and a total revenue increase of 8 cents per bushel, assuming corn sells for $2.50/bushel. The drying system also increased the efficiency of combine and harvest-time labor by eliminating waiting time at the country elevator and time spent traveling. The authors did not quantify the revenue associated with the efficiency gains of harvest. Because drying also reduces weight and volume, the authors subtract off the average loss in market value due to shrinkage from average drying revenue. Shrinkage was assumed to be the weight loss per bushel times the per pound price of dry corn. Gross returns on investment in storage equipment consists of the increased market value of corn earned by postponing sales until some months after harvest. Average storage margins are based on price changes over time periods of five years, ten years, and nineteen years. Average storage margin is assumed to be the difference between the September harvest price and three selected months in the future, namely January, April and July. Total revenue from drying and storage is the summation of average drying and storage revenue.

The final section of the study by Nichols and Updaw (1978) was to determine the profitability of drying and storage relative to the profitability of alternative investment opportunities. Profitability was determined by examining the expected returns to capital. The internal rate of return on investment was estimated using the expected costs and revenue streams for each drying and storage system, and

drying without storage.

Skees, Davis, Brannon, Loewer, and Shuffett (1978) analyzed costs and returns associated with on-farm storage of corn, wheat, and soybeans in Kentucky. This study was quite different from other cost and return studies analyzed. These authors first conducted a survey of farms in Christian County, Kentucky to determine three representative farms. The three representative farms were: 1) the small farm, 100-175 tillable acres, 2) the medium size farm, 176-450 tillable acres, and 3) the large farm, more than 450 tillable acres. Using the representative data obtained from this farm survey, the authors developed two different types of grain storage systems for each of the three representative size farms. The first set of three storage systems represented current practices and were obtained directly from the farm survey. This set of storage systems is referred to as the representative grain system. The second set of three storage systems was developed on the basis of engineering recommendations with the objective of designing a least-cost storage system that would meet harvest requirements and accomodate storage of all grains provided.

These three representative storage systems were constructed on the basis of what appeared to be typical for the respective size farms under study. The storage system designed for the small farm consisted of a single 3,334 bushel storage bin with a ten horsepower drying fan. This system was designed for the use of forced natural air only. No heating unit was built into the fan system. This storage and drying system required layer drying of grains and each layer has to be dry before another is placed on top. This system of layer drying may actually extend the harvest period over a longer time than

would be required in the absence of on-farm storage.

The storage system designed for representative farm-size two consisted of three storage bins all of equal size. One bin included a perforated floor and a ten horsepower fan with a heating unit. This bin was designed to dry one day's harvest of grain at a time and then transfer it to one of the other two bins. The other two bins included aeration fans so that grains could be aerated throughout the storage period. This storage system involved transport augers for loading and unloading and for transferring grain between bins. A noted fault with this system's design is that corn has to be harvested prior to soybeans because corn required more drying and cannot be dryed as rapidly.

The grain storage and drying system designed for representative farm-size three consisted of three 10,948 bushel bins with unloading equipment, aeration sub-floors and aeration fans in each bin. The major distinguishing feature of this system is the portable dryer which has a 400 bushel per hour drying capacity and can be moved to any of the three storage bins. This drying system allows more flexibility than any of the other storage and drying systems discussed so far. Also included in this storage system is a bucket elevator. The bucket elevator system increased the capacity of the handling systems over that possible with transport augers.

The recommended grain storage systems were designed to eliminate some of the problems associated with the various representative grain systems. As mentioned before, these systems were designed on the basis of engineering recommendations with the objective of designing a least-cost storage system that would meet harvest requirements and accommodate storage of all grains produced. The recommended grain storage system

for the small farm included a heating unit on the drying fan and two bins instead of one to allow for batch-in-bin drying. This system was designed to permit storage and drying of grains produced on the farm in such a way as to facilitate a more rapid harvest. This system used a transfer auger. The recommended system for farm-size two was similar to the representative grain storage system. The basic difference being that the recommended grain storage system was designed to handle all grain produced on the farm in two bins instead of three. This system was also equipped to handle a more rapid harvest than the corresponding representative system. The recommended grain storage system of the large farm was exactly the same as the representative grain storage system except that the recommended system's three storage bins had a capacity of 17,734 bushels each instead of 10,948 bushels as in the representative system. The change allowed for storage of all grains produced.

Fixed and variable costs were computed for each storage system to provide an estimate of total annual costs. Fixed costs were estimated by a computer simulation program called BNDZN (Bin Design). This program calculated depreciation using the straight-line method assuming each item has a given life expectancy and zero salvage value. Other assumptions made by the BNDZN program when computing fixed costs are: 1) a 1 percent charge for taxes and insurance on each item, 2) an 8½ percent interest charge on borrowed money, and 3) an even repayment over the life of each item. Variable costs were estimated for each storage system by the computer simulation program CHASE (Corn Handling and Storage Elevator). Variable costs include labor costs, fuel and electrical costs, insect control costs, interest on income foregone by

storing grain, cost of shrinkage due to drying, and costs of market.

To determine the profitability of on-farm storage for the various storage systems, the authors compared gross returns associated with the total cost of storing grain. Returns to farm storage included the following; 1) returns due to decreases in harvest losses associated with drying capability, 2) returns related to drying yellow corn, 3) returns associated with increasing double-cropped soybean yields through earlier harvest of high moisture wheat. Returns to drying were determined by the simulation model CACHE which compares harvest losses with and without an on-farm storage and drying system. Returns to drying were calculated for corn only, since it was determined that drying was more critical for corn than for wheat or soybeans. To determine returns associated with drying corn, the authors assumed that wet corn was discounted for being too wet. The discounted price was compared to the price per acre which would be received if the grain were dried. Returns to storage for the various crops was calcualted by looking at monthly price fluctuations during the months preceeding harvest. More specifically, returns to the representative grain storage systems were calculated by comparing generated prices at traditional selling times and recommended selling times. The returns to recommended grain storage systems were calcualted on the basis of a single recommended selling time, after considering the system's constraints and the optimal selling prices. To determine the returns associated with yields of double-cropped soybeans, the authors used data collected by Egle (1977) which indicated that soybean yields were reduced by approximately 2 percent per each day they were planted after June 13. The increase in soybean yields, due to earlier harvest of high moisture wheat, were then compared to the cost of drying wheat to determine the approximate

return associated with harvesting wheat early.

Linville and Sorenson (1977) conducted a cost analysis of on-farm grain storage system both with and without drying facilities. In the storage system only section of this study, the authors analyzed nine separate storage systems ranging in size from 5,000 bushels to 120,000 bushels. The authors determined the investment cost and annual operating costs for each of these nine storage systems. When analyzing the costs of storage systems with dryers, the authors looked at six seperate storage systems ranging in size from 10,000 bushels to 120,000 bushels. Three type of drying systems were analyzed on each of the separate systems. The drying systems under study were; 1) batch-in-bin, 2) in-bin continuous flow, and 3) continuous flow system. Each of these dryers were designed to remove ten percentage points of moisture from all grain delivered to farm bin storage during the harvest period.

Investment costs for both the storage with and without drying systems were based on price quotations from manufacturers in Kansas. Investment cost for the storage only facilities were broken into two categories: 1) building costs, and 2) equipment costs. Building costs included the cost of the bin itself, its' construction, concrete floor or foundation, flush floor aeration, ladders and control pipe. Equipment costs included the cost of the aeration fans, unloading augers, sweep augers, and portable augers. Investment costs for the storage and drying system were broken down much the same as the storage only systems except now the dryers and their components are added to total investment costs. The authors separated investment cost into building costs, equipment costs and drying costs, in each of the different drying systems and sizes of facilities.

Annualized fixed or variable costs for operating the storage system and drying systems are provided. To determine annual total costs the authors have assumed a storage period of six months at maximum capacity. To determine total costs associated with drying, the authors have assumed that the dryers will remove 10 percentage points of moisture from all grain delivered to farm bin storage during the harvest period. Grain was assumed to enter storage at 25 percent moisture. These authors present much the same breakdown of fixed and variable costs as previous studies reviewed. One major difference between this study and others is that these authors felt repairs and maintenance was best represented as a fixed cost instead of a variable cost. These authors also included weight loss as a component of variable costs. Weight loss was divided into two segments, moisture loss and dry matter loss in the storage only section of the studies, and shrink and invisible losses in the storage plus drying section of the study. Moisture losses are due to operating the aeration system to cool stored grain. This cooling process reduces the moisture content of grain below levels acceptable in the market place without discounting. Dry matter losses are weight losses due to loading and unloading storage bins. These losses include grain spillage and leakage from handling equipment. Although the authors title weight losses differently in the storage with drying segment of their analysis, they do not seem to make a differentiation in meaning. Generally, shrinkage is thought of as the weight loss due to moisture loss in the stored grain and invisible losses are generally referred to as weight loss due to moving grain in and out of storage. The authors do not, with this text, define what they mean by shrinkage and inviisible losses. They do, however, apply the same per bushel costs to each respectively as they

do to moisture and dry matter losses. This indirectly implies the authors are assuming moisture loss and shrinkage are one in the same and that dry matter losses and invisible losses too, have the same meaning. The authors did not include interest on operating capital or interest on inventory in the variable cost section of their analysis.

Adeyemo, Malone, Phillips, and Couvillian (1977) analyzed the costs and potential returns associated with on-farm storage of soybeans in Mississippi. The objective of their study was to; 1) develop a detailed cost estimate of soybean storage facilities of various sizes, and 2) to evaluate the economic feasibility of constructing storage facilities. These authors determined investment requirements and annual operating costs for storage and drying systems with capacities of 15,000, 30,000, 45,000 and 60,000 bushels. All facilities were metal bins on concrete foundations arranged in a semi-circle around a dump pit with transport augers. All systems also included heated-air drying facilities. Investment costs included the cost of the storage unit, equipment and land upon which the facility was built. All costs were "lock and key" estimates, except for electrical hook-up and site preparation. The investment costs were determined using mid-1976 costs obtained from secondary sources and commercial companies.

The authors classified annual costs with fixed and variable costs assuming a six month storage period and only soybeans could be stored. These authors felt that the opportunity cost of holding soybeans was not a variable cost, per se, and chose to separate it from the variable cost category. After determining the annual costs associated with storing soybeans for six months, the authors estimate the monthly per

bushel costs of owning and operating storage facilities. Monthly estimates were made of costs that are fixed if facilities are used and variable by the time of use. Fixed costs are the costs which are incurred whether or not the storage systems are used. Fixed if facilities are used costs are variable costs which become fixed if sunk once soybeans are placed in storage. Variable by time of use costs are variable costs which vary with the length of storage period. Monthly costs estimates were obtained by dividing six into one-half the electricity, all of the soybean insurance, opportunity costs and the interest on operating capital represented by electricity and insurance costs.

Monthly cost estimates were compared with average monthly cash price movement from the harvest price level to determine whether seasonal price increases covered storage costs. The authors used average monthly soybean prices for Mississippi, the North Delta and Central Delta as reported by the Mississippi Crop and Livestock Reporting Service and Grain Market News.

The final objective of Adeyemo, et al (1977) study was to evaluate the on-farm storage facility investment. The authors applied two separate methods to analyze the storage investment; 1) payback period, and 2) discounted cash flow. The payback period is the amount of time required to recover the investment. It is calculated by taking the amount of capital required for the investment and dividing it by the estimated annual cash earnings. The authors assumed a 15 year useful life on equipment and a 20 year life on the storage bins, when calculating the payback period. The discounted cash flow method of analysis determines the economic worth of an investment allowing for

reflection of time preference for money.

Other cost and return studies reviewed included Malone, Holder, and Parvin (1979), "The Economics of On-Farm Rice Drying-Storage Facilities in Mississippi", Schwart and Hill (1977), "The Costs of Drying and Storing Shelled Corn on Illinois Farms", Holder, Usman and Parvin (1976), "Costs of On-Farm Rice Drying-Storage Facilities in Mississippi", and, Nichols (1978), "The Economies of Drying Grain on the Farm."

Review of Results. Nichols and Updaw (1978) found that batch-in-bin dryers were the least-cost initial investment in annual storage volume of 6,000 to 24,000 bushels and the automatic batch dryer provided the least-cost system for an annual storage volume of 40,000 to 100,000 bushels. Investment costs for these least-cost storage and drying systems ranged from $3.11/bushel in the 6,000 bushel facility to $1.22/bushel for the 100,000 bushel facility. Investment costs for the least-cost drying system alone ranged from $0.31/bushel in the 6,000 bushel capacity unit to $.29/bushel for the 100,000 bushel unit. Economics of size were evident when examining annual costs of storing and drying combined. Total costs per bushel ranged from 77 cents/bushel in the 6,000 bushel least-cost facility to 46 cents/bushel in the 100,000 bushel least-cost storage plus drying facility. Total costs per bushel associated with the drying system alone ranged from 51 cents/bushel for the 6,000 bushel least-cost system to 15 cents/bushel for the 100,000 bushel least-cost drying system. The storage facility by itself did not show the same economics of size as does the storing plus drying system and the drying system alone. Total storage costs range from 26 cents/bushel for the 6,000 bushel facility to 31 cents/bushel for

the 100,000 bushel facility. The reason for the apparent increase in per unit total costs is because of difference in the handling equipment used in the larger systems. The handling system of the 40,000 to 100,000 bushel storage system was designed around using a bucket elevator to handle grain. The initial investment in the bucket elevator is tremendous, causing per bushel fixed costs to increase, which in turn increases per unit total costs.

The rate of return associated with drying without storage exceeded those of drying plus storage. The before-tax rate of return for drying and storage ranged from negative values for all the 6,000 bushel facilities to a high of 23.30 percent for the 100,000 bushel automatic batch dryer and storage facility. The annual before-tax rate of return for only the drying system ranges from negative values for all the 6,000 bushel capacity dryers to 172.20 percent for the 100,000 bushel automatic batch dryer. These findings indicate that producers who produce less than 24,000 bushels of corn annually could not earn a rate of return before-taxes that covered the cost of borrowed funds. Nichols and Updaw (1978) computed the after-tax rate of return for each drying and storage system by incorporation tax incentives such as the investment tax credit and accelerated depreciation methods into the analysis. Such tax incentives were found to raise the after-tax rate of return to a level which exceeded the before-tax rate of return. The after-tax rate of return for drying and storage ranged from negative values for all the 6,000 bushel facilities to 35.40 percent for the 100,000 bushel automatic batch dryer and storage facility. The annual after-tax rate of return for only the drying system ranges from negative values for all the 6,000 bushel capacity

dryers to 320.00 percent for the 10,000 bushel automatic batch dryer. Even after including tax benefits, the rate of return for all the 6,000 and some of the 12,000 bushel facilities were still unfavorable. In general, the author concluded that volumes of grain 12,000 bushels or greater were needed to make an investment in drying and storage facilities profitable.

Skees, et al (1978) found that per unit variable costs were generally higher for the recommended systems than for the representative systems. Recall, the recommended storage systems were constructed on the basis of what appeared to be typical for each of the representative size farms under study. The recommended storage systems were designed on the basis of engineering recommendations with the ojbective of designing a least-cost storage system that would meet harvest requirements and accomodate storage of all grains produced. The authors feel the main costs are higher in the recommended storage systems that in the representative storage system, due to the increased drying requirements of the recommended storage systems. Net returns associated with storing corn, wheat, and soybeans was typically highest for each size farm for the recommended system selling at the recommended times. Net returns were higher in all cases when grains were sold at the recommended time versus selling grains at the traditional times of year. The authors found that traditionally, farmers sell wheat during the fall, corn between January and May, and soybean between January and April. The recommended selling period for each grain is; September for wheat, August for corn and June for soybeans. Returns ranged from negative in the small-sized farm (100-175 tillable acres) and mid-sized farm (176-450 tillable acres)

to $921.30 in the large-sized farm (more than 450 tillable acres) in the representative system selling at traditional times, while selling at the recommended dates increased the profitability of each of the representative farm systems. Net returns for the recommended system selling at the recommended times ranged from $522.82 for the small-size farm to $20,512.07 for the large-size farm.

Linville and Sorenson (1977) found that average total cost for storage alone ranged from 21.2 cents per bushel for the 5,000 bushel storage system to 12.7 cents per bushel for the 120,000 bushel system at the 100 percent utilization level. Average fixed costs for the storage only systems ranged from 15.5 cents per bushel for the 5,000 bushel system to 7.2 cents per bushel for the 120,000 bushel system at 100 percent utilization. Average variable costs were found to range from 5.7 cents per bushel to 5.5 cents per bushel for the 5,000 bushel and 120,000 bushel storage systems, respectively. Linville and Sorenson (1977) found depreciation and interest in inventory to be the largest component of total annual costs. Together, depreciation and interest on investment account for between 60 and 73 percent of the total annual fixed costs of the storage systems under study. Weight loss due to moisture loss and dry matter loss was found to be the single largest component of total annual variables for storage systems without dryers. Weight loss accounted for over 50 percent of the total annual variable costs of each storage system. Linville and Sorenson (1977) found that the level of utilization and average total costs were conversely related. That is, as utilization of the storage system decreases, average total costs increase and vice-versa. This situation occurs because average fixed, a component of average

total costs, is inversely related to the level of utilization while average vairiable cost, the other component of average total cost, does not vary with the level of utilization.

Linville and Sorenson (1977) determined the annual costs associated with storage systems that included dryers. The authors found that the in-bin continuous dryer was the least-cost drying system to operate for most of the storage systems studied. Annual variable costs for drying varied from 4 cents per bushel in the 10,000 bushel system to 8.72 cents per bushel for the 120,000 bushel facility. The in-bin drying and storage system was the least-cost initial investment for all sizes of facilities under study. Per bushel investment ranged from 1.32 dollars per bushel for the 10,000 bushel facility to .65 dollars per bushel for the 120,000 bushel facility. All storage systems under study showed definite economics of scale associated with increasing storage and drying capacities.

Adeyemo, et al (1977) found that total investment in on-farm storage systems for soybeans ranged from $21,050 for the 15,000 bushel facility to $49,150 for the 60,000 bushel facility. Investment costs per bushel declined from $1.40 for the smallest facility to $.82 for the largest facility. Annual costs for storing a bushel of soybeans ranges from 47.3 cents for the 15,000 bushel facility to 37.1 cents for the 60,000 bushel facility. Storage costs were estimated assuming that only soybeans would be stored for a six month period. The authors found that during the five year period under study, the sixth and tenth month after harvest were the most profitable months to sell on the average. Storage of corn at harvest with removal during April was shown to be unprofitable in the last five years.

Pay-off periods for the feasible storage facilities ranged from less than one year to over 30 years, depending upon the system's size and when grain was removed from storage. Net present value, assuming October harvest, is negative for the months of April and May. On the average, storage in October with sales in August would result in positive net present value for all storage systems at all market locations. Net present value, assuming November harvest, is negative when rice is removed from storage in April. All other removal months show a positive net present value. Positive net present value for November harvest and storage ranged from 11 cents per bushel to $4.80 per bushel for the different market locations and selling dates. Again, storage in November with sales in August would result in the highest net present value for all storage systems at all market locations.

Other studies that need to be mentioned in this section of literature review were conducted by; Trapp (1977), and Bloome, Nelson, and Roush (1975). Each of these studies have provided helpful guidelines in developing aspects of the current study.

Trapp (1977) presented information guidelines to help farmers make decisions concerning the storage of wheat. Trapp (1977) assumed the cost of storage to be made up of the commercial storage rate and interest costs on money tied up in the stored wheat. Commercial storage fees were assumed to be 1.5 cents per bushel per month and the rate of interest depended upon the producers' position. A 12 percent rate of interest was applied to represent a situation where a producer has outstanding debts which could be removed by selling his wheat. If the producer had no debts, money from the sale of his

wheat could be placed in the bank and upwards of six percent interest could be earned.

The revenue earned from storing wheat depends upon the direction and magnitude of price movements from the post-harvest level. With these cost and revenue figures, the author determined net revenue from storing wheat for various months during the year. Trapp (1977) found that "on the average" December showed the largest net-revenue level and thus was the most profitable month to sell wheat, assuming no tax advantage associated with holding wheat into the next tax year. However, when looking at each year individually no real trend as to the "best" sales month could be found and December never once showed up as the optimal sales month.

The rest of Trapp's (1977) study was devoted to predicting returns to commercial storage of wheat and using these predictions to make storage decisions. The prediction model presented in this paper used fundamental supply and demand conditions to determine when wheat storage could be profitable. Trapp (1977) found that returns to wheat storage until December were likely to be higher when the supply/demand ratio for wheat was low and wheat stocks were being liquidated. After developing the prediction model, Trapp (1977) used it to aid in the task of deciding whether or not to commercially store wheat. Trapp (1977) used U.S.D.A. pre-harvest and post-harvest estimates of supply, demand and stock changes in his decision model. Three decision models were developed based upon these U.S.D.A. estimates: 1) Pre-harvest Decision; 2) Post-harvest Decision; and 3) Combined pre- and post-harvest Decisions. Pre-harvest decision method is used to determine whether wheat should be sold at harvest or stored. If the

pre-harvest rate of return is forecast to be negative, the decision is made to sell wheat at harvest, otherwise wheat is stored until December. When post-harvest forecasts are available they are used to determine whether wheat should be stored until December or sold immediately. So long as the post-harvest rate of return is positive and/or greater than the rate of return obtained by immediately selling wheat, the decision is made to store wheat until December. The combination decision method uses both the pre- and post-harvest decision method to help make storage decisions. In this method, the pre-harvest decision is double checked in July with the post-harvest information. The decision rules applied in the combination method are the same as the decision rules applied individually to the pre- and post-harvest decision methods discussed earlier.

Bloome, et al (1974) compare fixed and variable cost analysis (Conventional Economics Analysis) with cash flow analysis for the same grain system. A primary weakness in total annual cost analysis is the fact that annual usage is seldom uniform over the life of an investment. Conventional economic analysis is useful in determining the average annual costs or average annual profitability of an investment. Such an analysis does not take into consideration income tax benefits or accelerated depreciation methods. Cash flow analysis, on the other hand, takes into consideration current tax incentives such as investment credits and accelerated depreciation. Cash flow analysis involves charting the flow of cash, resulting from an investment. Cash flow analysis is not directed to the question of profitability or maximum profit, it is directed to the question of fiscal feasibility, or the ability to meet the financial obligation of the investment. Cash flow analysis projects the timing and magnitude of cash shortages and

surpluses.

In their paper, Bloome, et al (1974) present the net present value or discounted cash flow concept. This type of analysis allows the prospective investor to view the investment at any point in the future in terms of its' present value in current dollars. A negative net present value for an investment means savings is a better investment. A positive net present value for an investment means it will provide greater returns than savings would.

CHAPTER III

Procedures

This section of the study is concerned with the procedures and assumptions utilized to analyze the costs and returns associated with owning and operating on-farm storage systems of various sizes in Oklahoma. More specifically, the topics discussed in this section will include the assumptions and procedures necessary to determine, 1) the capital investment requirements for each storage system under study, 2) the annual and monthly costs associated with owning and operating on-farm storage systems of various sizes and 3) the returns associated with storing wheat on-farm for various lengths of time. Each topic will be discussed, in order, within this chapter.

On-Farm Wheat Storage Systems in Oklahoma

For the purpose of this study, on-farm storage systems will be categorized into three groups depending upon the type of handling equipment utilized and the type of electric motors. The first category of storage systems will utilize a portable auger to handle wheat and all motors will be single-phase electric motors. There will be ten storage systems, ranging from 2,000 bushels to 80,000 bushels of storage capacity, within this category of storage systems. The second category of storage systems analyzed will also handle wheat with a portable auger, however,

this category of storage systems will utilize three-phase electric motors. This category of storage systems will consist of six storage systems ranging in storage capacity from 10,000 bushels to 80,000 bushels. The third category of storage systems will consist of four storage systems ranging in size from 30,000 bushels of storage capacity to 80,000 bushels of storage capacity. This category of storage systems will utilize a bucket elevator to handle wheat and all motors will be three-phase electric motors. The investment requirements for each category of storage systems will be discussed below.

Capital Investment Requirement

Investment requirements will be developed for, 1) Category One storage systems having storage capacities of approximatley 2,000, 3,000 5,000 7,000, 10,000, 20,000, 30,000, 40,000, 60,000 and 80,000 bushels, 2) Catory Two storage systems having storage capacities of approximately 10,000, 20,000, 30,000, 40,000, 60,000 and 80,000 bushels, and 3) Category Three storage systems having storage capacities of approximatley 30,000, 40,000, 60,000 and 80,000 bushels. Each storage system analyzed in this study will be designed on the basis of engineering recommendations, current practices and equipment availability, with the objective of developing a least-cost on-farm storage system which will meet the needs of wheat producers in Oklahoma. For the purpose of this study, all storage systems will be designed solely for the purpose of storing wheat and all what entering storage will be assumed to enter storage at a moisture concent of 12.5 percent. All on-farm storage systems in this study, whether they are Category One, Two or Three, will be designed such that a doubling of the storage capacity can be easily accomplished with

minimal addition investment required in handling equipment.

Capital investment information for the various categories of on-farm storage systems will be obtained from equipment dealers and manufacturers in Oklahoma. All investment requirements will be based on a ready to use storage system and mid-May 1980 list price quotations. Capital investment requirements will be broken into three categories; 1) the Storage Unit, 2) the Aeration and Handling Equipment and 3) the Land Requirement. Each investment category will be discussed separately.

The Storage Unit. Twenty separate storage systems ranging in total non-compacted storage capacity from 2,000 bushels to 80,000 bushels will be analyzed. The non-compacted storage capacity of each storage system represents the storage capacity of each bin when grain depth equals the storage bin's sidewall height. That is, the non-compacted storage capacity of each storage bin does not include storage of grain in the roof section. Storage bins within each storage system will be combined such that the combination of bins results in the lowest initial investment requirement for each storage system. Storage systems having a non-compacted storage capacity of 10,000 bushels or less will be assumed to consist of a single storage bin, while storage systems with greater than 10,000 bushels of non-compacted storage capacity will consit of multiple storage bins arranged in a semi-circle around either the portable auger or bucket elevator.

Investment requirements for the storage unit will be categorized into three investment components; 1) Storage Bins, 2) Foundation and 3) Erection Bin.

Storage Bins. All storage bins utilized in this study will be flat-bottom unstiffened round metal bins with step-in access side door and a port-hole roof door. Also included with all storage bins will be an outside ladder, auger slat hood, roof ladder, safety cleats and a center fill opening with cover plate. An inside ladder will be included with all storage bins with an eave height of 22 feet or greater. Price quotations on all storage bins and related accessories will be attained from equipment dealers and manufacturers in Oklahoma. All price quotations will be based on mid-May 1980 quotations of the current list price for each bin and its' related equipment.

Foundation. All storage bins in this study will be placed on a concrete foundation which will be approximatley one foot in height and one foot wider in diameter than the storage bin which rests upon it. The foundation costs will include concrete, all necessary forming for aeration ducts and unloading auger, steel reinforcing, anchor bolts and all labor and other material necessary to complete the foundation. Site preparation will not be included in the foundation costs. It will be assumed, for the purpose of this study, that very little if any work is required to prepare the proposed site. Foundation costs will not include the investment necessary for the bucket elevator foundation and dump pit. These investment requirements will be included with the handling equipment. Estimated cost of the foundation will be determined by applying a rate of $2.00 per square foot to the estimated square footage of each bins' foundation. For example, if a storage bin has a diameter of 14 feet, the bin foundation would have a diameter of 15 feet and would cost $353.57 ($2.00/sq. ft. x 3.14 $(15 \div 2)^2$). Recall, the area of a circle

equals $pi(r)^2$ where pi = 3.14 and r is the radius of the circle.

Erection of Bin. Erection costs are the costs associated with the actual construction of each storage unit. Construction costs will be obtained from a bin construction company in Oklahoma, and will cover the actual putting together of each storage bin. Construction costs will not cover the installation of augers, construction of the bucket elevator or placing of spouting. These costs will be included with the handling equipment. Erection costs for the storage unit will be based upon the storage systems rated non-compacted storage capacity. Erection costs will be computed at 10 cents per bushel rated non-compacted storage capacity. For example, suppose a storage system consists of three storage bins, each having a rated non-compacted storage capacity of 11,036 bushels. This storage system's total non-compacted storage capacity would be 33,108 bushels and the estimated cost of erecting this storage system would be $331.08 (33,108 bu x .10/bu).

The Aeration and Handling Equipment. Each storage system will be designed to maintain wheat quality and to efficiently meet the harvest requirements of wheat producers in Oklahoma. Recall, storage systems analyzed in this study will be categorized accorinding to, 1) the type of handling equipment the storage system utilizes, more specifically whether the storage system uses a portable auger or a bucket elevator to handle wheat, and 2) the type of electric motor utilized, that is, whether the electric motor is single-phase or three-phase. Categorizing storage systems according to type of handling equipment will allow an economic comparison of the two modes of handling wheat. Generally, portable augers require substantially less initial capital outlay, while

bucket elevators tend to handle wheat more efficiently. The categorization according to power sources will allow for a more complete analysis of on-farm storage in Oklahoma. Many areas of Oklahoma are without three-phase electric service and thus, if this study only considered the use of three-phase motors it would have limited usefulness to many producers in Oklahoma. However, because three-phase motors are not available in horsepowers less than 1 h.p., three-phase motors will not be an alternative in storage systems with less than 10,000 bushels of storage capacity. It is also assumed that all electric motors within any single storage system will be of like phase, i.e. either all single-phase or all three-phase.

Investment requirements for Aeration and Handling Equipment will be broken into four investment categories; 1) Aeration Equipment, 2) Portable Auger or Bucket Elevator, depending upon the category of storage system analyzed, 3) Unloading Equipment, and 4) Electrical Wiring. Each investment category is discussed separately below.

Aeration Equipment. Each individual storage bin will be equipped with the aeration system specified by the bin manufacturer for the type of grain to be stored. The aeration system utilized in this study will be a flush-floor aeration system with "Y" pattern aeration ducts. Flush-floor aeration means that the aeration ducts are set below floor level and formed directly into the bin foundation. Included with the aeration system will be tunnel covers, transactions and ducts and the specified aerations fan. The aeration fan will be an axial type fan designed to complete cooling grain in 120 hours. All aeration fans utilized in this study will blow air upward through the grain mass rather than drawing

air downward through the grain mass.

Handling Equipment. Handling equipment will be designed to prevent bottlenecks from occurring during peak harvest periods. Storage systems analyzed in this study will be equipped with either a portable auger or bucket elevator. Category One and Two storage systems will handle wheat with a portable auger while Category Three storage systems use a bucket elevator to handle wheat.

The portable auger utilized in this study will be powered with either a single-phase or three-phase electric motor and all portable augers come complete with an undercarriage, reduction winch, belts, auger pulley, 15 inch rims, hitch with intake guard, and gear drive. Optimal equipment included with all portable augers will be either a plastic pit hopper or concrete dump pit and a three foot flex tube with 45-degree safety spout. A swivel arc kit will be included with the portable auger in all multiple bin storage systems. The multiple bin storage systems will also include a concrete dump pit, whereas all single bin storage systems will be equipped with a plastic dump hopper. Investment requirements for the concrete dump pit will be computed at $100 per cubic yard and will cover the cost of forming, steel reinforcing, concrete and all labor necessary to complete the dump pit.

All Category Three storage systems will utilize a bucket elevator to handle wheat. The bucket elevator will use only three-phase electric motors. Investment requirements for the bucket elevator includes the investment necessary for the bucket elevator, ladders, downspouting, drive-over unloading pit, erection costs, and foundation costs for the elevator and drive-over pit. Investment requirements for the bucket elevator, it's related equipment, spouting and the drive-over unloading

pit will be based on mid-May 1980 list price quotations from manufacturers and dealers in Oklahoma. Major elevator components include drives, motors, grain distributor and spouting. An 8-way grain distributor will be utilized on all bucket elevators in the study so expansion of each storage system can be accomplished easily. The major components of the drive-over unloading pit include the u-trough auger, motor, and dump pit. The erection costs for the elevator will include erection of the elevator and placement of the spouting. Erection costs will represent approximately 50 percent of the total cost of the bucket elevator foundation which will include all concrete, steel, forming, and labor necessary to complete the foundation and will be computed at $125.00 per cubic yard of concrete needed. Erection costs and foundation costs utilized in this study will be based on having an experienced millwright complete all necessary work.

Bin Unloading Equipment. The bin unloading equipment will include the bin sweep augers, horizontal flights, 25-degree augers, low-boy augers and variable height auger utilized within each storage system. Each individual storage bin will be equipped with its' own sweep auger and 25-degree auger. Category One and Two multiple bin storage systems will include a low-boy auger to transport grain from the storage bin to the permanent concrete dump pit. Category Three storage systems will be equipped with a variable height auger vs. 25-degree auger utilized in the Category One and Two storage systems. The variable height augers will carry grain directly to the bucket elevator or drive-over unloading pit. Category One storage systems with 5,000 bushels or less storage capacity will be equipped with six inch unloading equipment. Each storage bin

will be equipped with a center bin well and unloading tube of specified length. An optimal band-on intermediate well will be included with all storage bins 18 feet to 27 feet in diameter and two band-on intermediate wells will be included with storage bins between 30 feet and 36 feet in diameter. Bin wells and unloading tubes will be formed directly into the foundation of each storage bin. Investment requirement in bin unloading equipment will include the cost of the unloading augers, electric motors either single-phase or three-phase, and the installation of the augers. Bin unloading equipment and electric motors are priced according to mid-May 1980 list price quotation from manufacturers and dealers in Oklahoma. Installation costs for the augers will be computed at 10 percent of the total investment required for the augers utilized in each storage system.

Electrical Wiring. Electrical wiring costs for each storage system will be determined according to the total horsepower requirement of the storage system. Electrical wiring costs will be estimated at $125 per horsepower and, will include all neceassary electric panels, wiring and labor necessary to properly wire each storage system to meet state building codes. Note, electrical wiring costs will not cover the cost of bringing electricity to the proposed building site. It will be assumed that the necessary power source, either single-phase or three-phase, will be available at the proposed building site. The cost of wiring a storage system that utilizes two 1 1/2 h.p., one 5 h.p. and one 10 h.p. electric motors would be $2,250.00 (18 total horsepower x $125/h.p.).

Land Equipment. Each storage system is required to purchase the land on which the storage system is built. Land requirement will con-

sider the current market value of the land occupied by the storage system. The current market value of land will be based upon the average value of land in the wheat producing region of Oklahoma. The average per acre value land used in this study will be $522 per acre. The investment requirement for land will be determined by multiplying the area of land occupied by the storage system by the average per acre value of the land. For example, suppose the storage system requires 1/10 of an acre of land, the investment requirement for land would be $52.00 (1/10 acre x $522.00).

Total Cost of On-Farm Wheat Storage

The total costs of owning and operating on-farm storage systems of selected storage capacities will be determined on an annual and monthly basis. Annual total costs of owning and operating on-farm storage systems in Oklahoma will be computed assuming wheat is stored for six months. Monthly costs of owning and operating on-farm storage systems in Oklahoma will be estimated from each stoage system's annual total costs by categorizing annual total costs into fixed costs, use-conditional variable costs. All annual and monthly costs are based on the assumption that only wheat is stored within each storage system.

Total Annual Costs of On-Farm Storage. Total annual costs of owning and operating on-farm storage systems in Oklahoma will be computed at three levels of utilization; 100 percent, 75 percent, and 50 percent. Where, 100 percent utilization will be defined as storage for six months at 100 percent of the storage systems rated non-compacted storage capacity. Seventy-five percent utilization will be defined as storage for

six months at 75 percent of the storage systems rated non-compacted storage capacity and 50 percent utilization will be defined as storage for six months at 50 percent of the storage systems rated non-compacted storage capacity. For example, if a storage systems rated non-compacted storage capacity is 11,036 bushels, 100 percent utilization of this storage system would require 11,036 bushels of wheat to be stored for six months, 75 percent and 50 percent utilization would require 8,277 bushels and 5,518 bushels of wheat to be stored for six months, respectively. Total annual costs of on-farm storage will be broken into two categories; total annual fixed costs and total annual variable costs. Each cost category will be defined and discussed below.

Total Annual Fixed Costs. Fixed costs are those costs which, once the storage system is built, are incurred whether or not the storage system it utilized. Total annual fixed costs will include depreciation, insurance on the storage system, interest on the inventory, and property taxes.

The straight line method of depreciation will be used to compute annual depreciation. The storage bins and bucket elevator will be assumed to have a useful life of 20 years and zero salvage value. Annual depreciation on the storage bins and elevator will be calculated at five percent per annum of the original investment. The bin unloading equipment, portable augers and u-trough augers will be assumed to have a useful life of 10 years and zero salvage value. Annual depreciation on the bin unloading equipment, portable augers and u-trough augers will be calculated at 10 percent annum of their original investment.

Fire and extended coverage insurance will be provided for all storage systems analyzed in this study. An annual rate of $10 per $1000

valuation will be applied for the storage bins, while an annual rate of $20 per $1000 valuation will be applied for storage system equipment. The storage bins and equipment will be insured according to their current value.

Property taxes vary widely from county to county in Oklahoma. For the purpose of this study property taxes will be based on a 7 percent assessment rate and a millage rate of 66.87 ($66.87 per $1,000 valuation). The assessment rate and mill utilized in this study is the average assessment rate and mill for the major wheat producting counties of Oklahoma. Property taxes will be determined using the current investment requirements for the storage system and land.

Total Annual Variable Costs. Variable costs are those costs which can be avoided by not using the on-farm storage sytem. Variable costs will include grain insurance, grain handling, aeration, insect control, maintenance and repairs, interest on operating capital and shrinkage.

While in storage, all wheat will be insured against the possibility of losses caused by wind, fire and theft. Insurance costs will be based on an annual rate of $8.00 per $1,000 valuation of wheat which is assumed to be valued at $4.00 per bushel.

Grain handling costs involve the time associated with placing wheat in and removing wheat from the storage systems. The time required to load and unload storage systems is directly tied to the capacity of the handling equipment. For example, if the handling equipment is rated at 2000 bushels per hour, it would take approximately 5 hours to load and 5 hours to unload a 10,000 bushel storage system. Grain handling costs are divided into labor costs and electrical costs. Labor required to load and unload Category One and Two storage system will be computed at

100 percent of the total operating hours of the handling system. The difference in labor requirments is associated with the additional time necessary to set up and move the portable auger. An hourly wage rate of $3.82 will be used to compute labor costs associated with grain handling. Electrical costs for handling wheat will be computed by assuming one horsepower times one hour of operation equal one kilowatt hour and one kilowatt hours cost 4.5 cents. It will also be assumed that the sweep auger operates 20 percent of the time while removing wheat from storage. The formula for computing electrical costs for handling wheat is Hrs. x H.p. x 4.5 cents, where Hrs. equals the total hours of operating the handling system (including the operating time associated with running the sweep auger), H.p. equals the horsepower requirements of the handling equipment and 4.5 cents represents the charge per kilowatt hour.

Aeration costs are divided into labor charges and electricity charges. Labor associated with the aeration system represents the time necessary to manage the aeration system and to periodically inspect the stored wheat. It will be assumed that 1/2 hour per week is needed to properly manage and inspect stored wheat. It will also be assumed that the producer himself manages and inspects the stored wheat. An hourly wage rate of $8.00 is applied for the producer's time. Electrical charges are associated with the electricity used to operate the aeration fan. It will be assumed that wheat will be aerated when first placed in storage and then again in the fall when night time temperatures fall below freezing. Aeration of wheat immediately after placing grain in storage helps remove field heat. Aeration in the fall when night time temperatures fall below freezing helps lower the temperature of the grain mass to about 40 degree F. The growth of common grain fungi and insects

are eliminated at temperatures below 40 degrees F. It is still recommended that the stored grain by routinely inspected. Both aeration periods will require the aeration fan to operate 120 hours. The formula applied to determine the electrical costs associated with operating the aeration fan is: Hrs. x H.p. x 4.5 cents, where Hrs. is the total hours of areation required (120 hours when wheat is first placed in storage and 120 hours in the fall), H.p. is the horsepower requirement of the aeration fan and 4.5 cents represents the charge per kilowatt hour of operation. It will be assumed that one horsepower times one hour of operation equals one kilowatt hour and one kilowatt hour costs 4.5 cents.

Insect control involves cleaning the storage bin and surrounding area, applying a residual spray to the floor and wall surfaces of all bins, and applying a protectant to the clean wheat as it enters storage. Insect control is divided into labor charges and chemical charges. Labor charges will include the time necessary to; 1) clean the storage bin and surrounding area, 2) apply the residual spray to all storage bins, and 3) apply protectant to clean wheat as it enters storage. It will be assumed that it takes the producers 3 hours per bin to perform the above described tasks. Again, because the producer will be assumed to perform the above described tasks, an hourly wage rate of $8.00 will be applied to determine labor costs associated with insect control. The residual spray utilized in this study will be premium grade 16% emulsifiable concentrated malethion at one pint per 3 gallons of water applied at a rate of one gallon of spray per 500 square feet of surface. Residual spray will be applied to the floor and wall surfaces of all bins to the point of runoff. Malethion is priced at $16.00 per gallon. Dry malethion is applied to clean wheat as a protectant at one pound per 100 bushels of

wheat. Dry malethion is priced at 75 cents per pound. Malethion applied as a protectant will help protect stored wheat through the summer months and until grain temperatures can be lowered through the use of aeration. A word of caution is issued to all producers applying chemical sprays and protectants to grain, these chemicals are very dangerous and should be handled with care and all container warnings should be read before using.

The aeration and insect controls described above DO NOT take the place of inspecting stored wheat. They are a supplement to a regular inspector schedule.

Maintenance and repairs associated with the storage bins and equipment will be allocated eventually over the life expectancy of the item. Maintenance and repairs for the storage bins will be computed at 10 percent of the original investment requirement and allocated evenly over 20 years. Maintenance and repairs associated with storage systems equipment will be computed at 30 percent of the original investment requirement allocated evenly over 10 years. Maintenance and repairs of the bucket elevator will be computed at 30 percent of the original investment requirement allocated evenly over 20 years. The maintenance and repair costs for the bucket elevator will be reported in the equipment maintenance and repair category.

Interest on operating capital assumes a loan period of six months at 15 percent per annum to cover annual operating costs. Interest on operating capital will be calculated by summing annual operating cost (insurance, grain handling, aeration, insect control and maintenance and repairs) and applying an annual interest rate of 15 percent over the six month storage period.

Shrinkage is treated as a farm storage cost because the producer

must absorb all shrinkage in weight of the wheat while the wheat is in on-farm storage. Shrinkage will be broken into two categories; 1) moisture loss and 2) invisible loss. Moisture loss is the shrinkage associated with reducing the moisture content of the wheat. Moisture loss is a by-product of grain aeration that is, as air is forced through the grain mass moisture is drawn from the wheat. However, aeration is needed to help maintain grain quality. Producers can avoid excess shrinkage of grain through careful management of the aeration system. That is, knowing when and for how long aeration fans should be operated. Invisible loss is shrinkage associated with spillage and leakage while wheat is being moved into and out of the storage system. Shrinkage cost will be computed by assuming wheat will shrink 2 percent (1.75 percent moisture loss and 125 percent invisible loss) while in storage. Wheat will be valued at $4.00 per bushel. Total shrinkage due to moisture loss will be 1.75 percent, of which .60 percent occurs when wheat is aerated in the fall. Shrinkage due to invisible loss will be .25 percent of which .125 percent occurs when wheat is moved into storage and the other .125 percent occurs when wheat is removed from storage.

Monthly Costs of On-Farm Storage. Annual total costs of owning and operating on-farm storage systems will be used to estimate monthly costs associated with owning and operating the various storage systems under study. Monthly cost estimates will be compared to historical wheat prices in Oklahoma to determine whether seasonal price increases are enough to cover on-farm storage costs. Monthly costs estimates will be calculated by categorizing total annual costs into fixed costs, use-conditional variable costs and time-conditional variable costs. Fixed

costs are those costs which occur whether the storage system is utilized or not. Use-conditional costs are variable costs which become fixed or sunk once the decision to store wheat on-farm is made. Use-conditional variable costs include, 1) grain insurance, 2) grain handling, 3) electrical costs of aeration, 4) insect control both labor and chemicals, 5) maintenance and repairs for both the storage bins and equipment, 6) interest on capital used to cover use-conditional variable costs, and 7) shrinkage. Time-conditional variable costs include the labor charge for aeration and the interest on operation capital associated with this labor charge.

The monthly cost equation will include an intercept, a slope variable, and a dummy variable. The intercept will represent the fixed costs and use-conditional variable costs. The slope will represent the time-conditional variable costs. The dummy variable will represent the additional aeration charge associated with aeration of wheat in the fall. Mathematically specified, the monthly cost equation is:

$$Y = a + bx_1 + cx_2$$

where, Y is the monthly cost of on-farm storage

a is the intercept

b is the slope coefficient

x_1 is the number of months wheat is in storage

c is the coefficient for the dummy variable

$x_2 = 0$ if < 5 months

$x_2 = 1$ if ≥ 5 months

The dummy variable allows the additional cost of aeration to be included only after five months. The dummy variable is a use-conditional

variable cost that occurs only after wheat has been stored for five months. This costs includes the electricity necessary to operate the aeration fans, the shrinkage associated with the additional aeration, and the interest on operating capital used to cover the cost of electricity. The slope of the cost equation will be computed by dividing the annual labor charge for aeration by six months and the interest charge associated with the monthly labor charge.

Opportunity Cost of Capital to Hold Wheat

The opportunity cost of capital to hold wheat is defined as the interest charge associated with potential use of capital tied up in the wheat inventory or the interest charge associated with borrowing money to pay off outstanding debts while wheat is kept in storage. Since the opportunity cost of capital is not a cost solely associated with on-farm storage of wheat, it will be handled separately in this study. The opportunity cost of capital is dependent upon the the value of wheat and the cost of capital. For the purpose of this study, the opportunity cost of capital to hold wheat will be computed assuming an annual interest rate of 15 percent and $4.00 per bushel value of wheat.

Returns to On-Farm Storage of Wheat

Returns to on-farm storage refers to the increased market value associated with postponing the sale of wheat until some months after harvest. Traditionally, wheat prices are lowest during harvest and as time passes they generally begin to rise. The magnitude prices increases after harvest determines the potential revenue that can be earned by postponing

the sale of wheat until some future date.

Storage Revenue. To determine the potential revenue associated with storing wheat in on-farm storage facilities in Oklahoma, this study will look at monthly average price changes for storage intervals of one month to ten months. The average storage margin--the difference between the June price level and a price sometime in the future--will be based on average wheat price spreads between June and selected months over the last ten and fifteen years.

Once the average monthly storage margin is known, it will be compared to average monthly storage costs to determine the historic profitibility of storing wheat in on-farm storage systems. Returns to on-farm storage will also be computed considering the opportunity cost of capital to hold wheat for storage intervals from one month to ten months. The opportunity cost of capital will be calculated using annual interest rates on 9 percent, 12 percent, 15 percent, and 18 percent. Wheat will be valued at $4.00 per bushel.

Return on Investment. The capital investment requirement for an on-farm storage system requires careful consideration by the producer before such an investment is made. Before the final investment decision is made, the producer should evaluate the profitability of this storage investment in relationship to the profitability of alternative uses for his capital. The two methods which will be utilized in this study to evaluate investment alternatives will be; 1) Internal Rate of Return and 2) Payback Period.

Internal Rate of Return. The internal rate of return is the interest rate that equates the present value of the expected future cash-flows to the initial investment. This internal rate of return will be estimated using the expected costs and returns for each on-farm storage system studied. The internal rate of return will only be computed on a before-tax basis. An investment will not be considered profitable unless the internal rate of return exceeds the cost of borrowed funds.

Payback Period. The payback period is the length of time required for an investment to pay for itself. The payback period will be determined by dividing the total investment in on-farm storage system by the estimated annual cash-flow generated by the investment. This method measures how quickly invested dollars can be recovered. An investment will be considered profitable if the estimated payback period is less than the investment average life expectancy.

CHAPTER IV

DESCRIPTION OF STORAGE SYSTEMS AND INVESTMENT REQUIREMENTS

This section of the study describes the physical characteristics and investment requirements of each storage system under study.

On-Farm Wheat Storage Systems

On-farm wheat storage systems analyzed in this study are categorized into two groups: 1) those systems utilizing portable augers to handle wheat, and 2) those systems utilizing a bucket elevator. The first group of storage systems, those using portable augers to handle wheat, is divided into two categories: a) those storage systems powered by single-phase electric motors, and b) those systems powered by three-phase electric motors. This distinction in power sources is made because of the price difference between single- and three-phase motors, and the availability of each power source. Three-phase motors are less expensive to purchase than single-phase motors, however, not all areas in the state or individual producers have three-phase power readily available. It is for these reasons that both power sources are examined when determining investment requirements for different storage systems. It is assumed in this study that storage systems employing bucket elevators to handle wheat use only three-phase electric motors.

Twenty separate storage systems are analyzed in this study. Ten of these storage systems use single-phase electric motors and portable auger, six storage systems use three-phase electric motors and portable auger and four storage systems use a bucket elevator to handle wheat. Each storage system is designed on the basis of engineering recommendations, current practices and equipment availability with the objective of developing a least-cost on-farm storage system which meets the needs of wheat producers in Oklahoma. All storage systems are designed with the idea of being able to double the storage capacity of each system with little additional investment necessary in handling equipment. Appendix A shows the current layout and proposed future expansion for each storage system under study. The dotted line represents proposed future expansion, while the solid lines indicate the current storage system. Notice that all storage systems with the exception of the 80,000 bushel Category Three storage system are expanded by doubling the number of storage bins. The 80,000 bushel Category Three storage system, however, is expanded by adding two 37,173 bushel storage bins. This is done because the bucket elevator system designed for these storage systems allow for only six storage bins surrounding the leg, three bins on each side of the leg. However, if additional bins are wanted they could be added behind the current bins. Such a system would require the use of an overhead distributing auger and a more complex bin unloading system.

Storage Bins

Nine storage bins ranging in storage capacity from 2,232 to 20,256 bushels were chosen for analysis in this study. Storage systems of

sizes 2,000 to 10,000 bushels are single bin systems -- meaning that the systems consists of only one storage bin -- while storage systems larger than 10,000 bushels are multiple bin systems. Storage bins in the multiple bin storage systems are arranged in a semi-circle around either the portable auger dump pit or bucket elevator. Refer to Appendix A for the number of bins, bin sizes and general arrangement of bins within each storage system under study. The number written within each storage bin in Appendix A represents the non-compacted storage capacity, diameter, eave height and overall height, respectively, of each storage bin. For example, refer to the 10,000 bushel storage system. The numbers 11,036, 27' x 22' and 29'9" are written in the bin diagram. The first number, 11,036, represents the bin's non-compacted storage capacity. The numbers 27' x 22' and 29'9" represents the bins diameter, eave height and overall height, respectively. These dimensions become critical when choosing the proper handling equipment for each bin. One important point to remember when matching the portable auger with each storage system is the height and diameter of the bin foundation. For this study, the bin foundation is assumed to be one foot in height. The length of portable auger to purchase depends upon the over all height and eave height of the bin when setting on its' foundation and the diameter of the foundation. The transport augers used in this study will be discussed in the Aeration and Handling Equipment section of this chapter.

All storage bins used in this study are unstiffened round metal bins with four inch corrugations. Standard features on all storage bins include step-in access door, man-hole roof access, roof sheets, galvanized roof ladder from eave to center collar, bin fill opening

with swing away cover, cleats around fill cap and all the necessary fastners, anchors, and sealants. Optimal bin accessories included with each bin in this study are inside and outside ladders and an auger slat hood. Other components of each storage system such as the aeration transaction and ducts, aeration fan, tunnel covers, roof vent, bin tubes and wells, flights, and sweep auger are discussed in the Aeration and Handling Equipment section of the chapter. Each storage bin is equipped with an outside ladder of specified length. However, inside ladders are only included in storage bins with an eave height of 22 feet or greater. Thus, inside ladders are included only in 10,000 bushel and larger bins. Each storage bin is equipped with an auger slat hood. The auger slat hood is a device which mounts on the back of the bottom slat of the step-in access door to keep grain from falling out when the slat is opened either for standby unloading or for inspecting and probing wheat. The auger slat hood allows for easy access to grain that ordinary probing and visual inspect through roof opening would miss.

Aeration and Unloading Equipment

A complete listing of the handling and aeration equipment used with each storage system is in Appendix B. As mentioned in the previous section of this chapter, each storage bin is equipped with an aeration system and bin unloading equipment. Other handling equipment included with each storage system, but not a part of the storage bin itself, are either a portable auger and auger dump pit or a bucket elevator and drive over dump.

This subsection of storage system description is broken into four categories. They are; 1) Aeration System, 2) Bin Unloading Equipment,

3) Portable Augers, and 4) Bucket Elevators. Each category is discussed in order.

Aeration Equipment. Each storage bin is equipped with the aeration system specified by the bin manufacturer for cooling wheat. The aeration system used in this study is a flush-floor aeration system with "Y" pattern aeration ducts. Flush-floor aeration means that the ducts are set below floor level and formed directly into the bin foundation. Aeration ducts used in this study are either the narrow or wide "Y" pattern ducts. The narrow "Y" pattern ducts are 21 ½ inches wide, while the wide "Y" pattern ducts are 36 inches wide. The narrow ducts are used in storage bins smaller than 36 feet in diameter. Included in all aeration systems are tunnel covers, transactions and ducts, and the specified horsepower aeration fan. All aeration systems in this study use a 14 inch diameter axial fan which has an air-flow rate of 0.1 CFM/bushel. Such an air-flow rate allows for complete cooling of grain in about 120 hours. Air will be blown upward through the grain mass rather than drawn downward through the grain mass. Storage bins less than 10,000 bushels are equipped with a one-half horsepower, single-phase aeration fan. All storage bins with storage capacity of 10,000 bushels and larger are equipped with one and one-half horsepower single-phase or three-phase aeration fans, depending on the power category of storage system. Listed in the specification of each aeration system are the number of roof openings required in each storage bin to allow for the escape of air during grain aeration. All storage bins in the study, with the exception of the 36 foot diameter bins, require a single roof opening. The 36 foot diameter bin requires two roof opeinings. The single roof opening is provided

by opening the man hole roof door during aeration operation. To provide the second roof opening in the 36 foot diameter bin, a round gravity roof vent is added to the roof of each storage bin.

Bin Unloading Equipment. Bin unloading equipment in this study consists of bin wells and tubes, intermediate wells, if needed, horizontal flights, unloading augers, either low-boy, 25-degree, or variable height augers, and a bin sweep auger. The unloading equipment used in each storage system is listed in Appendix B under unloading equipment.

The 2,000, 3,000, and 5,000 bushel storage systems are equipped with six inch unloading equipment. Six inch unloading augers are designed to operate at 1,000 bushels per hour. Storage systems larger than 5,000 bushels use eight inch unloading equipment which are designed to operate 2,000 bushels per hour. Each storage bin is equipped with a center bin well and unloading tube of specified length. Bin wells included a slice open half gate, pivot pipe for bin sweep auger and a clamp to attach well to unloading auger. Storage bins between 18 feet and 27 feet in diameter include an optimal intermediate band-on well with half gate. Two band-on intermediate wells with half gates are included in storage bins with diameters of 30 and 36 feet. Bin wells and unloading tubes are formed into the foundation of each bin. Each storage bin is equipped with its' own bin sweep auger of specified length, and motor of specified power requirement.

Single bin storage systems are equipped with 25-degree unloading auger and horizontal flight. These storage units assume the transport auger is turned around and wheat is discharged directly into the portable auger hopper. An important characteristic of the 25-degree

unloading auger is that the unit makes a transition at the elbow to a two inch larger diameter tube and flight. That is, a six inch horizontal flight has a corresponding eight inch 25-degree auger associated with it. This allows the incline auger to handle the maximum capacity of the horizontal auger.

Multiple bin storage systems use a portable auger and a single low-boy auger to unload wheat directly into the center auger dump pit. The low-boy auger is moved from bin to bin. The low-boy auger used in this study is eight inches in diameter and 42 feet long. This handling system allows wheat to be moved directly from one bin to another. Multiple bin storage systems using a bucket elevator to handle wheat use either 25-degree or variable height augers to unload storage bins. See Appendix B for specific unloading equipment used in each storage system. The three bins on the up-side of the elevator leg dump directly into the leg. If the storage bin is on the downside of the elevator leg, wheat is dumped into the drive-over pit by an eleven foot long variable height auger. This auger is equipped with a winch kit so it can be lowered over the dump pit and raised out of the way for storing. All other variable height augers used in this study are equipped with a support stand and are fixed at a specified discharge height.

Handling Equipment

As mentioned at the beginning of this chapter, storage systems analyzed in this study are categorized into groups according to whether a portable auger or bucket elevator is used to handle wheat.

Portable Augers Of the twenty storage systems under consideration in this study, sixteen use a portable auger to handle wheat. Portable augers used in this study are powered by a single-phase or three-phase electric motor. This study does not consider the use of P.T.O. or Hydraulic power portable augers. Generally speaking, the P.T.O. driven portable augers are less expensive to purchase than portable augers powered by electric motors. However, both the P.T.O. and Hydraulic driven augers require the use of a tractor which some producers may not have available during peak harvest periods.

Six inch portable augers are used in the 2,000, 3,000, and 5,000 bushel storage systems. The six inch auger is capable of operating at 1,000 bushels per hour. Eight inch portable augers were used in all other storage systems. The eight inch auger operates at 2,000 bushels per hour. Refer to Appendix B for the specific portable auger used with each storage system. Each portable auger comes complete with under carriage, reduction winch, belts, motor mounts, 15 inch rims, hitch with intake guard, auger pulley and gear drive. Added to the portable augers used in the single bin storage systems are 15 inch tires, plastic dump hopper, and a three foot flex tube with a 45-degree safety spout. Multiple bin storage systems use a portable pit auger to handle grain. The portable pit auger is identical to other portable augers except a swivel arc kit is added to the auger. The swivel arc kit allows the portable auger to travel in a circle to fill the storage bins or for unloading storage bins. The pit auger is anchored to a center concrete dump kit. Center dump pit is six feet in diameter and two and one-half feet deep. See Appendix A for arc radius of pit auger and layout of each storage system.

Bucket Elevator Four of the twnety storage systems analyzed in this study use a bucket elevator to handle wheat. The same bucket elevator is used in all four storage systems; the only difference between systems being the elevator discharge height. The 30,000 bushel storage system uses a 75 foot discharge height or its' bucket elevator. An 80 foot discharge height is used in the 40,000 bushel systems and an 85 foot discharge height is used in both the 60,000 and 80,000 bushel storage systems.

All bucket elevators used in this study operate at 3,000 bushels per hour and have a six inch bucket spacing. Each elevator is equipped with a back stop, nine inch by five inch polyethylene cups, eight inch - eight way distributor, specified ladder, cage, and work platforms. Eight inch 14 gauge galvanized spouting is used to carry wheat from the distributor to the storage bins or to truck load out. Bucket elevators are supported by three-eighths inch guy cables attached at the elevator's head and at 20 foot intervals along the bucket elevator running to six inch steel pipes which are buried in three feet of concrete. Guy cables attach to support pipes six feet above the ground so that cables are out of the way for cleaning around storage systems. Spouting is supported by three-eighths inch cable using adjustment spiders and tross anchors. For a listing of bucket elevator components refer to Appendix B.

Each storage system using a bucket elevator is also equipped with a drive-over dump pit. The drive-over dump pit used in this study is the same for all four bucket elevator systems. The dump pit uses a 24 foot by 12 inch U-trough auger to carry wheat from the dump hopper to the downside of the elevator leg. The U-trough auger is designed to handle 2,536 bushels of grain per hour. Again, refer to Appendix B

for dump pit specifications and component listing. A drive-over slab 15 feet by 44 feet is provided for trucks to rest on when loading or unloading wheat.

Capital Investment

Investment data is based on mid-May 1980 price quotation from bin and equipment manufacturers in Oklahoma. Investment costs are computed using the list price of bins and equipment.

Tables IV, V and VI show the capital investment requirements for each storage system under study. Investments range from $7,336 for the 2,000 bushel Category One storage system, to $103,799 for the 80,000 bushel Category Three storage system. Figure 2 and Tables VII, VIII and IX show the per bushel investment requirements for each storage system. Investments range from $3.29 per bushel Category One for the 2,000 bushel storage system to $.96 per bushel Category Two for the 80,000 bushel storage system. Storage systems which use three-phase electric motors and a portable auger, that is, Category Two storage systems, range from ten cents to two cents per bushel less investment than comparable Category One storage systems. Per bushel investment for Category Three storage systems range from $1.89 per bushel for the 30,000 bushel system to $1.28 per bushel for the 80,000 bushel system. Investment requirement in Category Three storage systems range from 65 cents per bushel to 32 cents per bushel more than comparable Category Two storage systems. Notice that in Figure 2 there is only one cent per bushel difference between the investment in a 5,000 and 7,000 bushel Category One storage systems. This occurs because of the change from six inch handling equipment to eight

TABLE IV

ESTIMATED INVESTMENT REQUIREMENT FOR CATEGORY ONE ON-FARM STORAGE SYSTEMS, OKLAHOMA, 1980

Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)									
Storage Unit										
Bins	2,245.00	2,658.00	3,733.00	4,498.00	6,431.00	12,862.00	19,293.00	22,488.00	30,714.00	40,952.00
Erection of Bins	223.00	327.00	553.00	731.00	1,104.00	2,207.00	3,311.00	4,132.00	6,077.00	8,102.00
Foundation	402.00	567.00	760.00	982.00	1,232.00	2,463.00	3,695.00	4,529.00	6,452.00	8,602.00
Sub-total	2,870.00	3,552.00	5,046.00	6,211.00	8,767.00	17,532.00	26,299.00	31,149.00	43,243.00	57,656.00
Aeration & Handling Equipment										
Aeration Equipment	639.00	639.00	641.00	669.00	737.00	1,474.00	2,211.00	2,313.00	3,861.00	5,148.00
Portable Auger	1,855.00	1,855.00	2,146.00	3,300.00	4,042.00	4,989.00	4,989.00	4,989.00	4,989.00	4,989.00
Unloading Equipment	1,178.00	1,279.00	1,394.00	1,947.00	1,992.00	4,898.00	5,872.00	6,125.00	6,392.00	7,193.00
Electrical Wiring	750.00	781.00	1,156.00	1,563.00	2,000.00	2,938.00	3,313.00	3,313.00	3,313.00	3,688.00
Sub-total	4,422.00	4,554.00	5,337.00	7,479.00	8,771.00	14,299.00	16,385.00	16,740.00	18,555.00	21,018.00
Land Requirement	44.00	44.00	44.00	52.00	52.00	104.00	157.00	157.00	261.00	348.00
TOTAL INVESTMENT	7,336.00	8,150.00	10,427.00	13,742.00	17,590.00	31,935.00	42,841.00	48,046.00	62,059.00	79,022.00
Investment per Bushel	3.29	2.49	1.89	1.88	1.59	1.45	1.29	1.16	1.02	.98

TABLE V

ESTIMATED INVESTMENT REQUIREMENT FOR CATEGORY TWO ON-FARM STORAGE SYSTEMS, OKLAHOMA, 1980

Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)					
Storage Unit						
Bins	6,431.00	12,862.00	19,293.00	22,488.00	30,714.00	40,952.00
Erection of Bin	1,104.00	2,207.00	3,311.00	4,132.00	6,077.00	8,102.00
Foundation	1,232.00	2,463.00	3,695.00	4,529.00	6,452.00	8,602.00
Sub-total	8,767.00	17,532.00	26,299.00	31,149.00	43,243.00	57,656.00
Aeration and Handling Equipment						
Aeration Equipment	713.00	1,426.00	2,139.00	2,241.00	3,789.00	5,052.00
Portable Auger	3,300.00	4,247.00	4,247.00	4,247.00	4,247.00	4,247.00
Unloading Equipment	1,592.00	4,066.00	4,902.00	5,155.00	5,422.00	6,431.00
Electrical	2,000.00	2,938.00	3,313.00	3,313.00	3,313.00	3,688.00
Sub-total	7,605.00	12,677.00	14,601.00	14,956.00	16,771.00	19,418.00
Land Requirement	52.00	104.00	157.00	157.00	261.00	348.00
TOTAL INVESTMENT	16,424.00	30,313.00	41,057.00	46,262.00	60,275.00	77,422.00
Investment per Bushel	1.49	1.37	1.24	1.12	.99	.96

TABLE VI

ESTIMATED INVESTMENT REQUIREMENT FOR CATEGORY THREE ON-FARM STORAGE SYSTEMS, OKLAHOMA, 1980

Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels	33,108	41,319	60,768	81,024
	Dollars ($)			
Storage Unit				
Bins	19,293.00	22,488.00	30,714.00	40,952.00
Erection of Bins	3,311.00	4,132.00	6,077.00	8,102.00
Foundation	3,695.00	4,529.00	6,452.00	8,602.00
Sub-total	26,299.00	31,149.00	43,243.00	57,656.00
Aeration & Handling Equipment				
Aeration Equipment	2,139.00	2,241.00	3,789.00	5,052.00
Bucket Elevator	24,205.00	25,037.00	26,161.00	26,552.00
Unloading Equipment	5,319.00	5,599.00	6,051.00	8,022.00
Electrical	4,063.00	4,875.00	5,500.00	6,125.00
Sub-total	35,726.00	37,752.00	41,501.00	45,751.00
Land Requirement	392.00	392.00	392.00	392.00
TOTAL INVESTMENT	62,417.00	69,293.00	85,136.00	103,799.00
Investment per Bushel	1.88	1.68	1.40	1.28

Estimated Per Bushel Investment Requirement

	Storage System Category		
	I	II	III
	Dollars Per Bushel		
2,000	3.29		
3,000	2.49		
5,000	1,89		
7,000	1.88		
10,000	1.59	1.49	
20,000	1.45	1.37	
30,000	1.29	1.24	1.89
40,000	1.16	1.12	1.68
60,000	1.02	.99	1.40
80,000	.98	.96	1.23

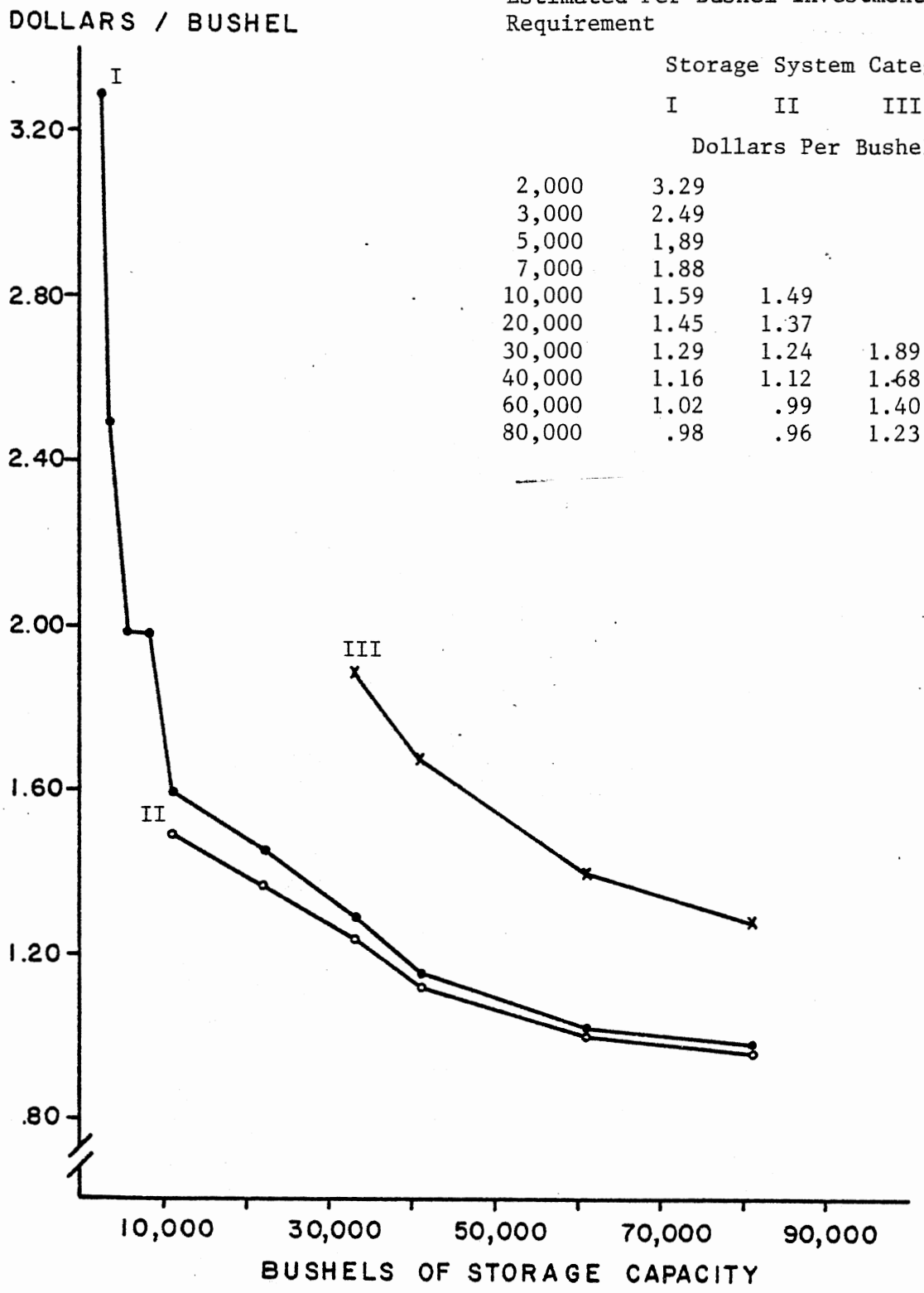


Figure 2. Estimated Per Bushel Investment Requirement for Each Category of On-Farm Storage System, Oklahoma, 1980.

TABLE VII

ESTIMATED PER BUSHEL INVESTMENT REQUIRMENT FOR CATEGORY ONE ON-FARM STORAGE SYSTEMS, OKALHOMA, 1980

Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars/Bushel ($/bu.)									
Storage Unit										
Bins	1.01	.81	.68	.62	.58	.58	.58	.54	.51	.51
Erection	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
Foundation	.18	.17	.14	.13	.11	.11	.11	.11	.11	.11
Sub-total	1.29	1.09	.91	.85	.79	.79	.79	.75	.72	.72
Aeration & Handling Equipment										
Aeration Equipment	.29	.20	.12	.09	.07	.97	.07	.06	.06	.06
Portable Auger	.83	.57	.39	.45	.37	.23	.15	.12	.08	.06
Unloading Equipment	.53	.39	.25	.27	.18	.22	.18	.15	.11	.09
Electrical Wiring	.34	.24	.21	.21	.18	.13	.10	.08	.05	.05
Sub-total	1.98	1.39	.97	1.02	.79	.65	.49	.41	.31	.26
Land Requirement	.02	.01	.01	.01	.005	.005	.005	.004	.004	.004
TOTAL INVESTMENT PER BUSHEL	3.29	2.49	1.89	1.88	1.59	1.45	1.29	1.16	1.02	.98

TABLE VIII

ESTIMATED PER BUSHEL INVESTMENT REQUIREMENTS FOR CATEGORY TWO ON-FARM STORAGE SYSTEMS, OKLAHOMA, 1980

Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, In Bushels	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars per Bushel ($/bu.)					
Storage Unit						
Bins	.58	.58	.58	.54	.51	.51
Erection	.10	.10	.10	.10	.10	.10
Foundation	.11	.11	.11	.11	.11	.11
Sub-total	.79	.79	.79	.75	.72	.72
Aeration and Handling Equipment						
Aeration Equipment	.06	.06	.06	.05	.06	.06
Portable Auger	.30	.19	.13	.10	.07	.05
Unloading Equipment	.14	.18	.15	.12	.09	.08
Electrical	.18	.13	.10	.08	.05	.05
Sub-total	.69	.57	.44	.36	.28	.24
Land Requirement	.005	.005	.005	.004	.004	.004
TOTAL INVESTMENT PER BUSHEL	1.49	1.37	1.24	1.12	.99	.96

TABLE IX

ESTIMATED PER BUSHEL INVESTMENT REQUIREMENT FOR CATEGORY THREE ON-FARM STORAGE SYSTEMS, OKLAHOMA, 1980

Item	Bushels Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels	33,108	41,319	60,768	81,024
	Dollars/Bushel ($/bu.)			
Storage Unit				
Bins	.58	.54	.51	.51
Erection	.10	.10	.10	.10
Foundation	.11	.11	.11	.11
Sub-total	.79	.75	.72	.72
Aeration and Handling Equipment				
Aeration Equipment	.07	.05	.06	.06
Bucket Elevator	.73	.61	.43	.33
Unloading Equipment	.16	.14	.10	.10
Electrical Wiring	.12	.12	.09	.08
Sub-total	1.08	.92	.68	.57
Land Requirement	.01	.01	.01	.01
TOTAL INVESTMENT PER BUSHEL	1.89	1.68	1.40	1.28

inch handling equipment.

Investment requirements are broken into three categories: 1) Storage Unit, 2) Aeration and Handling Equipment, and 3) Land Requirement. Each of these investment categories will be discussed in order below.

Storage Unit

Estimated investment requirements for the storage unit ranges from $2,870 to $57,656 for the smallest to largest storage system. (See Table IV, V and VI.) On a per bushel basis, the investment requirement for the storage unit ranges from $1.09 per bushel for the 2,000 bushel storage system to $.72 per bushel for the 80,000 bushel system. (See Tables VII, VIII and IX.) Investment in the storage bins makes up between 39 and 75 percent of the total investment cost of the storage systems which use portable augers. Investment in storage bins in systems using a bucket elevator range from 42 percent to 56 percent of the total investment requirement for the smallest to largest storage system.

Aeration and Handling Equipment

Investment in aeration and handling equipment range from $4,422.00 for the 2,000 bushel Category One storage system to $46,051.00 for the 80,000 bushel Category Three storage system. (See Tables IV, V and VI.) Investment economics are gained in aeration and handling equipment because of better utilization of equipment. Investment in aeration and handling equipment ranges from 60 percent to 25 percent of total investment for storage systems using portable augers, Category One and

Two storage systems, and from 56 percent to 44.5 percent for Category Three storage systems for the 80,000 bushel system.

Land Requirement

Each storage system is required to purchase the land on which the storage system is built. Land used for these storage systems is assumed to have no other use and zero opportunity costs. Land requirements range from one-twelfth of an acre for the 2,000 bushel system to three-fourth of an acre for the 80,000 bushel Category Three storage system. Investment in land ranges from $44.00 to $392.00. Land investment represents a very small proportion of the total investment in these storage systems, ranging from .61 percent to .75 percent.

The following chapter discusses annual cost and returns associated with owning and operating on-farm storage systems in Oklahoma.

CHAPTER V

EMPIRICAL RESULTS AND ANALYSIS

This section of the study presents the costs and returns associated with owning and operating on-farm storage systems in Oklahoma. The costs of storing wheat on-farm in Oklahoma is examined first.

Total Cost of On-Farm Wheat Storage

The costs of owning and operating on-farm storage system of selected capacities are determined on an annual and monthly basis. Annual total costs are computed by assuming wheat and only wheat is stored in each storage system for a six month period. Monthly costs are estimated for each storage system from annual total costs by categorizing annual costs into fixed costs, use-conditional variable costs and time-conditional variable costs. For more information concerning the procedure used to compute storage costs see the discussion or procedure in Chapter III.

Total Annual Costs of Owning and Operating

On-Farm Storage Systems in Oklahoma Total annual costs of owning and operating on-farm storage systems in Oklahoma are computed for three levels of utilization; 100 percent, 75 percent and 50 percent. One hundred percent utilization is defined as a storage period of six months

at 100 percent of the rated non-compacted storage capacity for the system. Seventy-five and 50 percent levels of utilization both assume a six month storage period, but storage is at 75 percent and 50 percent of the rated non-compacted storage capacity for the system, respectively. For example, the 10,000 bushel storage system has a rated non-compacted storage capacity of 11,036 bushels. One hundred percent utilization means 100 percent of the rated capacity is utilized, that is, 11,036 bushels of wheat are placed in storage for six months. At 75 percent utilization only 75 percent of the 11,036 bushels of rated storage capacity is utilized, thus, only 8,277 bushels of wheat is stored for six months. At the 50 percent level of utilization only half of the rated non-compacted storage capacity is used. Therefore, at 50 percent utilization only 5,518 bushels of wheat are stored in the six month storage period. Total annaul costs are based on once-a-year usage of the storage system for storing only wheat. Total annual costs are determined by summing total annual fixed costs and total annual variable costs. Tables X, XI, and XII show the total annual costs of owning and operating on-farm storage systems in Oklahoma at 100 percent utilization. Beneath the total annual fixed and total annual variable cost figures for each storage system in Tables X, XI and XII are the percentage figures that each cost category represents of total annual costs. For example, fixed costs represent 67.24 percent of total annual costs of the 2,000 bushel Category One storage system. The tables of Appendix C show the total annual storage at 100 percent, 75 percent, and 50 percent levels of utilization for the various storage systems under study.

Estimated total annual costs of owning and operating on-farm storage systems ranged from $1,806.52 for the 2,000 bushel Category One stor-

TABLE X

ESTIMATED ANNUAL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEMS, AND SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980.

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in bushels, 100 percent utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)									
Fixed Costs										
Depreciation										
Buildings	143.50	177.60	252.30	210.55	438.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	442.20	455.40	533.70	747.90	877.10	1,429.90	1,638.50	1,674.00	1,855.50	2,101.80
Insurance on Storage Facility										
Grain Bins	28.70	35.52	50.46	62.11	87.67	175.32	262.99	311.49	432.43	574.56
Handling Equipment	88.44	91.08	106.74	149.58	175.42	285.98	327.70	334.80	371.10	420.36
Interest on Investment										
Storage System	473.98	526.89	674.90	889.85	1,139.97	2,069.02	2,774.46	3,112.79	4,016.87	5,113.81
Land	2.86	2.86	2.86	3.38	3.38	6.76	10.21	10.21	16.97	22.62
Property Taxes										
Storage System	34.86	38.76	49.64	65.45	83.85	152.19	204.08	228.97	295.47	376.16
Land	.21	.21	.21	.25	.25	.50	.75	.75	1.25	1.66
TOTAL ANNUAL FIXED COSTS	1,214.75	1,328.32	1,670.81	2,129.07	2,805.99	4,995.77	6,533.64	7,230.46	9,151.74	11,495.77
Percent of Total Costs	67.24%	64.29%	60.87%	61.25%	59.60%	57.91%	55.42%	53.25%	50.52%	49.31%
Variable Costs										
Grain Insurance	71.42	104.58	176.80	234.02	353.15	706.30	1,059.46	1,322.21	1,944.58	2,592.77
Grain Handling										
Labor	23.02	33.71	56.98	37.71	56.91	113.83	170.74	213.08	313.38	417.84
Electricity	.81	1.20	3.27	3.01	5.79	13.80	20.70	25.85	38.01	50.68
Aeration										
Labor	96.00	96.00	96.00	96.00	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	5.40	5.40	5.40	5.40	16.20	32.40	48.60	48.60	48.60	64.80

TABLE X

(CONTINUED)

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 percent utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)									
Variable Costs (Continued)										
Insect Control										
Labor	24.00	24.00	24.00	24.00	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	17,68	25.51	43.04	56.65	85.23	170.54	255.17	320.40	465.70	621.02
Maintenance and Repair										
Storage Bins	14.35	17.76	25.23	31.06	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	132.66	136.62	160.11	224.37	263.13	428.55	491.55	502.20	556.65	630.54
Interest on Operating Capital	27.87	31.75	41.38	49.62	64.88	119.02	165.27	191.38	256.16	331.87
Shrinkage										
Moisture Loss	156.24	228.76	386.75	511.91	772.52	1,545.04	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	22.32	32.68	55.25	73.13	110.36	220.72	331.08	413.19	607.68	810.24
TOTAL ANNUAL VARIABLE COSTS	591.77	737.97	1,074.21	1,346.88	1,902.01	3,630.28	5,256.23	6,348.99	8,964.74	11,815.72
Percent	32.76%	35.71%	39.13%	38.75%	40.40%	42.09%	44.58%	46.75%	49.48%	50.69%
TOTAL ANNUAL COSTS	1,806.52	2,066.29	2,745.02	3,475.95	4,708.00	8,626,05	11,789.87	13,579.45	18.116.48	23,311.49

TABLE XI

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTIVE CAPACITY, OKLAHOMA, 1980.

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels, 100 Percent Utilization	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)					
Fixed Costs						
Depreciation						
Building	439.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	760.50	1,267.70	1,460.10	1,495.60	1,677.10	1,941.80
Insurance Facility						
Grain Bins	87.67	175.32	262.99	311.49	432.43	576.56
Handling	152.10	253.54	292.02	299.12	335.42	388.36
Interest on Investment						
Storage System	1,064.18	1,963.59	2,658.50	2,996.83	3,900.91	5,009.81
Land	3.38	6.76	10.21	10.21	16.97	22.62
Property Tax						
Storage System	78.28	144.44	195.55	220.44	286.94	368.51
Land	.25	.50	.75	.75	1.25	1.66
TOTAL ANNUAL FIXED COSTS	2,584.71	4,638.45	5,998.77	6,891.89	8,813.17	11,192.12
Percent of Total Costs	57.75%	56.39%	53.30%	52.05%	49.57%	48.76%
Variable Costs						
Grain Insurance	353.15	706.30	1,059.46	1,322.21	1,944.58	2,592.77
Grain Handling						
Labor	56.91	113.83	170.74	213.08	313.38	417.84
Electricity	5.79	13.80	20.70	25.85	38.01	50.68
Aeration						
Labor	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	16.20	32.40	48.60	48.60	48.60	64.80
Insect Control						
Labor	24.00	48.00	42.00	72.00	72.00	96.00
Chemicals	85.23	170.54	255.77	320.40	465.70	621.02
Maintenance and Repair						
Storage Bins	43.34	87.66	131.50	155.75	216.22	233.23
Equipment	263.13	423.97	491.55	502.20	556.65	630.54
Interest on Operating Capital	64.33	119.02	165.27	199.38	256.16	331.37
Shrinkage						
Moisture Loss	772.52	1,545.04	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	110.36	220.72	331.08	413.19	607.68	810.24

TABLE XI

(CONTINUED)

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in Bushels, 100 Percent Utilization	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($)					
TOTAL ANNUAL VARIABLE COSTS	1,890.96	3,625.28	5,256.19	6,348.99	8,964.74	11,760.17
Percent of Total/Costs	42.25%	43.61%	46.70%	47.95%	50.43%	51.24%
TOTAL ANNUAL COSTS	4,475.67	8.313.73	11,254.96	13,240.88	17,777.91	22,952.29

TABLE XII

ESTIMATED TOTAL ANNUAL COST OF OWNING AND OPERATING ON-FARM STORAGE SYSTEM WHICH UTILIZE A BUCKET ELEVATOR TO HANDLE WHEAT, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	33,108	41,319	60,768	81,024
	Dollars ($)			
Fixed Costs				
Depreciation				
Building	2,336.80	2,640.10	3,276.80	3,997.45
Equipment	1,558.80	1,683.10	1,950.70	2,375.30
Insurance on Facility				
Grain Bin	262.99	311.49	432.43	576.56
Handling Equipment	720.50	769.68	836.00	921.02
Interest on Investment				
Storage System	4,051.06	4,526.15	5,527.80	6,740.96
Land	25.48	25.48	25.48	25.48
Property Tax				
Storage System	297.98	332.93	406.61	495.84
Land			1.87	1.87
TOTAL ANNUAL FIXED COSTS	9,255.48	10,290.80	12,457.69	15,134.98
Percent of Total Costs	62.88%	61.00%	57.50%	55.61%
Variable Costs				
Grain Insurance	1,059.46	1,322.21	1,944.58	2,592.17
Grain Handling				
Labor	113.09	141.13	207.57	276.75
Electricity	19.71	25.22	49.31	65.75
Aeration				
Labor	192.00	192.00	192.00	240.00
Electricity	48.60	48.60	48.60	64.80
Insect Control				
Labor	72.00	72.00	72.00	96.00
Chemicals	255.70	320.40	465.70	621.02
Maintenance & Repair				
Storage Bins	131.50	155.75	216.22	288.28
Equipment	744.12	798.90	878.66	1,006.19
Interest on Operating Capital	178.33	198.18	273.22	350.55
Shrinkage				
Moisture Loss	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	331.08	413.19	607.68	810.24

TABLE XII

(CONTINUED)

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	33,108	41,319	60,768	81,024
		Dollars ($)		
TOTAL ANNUAL VARIABLE COSTS	5,463.15	6,579.91	9,209.30	12,083.43
Percent of Total Costs	37.12%	39.00%	42.50%	44.39%
TOTAL ANNUAL COSTS	14,718.63	16,870.71	21,666.99	27,218.41

age system to $27,218.41 for the 80,000 bushel Category Three storage systems, respectively. Category Two storage systems were the most inexpensive systems to operate. Average total costs of owning and operating Category Two systems range from a high of 40.56 cents per bushel to a low of 28.46 cents per bushel for the 10,000 and 80,000 bushel systems, respectively. Category Two storage sytems were found to be from 2.01 cents per bushel to .38 cents per bushel less expensive to own and operate than comparable Category One storage systems. Storage systems which use a portable auger to load and unload wheat range from 8.85 cents per bushel to 4.82 cents per bushel less expensive to comparable storage systems that use a bucket elevator.

Estimated total costs when storage systems are operated at 75 percent their capacity, range from $1,732.10 for the 2,000 bushel Category One storage system to $24,657.15 for the 80,000 bushel Category Three storage system. At 50 percent utilization, estimated total annual costs range from $1,657.98 for the 2,000 bushel Category One storage system to $22,095.56 for the 80,000 bushel Category Three storage system. Total annual costs decrease at lower levels of utilization because annual variable costs decrease due to less bushels of wheat being placed in storage. Notice that annual fixed costs are the same at all levels of utilization.

Annual Fixed Costs. Fixed costs are those costs which are incurred whether the storage system is used or not. These costs include depreciation, interest in investment, insurance on the storage system and property taxes. Estimated total fixed costs for the various storage systems under study range from $1,214.75 to $15,134.98 for the 2,000 bushel Category One storage sytem and 80,000 bushel Category Three storage system,

respectively. Total annual fixed costs represent from 67.24 percent to 55.61 percent of the total annual costs of these storage systems. The two largest components of fixed costs are depreciation and interest on investment. Together, these two cost items account for approximately 88 percent of total fixed costs. See bracketed numbers in Tables XXIX, XXXV and XXXXI of Appendix C for percentages.

Total annual fixed costs are not dependant on a storage system's level of utilization, thus, they do not change as the level of utilization is changed. Average fixed costs, on the other hand, are inversely related to the level of utilization, meaning that as utilization decreases per unit or average fixed cots increase. This occurs because fixed costs are being spread over less bushels of stored grain. Average fixed costs range from 54.42 cents per bushel for the 2,000 bushel Category One storage system to 13.81 cents per bushel for the 80,000 bushel Category Two storage system when these storage systems are operated at 100 percent capacity. When utilization is decreased to 50 percent, average fixed costs range from 108.85 cents per bushel to 27.63 cents per bushel for the 2,000 bushel Category One and 80,000 bushel Category Two storage system, respectively. See Appendic C for total fixed costs and average fixed costs associated with each storage system at the various levels of utilization.

Annual Variable Costs. Variable costs, also known as operating costs, are those costs which are related to using the storage system. That is, variable or operating costs are costs which can be avoided by not using the storage system. Variable costs include labor and electricity used to handle grain, grain insurance, labor and electricity associated with aerating wheat, insect control, maintenance and repairs, interest on

operating capital, and shrinkage. Total annual variable costs for the storage systems under study range from $1,806.52 for the 2,000 bushel Category One storage system to $12,083.43 for the 80,000 bushel Category Three storage system. The single largest component of total annual variable costs and one of the largest single components of total annual costs is shrinkage. Shrinkage represents from 30.17 percent to 55.12 percent of total annual variable costs and from 7.21 percent to 28.17 percent of the total annual costs associated with on-farm storage of wheat. Assuming wheat is valued at $4.00 per bushel and that wheat is kept for six months, shrinkage costs the producer from $178.56 for the 2,000 bushel storage system to $6,481.92 for the 80,000 bushel storage systems. Shrinkage in the form of moisture loss and invisible loss costs the producer eight cents per bushel annually. On a weight basis, producers will remove from storage approximately two percent less wheat than was placed in storage six months earlier. One and one-half percent of this shrinkage is due to moisture loss, that is, assuming wheat enters storage at 12.5 percent moisture. The other one-half percent weight loss is due to invisible losses. That is, weight loss caused by moving wheat into and out of the storage system.

As mentioned earlier, total variable costs are dependent on utilization and are directly related to the level of utilization. As utilization decreases so do total variable costs. Per unit or average variable costs are inversely related to utilization. That is, as utilization decreases average variable costs per unit increase. This occurs because some variable costs are not dependent upon the amount of wheat in storage and are the same no matter how many bushels of wheat are stored. Average variable costs range from 26.51 cents per bushel to 14.58 cents per

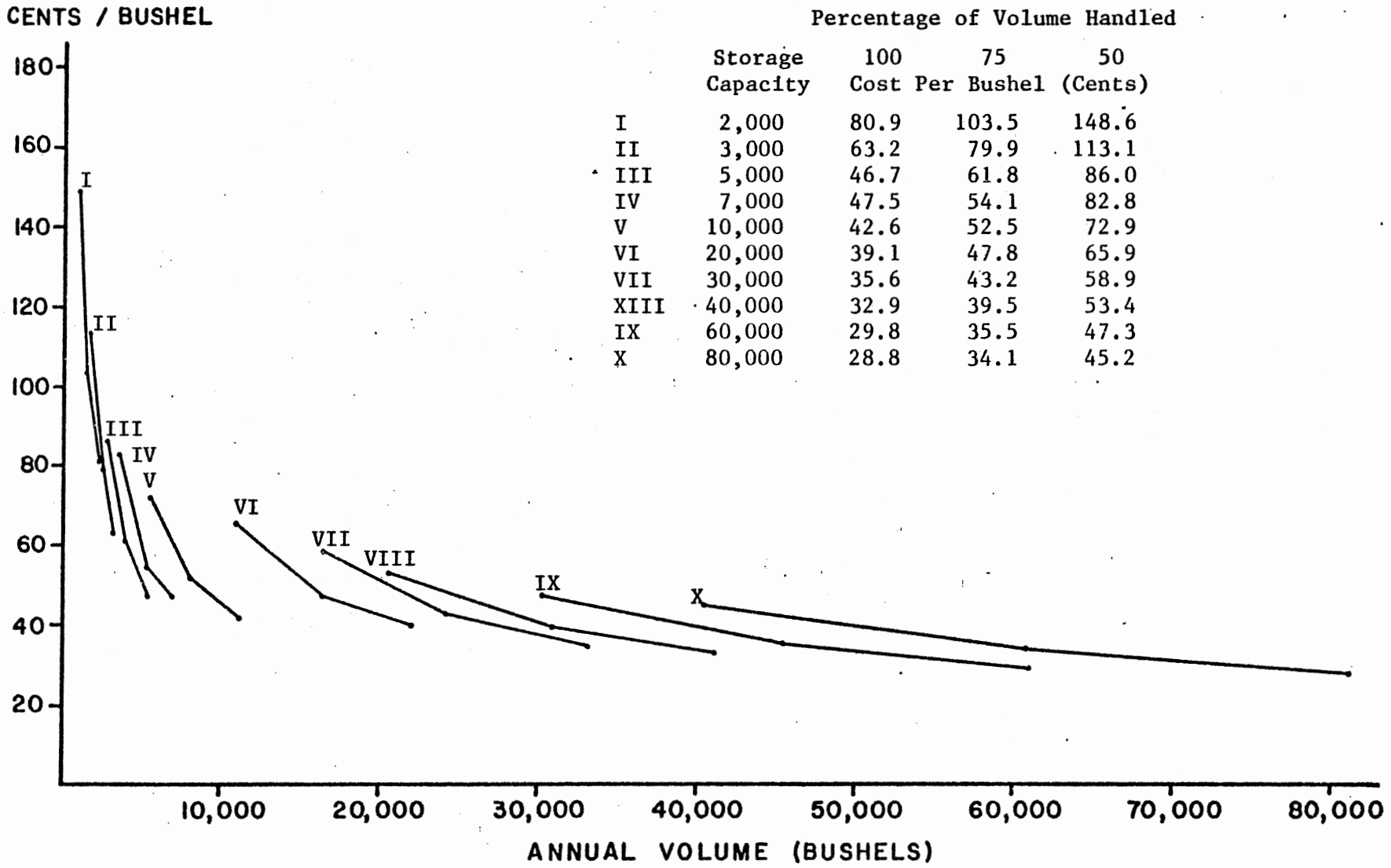
bushel when the storage systems are operated at 100 percent utilization. When utilization is decreased to 50 percent average variable costs range from 39.72 cents per bushel to 16.88 cents per bushel.

Total annual variable costs are the same for both categories of storage systems that utilize a portable auger to handle wheat. Total variable costs for the storage systems which use a bucket elevator to handle wheat range from 3.93 to 2.26 percent more expensive to operate than comparable storage systems which use a portable auger. On a per bushel basis, the storage systems which use portable augers range from two-thirds to one-third of a cent less expensive to operate than storage systems that use a bucket elevator. The bucket elevator systems tend to be more efficient in grain handling than portable auger systems and thus show a lower cost for handling wheat. However, any economies gained by efficiency is offset by the additional cost of maintenance and repair associated with the bucket elevator. The bucket elevator systems show a higher cost associated with repairing equipment than comparable portable auger systems. On a per bushel basis, there is very little difference between the variable costs of storage systems using a bucket elevator and those systems which use a portable auger.

The above discussion has been an overview of the cost fundings of this study. The following section discusses total annual and average costs of owning and operating on-farm storage systems in Oklahoma with respect to the three categories of on-farm storage systems analyzed. Recall, the three categories of on-farm storage systems are: those systems which use a portable auger and single-phase power, those storage systems which use a portable auger and three-phase power and those systems which handle wheat with a bucket elevator.

Category One. Table X shows the total annual costs of owning and operating on-farm storage systems which are powered by a single-phase electric motor and utilize a portable auger to handle wheat. Total annual costs range from $1,806.52 to $23,311.49 for the smallest to largest storage system, respectively. Per unit total costs range from 80.94 cents per bushel for the 2,000 bushel storage system to 28.77 cents per bushel for the 80,000 bushel storage system. Figure 3 illustrates average total costs for each storage sytem at the three levels of utilization. Definite economies of size are gained by using a larger storage system. However, this does not necessarily mean that larger storage systems will always result in a lower average total cost. For example, the 80,000 bushel storage system utilized at only 75 percent of its' capacity costs the producer more than the 60,000 bushel storage system operated at 100 percent of its' rated capacity. The 80,000 bushel system operated at only 50 percent of its' capacity costs the producer 12.3 cents per bushel more to operate than the 40,000 bushel system operated at full capacity. This implies that producers should carefully consider the amount of storage capacity needed and then construct the storage system to just accomodate their expected needs.

Total annual fixed costs for this category of storage systems range from $1,214.75 to $11,495.77 for the 2,000 and 80,000 bushel storage systems, respectively. Per bushel average fixed costs range from 54.42 cents per bushel to 14.19 cents per bushel when the storage system is utilized at full capacity. At 50 percent utilization, average fixed costs range from 108.85 cents per bushel to 28.38 cents per bushel. See Tables XXXI, XXXIV, in Appendix C. Again, the largest components of total fixed costs are depreciation and interest on investment. Total



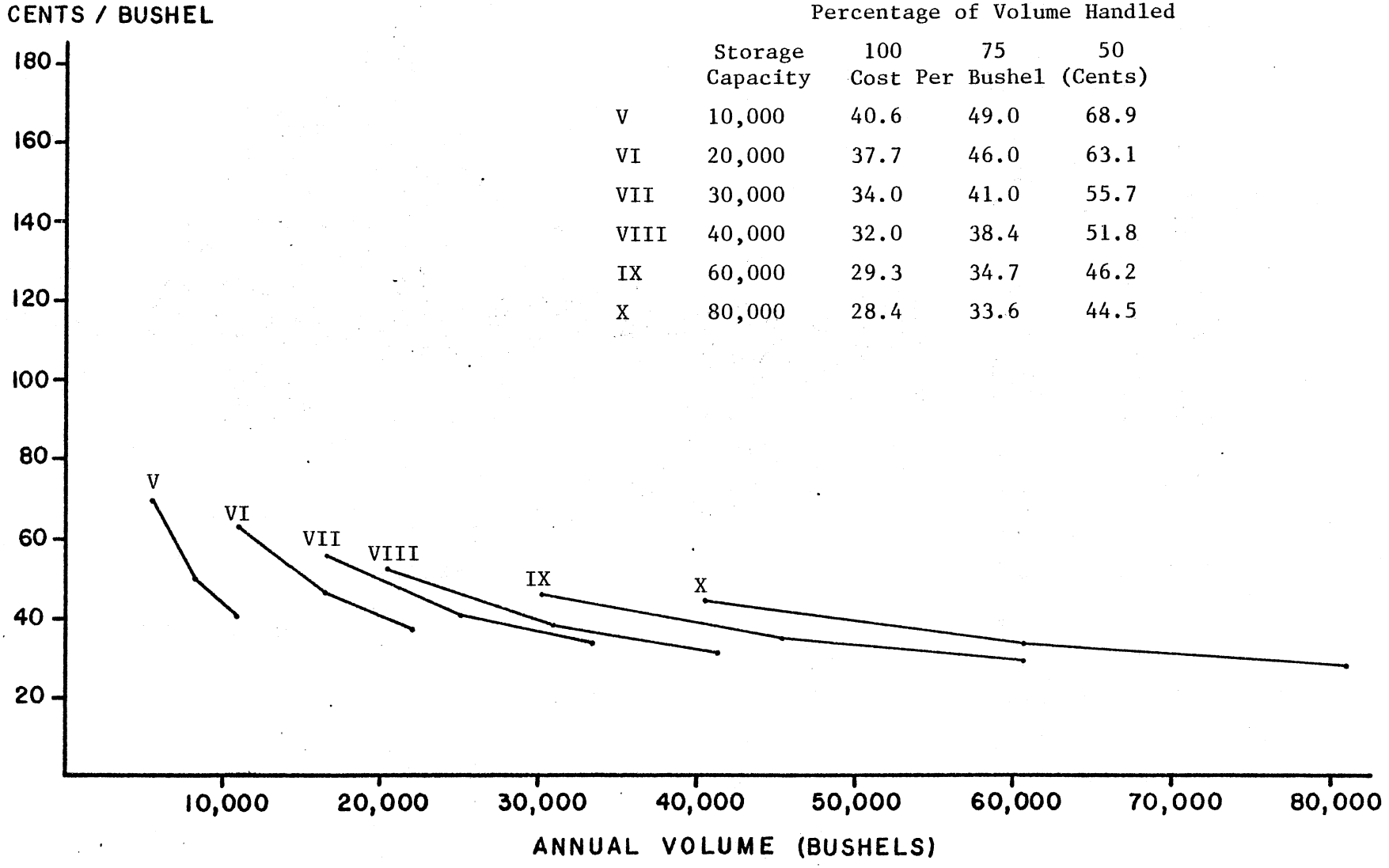
	Storage Capacity	Percentage of Volume Handled: 100 Cost Per Bushel	75 (Cents)	50
I	2,000	80.9	103.5	148.6
II	3,000	63.2	79.9	113.1
III	5,000	46.7	61.8	86.0
IV	7,000	47.5	54.1	82.8
V	10,000	42.6	52.5	72.9
VI	20,000	39.1	47.8	65.9
VII	30,000	35.6	43.2	58.9
XIII	40,000	32.9	39.5	53.4
IX	60,000	29.8	35.5	47.3
X	80,000	28.8	34.1	45.2

Figure 3. Average Cost Curves for Category One On-Farm Storage Systems, Oklahoma, 1980.

annual variable costs range from $591.77 for the 2,000 bushel storage system to $11,815.72 for the 80,000 bushel storage system when utilized at 100 percent capacity. At 75 percent utilization, variable costs range from $517.36 to $9,215.65 for the smallest to largest storage systems, respectively. When the storage systems are utilized at only one-half of their potential storage capacity, annual variable costs fall to $443.23 and $6,836.91 for the 2,000 and 80,000 bushel storage systems, respectively. Average variable costs for the 2,000 bushel storage system ranges from 26.51 cents per bushel at 100 percent utilization to 39.72 cents per bushel at 50 percent utilization. Average variable costs for the 80,000 bushel storage system at the various levels of utilization range from 14.58 cents per bushel to 16.88 cents per bushel for the 100 percent and 50 percent levels of utilization, respectively.

Category Two. This category of storage system utilizes a portable auger to handle wheat. The difference between Category One and Category Two storage systems is the type of electric motors used to operate handling and aeration equipment. Three-phase electric motors are used to power electric motors in the Category Two storage systems. See Chapter IV for a discussion on the different categories of storage systems analyzed.

Table XI shows the total annual costs of owning and operating on-farm storage systems. Total costs for these storage systems range from $4,475.67 for the 10,000 bushel storage system to $22,952.29 for the 80,000 bushel system. Figure 4 illustrates the average cost curves of on-farm storage systems at the three levels of utilization. Average total costs at 100 percent of utilization range from 40.56 cents per



	Storage Capacity	Percentage of Volume Handled 100 Cost Per Bushel	75	50 (Cents)
V	10,000	40.6	49.0	68.9
VI	20,000	37.7	46.0	63.1
VII	30,000	34.0	41.0	55.7
VIII	40,000	32.0	38.4	51.8
IX	60,000	29.3	34.7	46.2
X	80,000	28.4	33.6	44.5

Figure 4. Average Cost Curves for Category Two On-Farm Storage Systems, Oklahoma, 1980.

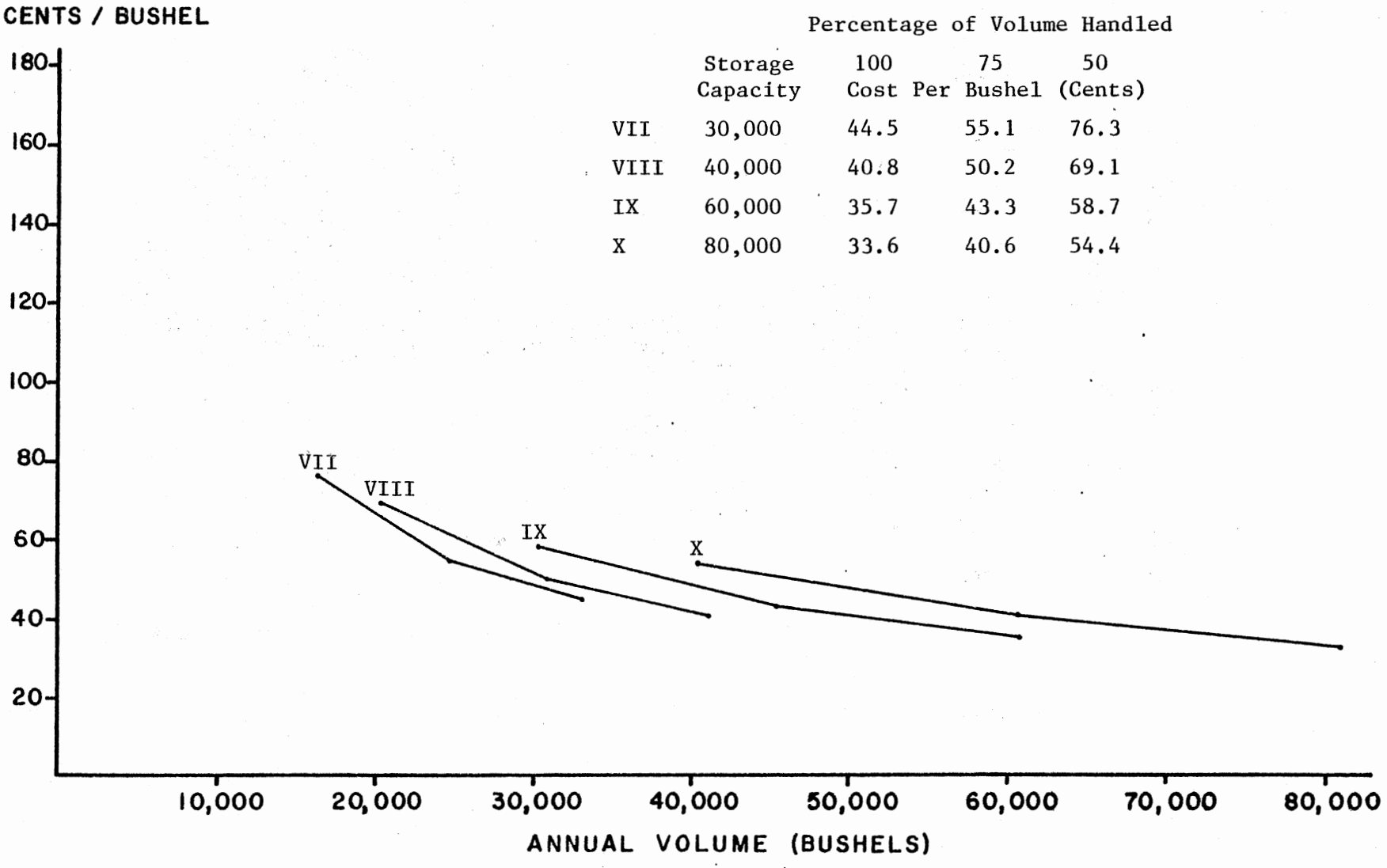
bushel for the smallest storage systems to 28.40 cents per bushel for the largest storage system. Again, the economies associated with larger storage systems is definite. At 50 percent utilization average total costs range from 68.86 cents per bushel to 44.50 cents per bushel. The idea of building a storage facility to just meet the producers needs are again illustrated in Figure 4. A producer who wishes to store 60,000 bushels of wheat is better off constructing a 60,000 bushel storage system and using it at 100 percent of capacity than constructing a 80,000 bushel storage system and only using it at 75 percent of its capacity.

Annual fixed costs for these storage systems range from $2,584.71 to $11,192.13, which is from 8.56 to 2.54 percent less than the comparable storage systems which use single-phase motores. Average fixed costs at 100 percent utilization range from 23.42 to 13.81 cents per bushel for the 10,000 bushel and 80,000 bushel storage system, respectively. See Tables XXXV and XXXVIII in Appendix C. When these storage systems are utilized at only 50 percent of their rated storage capacity average fixed costs range from 46.84 cents per bushel to 27.63 cents per bushel. Total annual variable costs for this category of storage systems are the same as those of comparable storage systems in Category One.

Category Three. This category of storage systems consists of four storage systems which range in size from 30,000 to 80,000 bushels of total non-compacted storage capacity. These storage systems utilize a bucket elevator to handle grain rather than a portable auger. Annual total costs of owning and operating Category Three storage systems are shown in Table XII. Total annual costs range from $14,718.63 for the 30,000 bushel system to $27,218.41 for the 80,000 bushel system. At

maximum annual storage capacity, average total costs range from 44.46 to 33.59 cents per bushel. See Tables XXXXII and XXXV in Appendix C. Average total costs associated with owning and operating on-farm Category Three storage systems range from 10.46 to 5.20 cents per bushel more to operate than comparable storage systems which utilize a portable auger to handle wheat. Average total costs for the three levels of utilization are illustrated in Figure 5. At 50 percent utilization, average total costs range from 76.07 cents per bushel to 54.54 cents per bushel for the 30,000 and 80,000 bushel storage systems, respectively. Again, definite economies of size are gained by using a larger storage system. However, once again, producers should be careful and not build a storage system which exceeds his expected needs. A 60,000 bushel storage system operated at full capacity is 4.90 cents per bushel less expensive to operate than the 80,000 bushel system utilized at only 75 percent of its' capacity.

Average annual fixed costs for the Category Three storage systems range from 27.96 cents per bushel to 18.68 cents per bushel when those storage systems are utilized at full capacity. When utilization decreases to 50 percent, average fixed costs range from 55.91 to 37.40 cents per bushel for the 30,000 to 80,000 bushel storage systems, respectively. Average variable costs for the 30,000 bushel storage system ranges from 16.50 cents per bushel when utilized at full capacity to 20.37 cents per bushel when utilized at 50 percent of its' total rated storage capacity. Average variable costs for the 80,000 bushel storage system range from 14.91 cents per bushel to 17.18 cents per bushel when utilized at 100 percent and 50 percent of its' total rated storage capacity, respectively.



	Storage Capacity	Percentage of Volume Handled: 100 Cost Per Bushel	75 (Cents)	50
VII	30,000	44.5	55.1	76.3
VIII	40,000	40.8	50.2	69.1
IX	60,000	35.7	43.3	58.7
X	80,000	33.6	40.6	54.4

Figure 5. Average Cost Curves for Category Three On-Farm Storage Systems, Oklahoma, 1980.

Monthly Costs of On-Farm Storage

As mentioned earlier in this chapter, monthly storage costs are estimated for each storage system by categorizing annual total costs into fixed costs, use-conditional variable costs and time-conditional variable costs. The fixed costs and use-conditional variable costs become the intercept of the monthly cost equation, while the time-conditional variable costs represent the slope of the monthly cost equation. Monthly cost equations are computed using the total annual cost data, associated with utilizing the storage system at full capacity. Monthly cost equations are not computed at alternative utilization levels.

The monthly per bushel cost of owning and operating on-farm storage systems, expressed in cents per bushel for 1980 are as follows:

Category One Storage Systems	Storage System	Monthly Cost Equation (Cents Per Bushel ¢/bu.)
Equation (1)	2,000	$71.583 + .7707X_1 + 4.730X_2$
Equation (2)	3,000	$55.383 + .5264X_1 + 4.6887X_2$
Equation (3)	5,000	$43.163 + .3114X_1 + 4.6527X_2$
Equation (4)	7,000	$41.480 + .2353X_1 + 4.64X_2$
Equation (5)	10,000	$36.950 + .1559X_1 + 4.6786X_2$
Equation (6)	20,000	$33.703 + .1168X_1 + 4.6786X_2$
Equation (7)	30,000	$30.307 + .1039X_1 + 4.6786X_2$
Equation (8)	40,000	$27.722 + .0833X_1 + 4.6632X_2$
Equation (9)	60,000	$24.830 + .0566X_1 + 4.6434X_2$
Equation (10)	80,000	$23.810 + .0530X_1 + 4.6434X_2$

Category One Storage Systems	Storage System	Monthly Cost Equation (Cents Per Bushel ¢/bu.)
Category Two Storage Systems		
Equation (11)	10,000	$34.945 + .1559X_1 + 4.6786X_2$
Equation (12)	20,000	$32.311 + .1168X_1 + 4.6786X_2$
Equation (13)	30,000	$28.694 + .1039X_1 + 4.6786X_2$
Equation (14)	40,000	$26.903 + .0833X_1 + 4.6632X_2$
Equation (15)	60,000	$24.273 + .0566X_1 + 4.6434X_2$
Equation (16)	80,000	$23.435 + .0530X_1 + 4.6434X_2$
Category Three Storage Systems		
Equation (17)	30,000	$39.154 + .1039X_1 + 4.6786X_2$
Equation (18)	40,000	$35.653 + .0833X_1 + 4.6632X_2$
Equation (19)	60,000	$30.672 + .0566X_1 + 4.6434X_2$
Equation (20)	80,000	$28.632 + .0530X_1 + 4.6434X_2$

Where X_1 = number of storage months
X_2 = 0 if < 5 months
X_2 = 1 if $\geq$ 5 months

For example, suppose a producer is interested in finding out the average total cost of holding wheat for three months and five months, respectively, in the 80,000 bushel Category Three storage system. The monthly cost can be determined by using Equation 20. The average total cost of holding wheat for three months in the 80,000 bushel Category Three storage system equals 28.79 cents per bushel (28.632 + .0530(3) + 4.6434(0)). The average cost of holding wheat for five months in the 80,000 bushel Category Three storage system equals 33.54 cents per bushel (28.632 + .0530(5) + 4. 6434(1)).

The X_2 variable represents the additional aeration needed during the year to help cool wheat to a safe storage temperature. This variable changes the intercept of the cost equation after five months. The slope coefficient in each cost equation remains unchanged.

Once the decision has been made to store wheat, the variable cost associated with holding wheat an additional month is very small ranging from .7707 cents per bushel to .053 cents per bushel. Table XIII shows the average total costs associated with holding wheat up to ten months after harvest for each category of storage system. The average total costs associated with holding wheat six months are the same as those presented in Tables X, XI and XII of this chapter. Average total costs for the various length of storage are compared with historical wheat prices to determine whether seasonal price increases are enough to cover storage costs.

Seasonal price movements of wheat and the returns associated with storing wheat for various lengths of time are examined after a brief discussion of the opportunity costs associated with holding wheat.

Opportunity Cost of Capital to Hold Wheat

The opportunity cost of capital to hold wheat has not been overlooked. Up to this point, the author has not discussed this topic because it is not a cost associated only with on-farm wheat storage. Opportunity cost of capital to hold wheat, also referred to as the opportunity cost of inventory, is one of two costs associated with holding wheat for sale at a later date. The other cost being storage costs, either on-farm or commercial. The opportunity cost of capital should be

TABLE XIII

ESTIMATED PER BUSHEL COSTS OF STORING WHEAT ON FARM FOR VARIOUS LENGTHS OF STORAGE PERIODS AND SIZES OF STORAGE SYSTEMS, OKLAHOMA, 1980

Storage Systems	Length of Storage After Harvest in Months									
	1	2	3	4	5	6	7	8	9	10
Category One	Cents Per Bushel									
2,000	72.35	73.12	73.90	47.67	80.17	80.94	81.71	82.48	83.25	84.02
3,000	55.91	56.44	56.96	57.49	62.70	63.23	63.76	64.28	64.81	65.34
5,000	43.47	43.79	44.10	44.41	49.37	49.68	50.00	50.31	50.62	50.93
7,000	41.72	41.95	42.19	42.42	47.30	47.53	47.77	48.00	48.24	48.47
10,000	37.11	37.26	37.42	37.57	42.41	42.56	42.72	42.88	43.03	43.19
20,000	33.82	33.94	34.05	34.17	38.97	39.08	39.20	39.32	39.43	39.55
30,000	30.41	30.51	30.62	30.72	35.5.	35.61	35.71	35.82	35.92	36.02
40,000	27.81	27.89	27.97	28.06	32.78	32.87	32.95	33.03	33.12	33.20
60,000	24.89	24.94	25.00	25.06	29.76	29.81	29.87	29.93	29.98	30.04
80,000	23.86	23.92	23.97	24.02	28.72	28.77	28.82	28.87	28.93	28.98
Category Two	Cents Per Bushel									
10,000	35.10	35.26	35.41	35.57	40.40	40.56	40.71	41.81	41.03	41.18
20,000	32.43	32.54	32.66	32.78	37.57	37.69	37.81	37.92	38.04	38.16
30,000	28.80	28.90	29.01	29.11	33.89	34.00	34.10	34.20	34.31	34.41
40,000	26.99	27.07	27.15	27.24	31.96	32.05	32.13	32.21	32.30	32.38
60,000	24.33	24.39	24.44	24.50	29.20	29.26	29.31	29.37	29.43	29.48
80,000	23.49	23.54	23.59	23.65	28.34	28.40	28.45	28.50	28.56	28.61
Category Three	Cents Per Bushel									
30,000	39.26	39.36	39.47	39.57	44.35	44.46	44.56	44.66	44.77	44.87
40,000	35.74	35.82	35.90	35.99	40.75	40.83	40.91	41.00	41.08	41.16
60,000	30.73	30.79	30.84	30.90	35.60	35.66	35.71	35.77	35.82	35.88
80,000	28.69	28.74	28.79	28.84	33.54	33.59	33.65	33.70	33.75	33.81

considered whether the producer stores wheat in his own on-farm storage facility or in a commerical storage facility. Opportunity cost of capital is defined as the interest change associated with potential use of capital tied up in the wheat inventory or the interest charge associated with borrowing money to payoff outstanding debts while wheat is kept in storage. The longer wheat is kept in storage the higher the price producers must realize for their wheat, that is, unless the producer can gain greater income tax benefits by holding and selling wheat into the next tax year.

The opportunity cost of capital is dependent upon the price of wheat and the cost of capital. Table XIV shows the opportunity cost of capital to hold wheat for six months based on wheat prices ranging between $2.50 per bushel and $6.00 per bushel and interest rates ranging from 9 percent per annum to 20 percent per annum. Table XV shows the opportunity cost of capital for storage periods of one to twelve months based on wheat prices ranging from $2.50 to $6.00 per bushel and on annual interest rate of 15 percent. Table XVI shows the total cost of holding wheat for periods from one month to ten months for the various categories and sizes of storage systems analyzed in this study. Holding costs are based on $4.00 per bushel wheat price and a 15 percent annual rate of interest. Opportunity cost of capital of $4.00 per bushel wheat and a six month storage period is 30 cents per bushel. Adding this 30 cents per bushel to average annual costs of owning and operating on-farm storage systems, the cost of holding wheat for six months ranges from 110.94 cents per bushel for the 2,000 bushel Category One storage system to 58.40 cents per bushel for the 80,000 bushel Category Two storage system. Opportunity cost of capital calculated at an annual interest rate of 15 percent on

TABLE XIV

OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT AT VARIOUS PRICES AND INTEREST RATES FOR SIX MONTHS, CENTS PER BUSHEL.

Price of Wheat	Rate of Interest											
	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
$/Bushel	Cents Per Bushel											
2.50	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00	21.25	22.50	23.75	25.00
2.75	12.38	13.75	15.13	16.50	17.88	19.25	20.63	22.00	23.38	24.75	26.13	27.50
3.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00	35.50	27.00	28.50	30.00
3.25	14.63	16.25	17.88	19.50	21.13	22.75	24.38	26.00	27.63	29.25	30.88	32.50
3.50	15.75	17.50	19.25	21.00	22.75	24.50	26.25	38.00	29.75	31.50	33.25	35.00
3.75	16.88	18.75	20.63	22.50	24.38	26.25	28.13	30.00	31.88	33.75	35.63	37.50
4.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00
4.25	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00	36.13	38.25	40.38	42.50
4.50	20.25	22.50	24.75	27.00	29.25	31.50	33.75	36.00	38.25	40.50	42.75	45.00
4.75	21.38	23.75	26.13	28.50	30.88	33.25	35.63	38.00	40.38	42.75	45.13	47.50
5.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00
5.25	23.63	26.25	28.88	31.50	34.13	36.75	39.38	42.00	44.63	47.25	49.88	52.50
5.50	24.75	27.50	30.25	33.00	35.75	38.50	41.25	44.00	46.75	49.50	52.25	55.00
5.75	25.88	28.75	31.63	34.50	37.38	40.25	43.13	46.00	48.88	51.75	54.63	57.50
6.00	27.00	30.00	33.00	36.00	39.00	42.00	45.00	48.00	51.00	54.00	57.00	60.00

TABLE XV

COST OF CAPITAL TO HOLD WHEAT FROM ONE TO TWELVE MONTHS AT VARIOUS PRICES, GIVEN AN INTEREST RATE OF FIFTEEN PERCENT

Price of Wheat	Months of Storage											
	1	2	3	4	5	6	7	8	9	10	11	12
$/Bushel	Cents Per Bushel											
2.50	3.13	6.25	9.38	12.50	15.63	18.75	21.88	25.00	28.13	31.25	34.38	37.50
2.75	3.44	6.88	10.31	13.75	17.19	20.63	24.08	27.50	30.94	34.38	37.31	41.25
3.00	3.75	7.50	11.25	15.00	18;75	22.50	26.25	30.00	33.75	36.50	41.25	45.00
3.25	4.06	8.13	12.19	16.25	20.31	24.38	28.44	32.50	36.56	40.63	55.69	48.75
3.50	4.38	8.75	13.13	17.50	21,88	26.25	30.63	35.00	39.38	43/85	48.13	52.50
3.75	4.69	9.38	14.06	18.75	23.44	28.13	32.81	37.50	42.19	46.38	51.56	56.25
4.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00
4.25	5.31	10.63	15.95	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.44	63.75
4.50	5.63	11.25	16.88	22.50	28.13	33.75	39.38	45.00	50.63	56.25	61.88	67.50
4.75	5.94	11.88	17.81	23.75	29.69	35.63	41.56	47.50	53.44	59.38	65.31	71.25
5.00	6.25	12.50	18.75	25.00	31.25	37.50	43.75	50.00	56.25	62.50	68.75	75.00
5.25	6.56	13.13	19.69	26.25	32.31	39.38	45.94	52.50	59.06	65.63	72.19	78.75
5.50	6.88	13.75	20.63	27.50	34.38	41.25	48.13	55.00	61.88	68.75	75.63	82.50
5.75	7.19	14.38	21.56	28.75	35.94	43.13	50.31	57.50	64.69	71.88	79.06	86.25
6.00	7.50	15.00	22.50	30.00	37.50	45.00	52.50	60.00	67.50	75.00	82.50	90.00

TABLE XVI

ESTIMATED TOTAL ANNUAL COSTS OF STORING WHEAT ON-FARM FOR VARIOUS LENGTHS OF STORAGE PERIODS AND SIZES OF STORAGE SYSTEMS, GIVEN THE OPPORTUNITY COST OF CAPITAL IS INCLUDED AND COMPUTED USING AN ANNUAL INTEREST RATE OF 15 PERCENT AND $4.00 PER BUSHEL WHEAT PRICES, OKLAHOMA, 1980

Storage Systems	Length of Storage After Harvest in Months									
	1	2	3	4	5	6	7	8	9	10
Category One	Cents Per Bushel									
2,000	77.35	83.12	88.90	94.67	105.17	110.94	116.71	122.48	128.25	134.02
3,000	60.91	66.44	71.96	77.49	87.70	93.23	98.76	104.28	109.81	115.34
5,000	48.47	53.79	59.10	64.41	74.37	79.68	85.00	90.31	95.62	100.93
7,000	46.72	51.95	57.19	62.42	72.30	77.53	82.77	88.00	93.24	98.47
10,000	42.11	47.26	52.42	57.57	67.41	72.56	77.42	82.88	88.03	93.19
20,000	38.82	43.94	49.05	54.17	63.97	69.08	74.20	79.32	84.43	89.55
30,000	35.41	40.51	45.62	50.72	60.51	65.61	70.71	75.82	80.92	86.02
40,000	32.81	37.89	42.97	48.06	57.78	62.87	67.95	73.03	78.12	83.20
60,000	29.89	34.94	40.00	45.06	54.76	59.81	64.87	69.93	74.98	80.04
80,000	28.86	33.92	38.97	44.02	53.72	58.77	63.82	68.87	73.93	78.98
Category Two	Cents Per Bushel									
10,000	40.10	45.26	50.41	55.57	65.40	70.56	75.71	80.87	86.03	91.18
20,000	37.43	42.54	47.66	52.78	62.57	67.69	72.81	77.92	83.04	88.16
30,000	33.80	38.90	44.01	49.11	58.89	64.00	69.10	74.20	79.31	84.41
40,000	31.99	37.07	42.15	47.24	56.96	62.05	67.13	72.21	77.30	82.38
60,000	29.33	34.39	39.44	44.50	54.20	59.26	64.31	69.37	74.43	79.48
80,000	28.49	33.54	38.59	43.65	53.34	58.40	63.45	68.50	73.56	78.61
Category Three	Cents Per Bushel									
30,000	44.26	49.36	54.47	59.57	69.35	74.46	79.56	84.66	89.77	94.87
40,000	40.74	45.82	50.90	55.99	65.75	70.83	75.91	81.00	86.00	91.16
60,000	35.73	40.79	45.84	50.90	60.60	65.66	70.71	75.77	80.82	85.88
80,000	33.69	38.74	43.79	48.84	58.54	63.59	68.65	73.70	78.75	83.81

$4.00 wheat ranges from five cents per bushel for storage of one month, to fifty cents per bushel for storage of ten months.

The following section of analysis presents the returns associated with on-farm storage of wheat in Oklahoma.

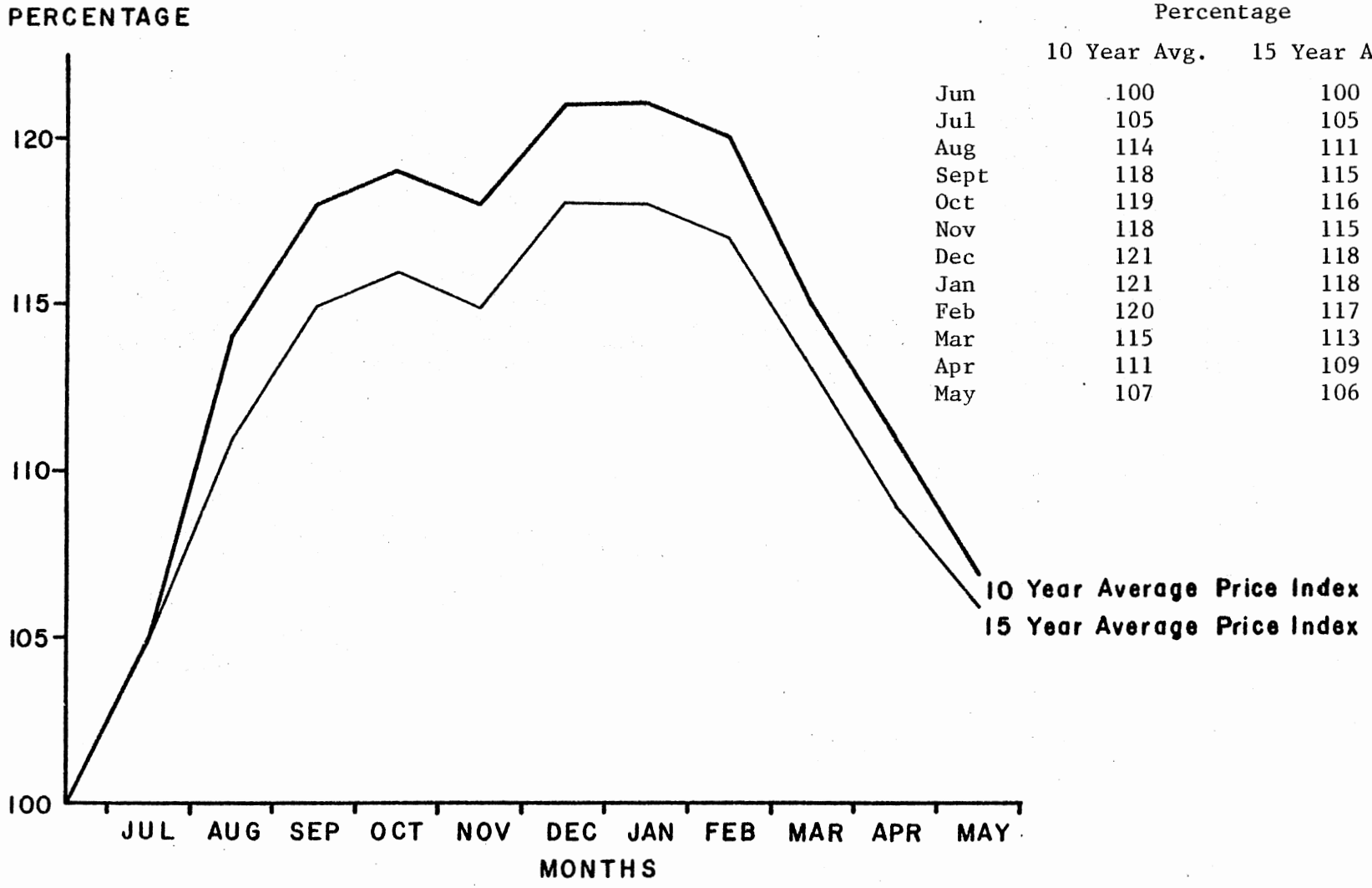
The Returns Associated with On-Farm Storage of Wheat in Oklahoma

The returns associated with on-farm storage in Oklahoma are determined by comparing average cash price spreads of wheat between June and selected months to the average cost of storing wheat on-farm for the same length of time. Returns are computed for each of the twenty storage systems under study.

Seasonal Pattern Of Cash Wheat Prices In Oklahoma

Typically, wheat prices are expected to be at their lowest level during harvest and as time passes they generally begin to rise. The extent that wheat prices rise from the harvest level determines the potential revenue that can be earned by postponing sale of wheat to some future date.

Figure 6 shows average indexes of monthly Oklahoma wheat price levels for the last ten and fifteen years. Both indexes indicate that wheat prices, on the average, peak in December and January at a price level between 18 percent and 21 percent above the mid-June cash price. Both indexes show wheat prices peaking in October, falling off in November and then peaking again, but at a higher level, in December and



	Percentage	
	10 Year Avg.	15 Year Avg.
Jun	100	100
Jul	105	105
Aug	114	111
Sept	118	115
Oct	119	116
Nov	118	115
Dec	121	118
Jan	121	118
Feb	120	117
Mar	115	113
Apr	111	109
May	107	106

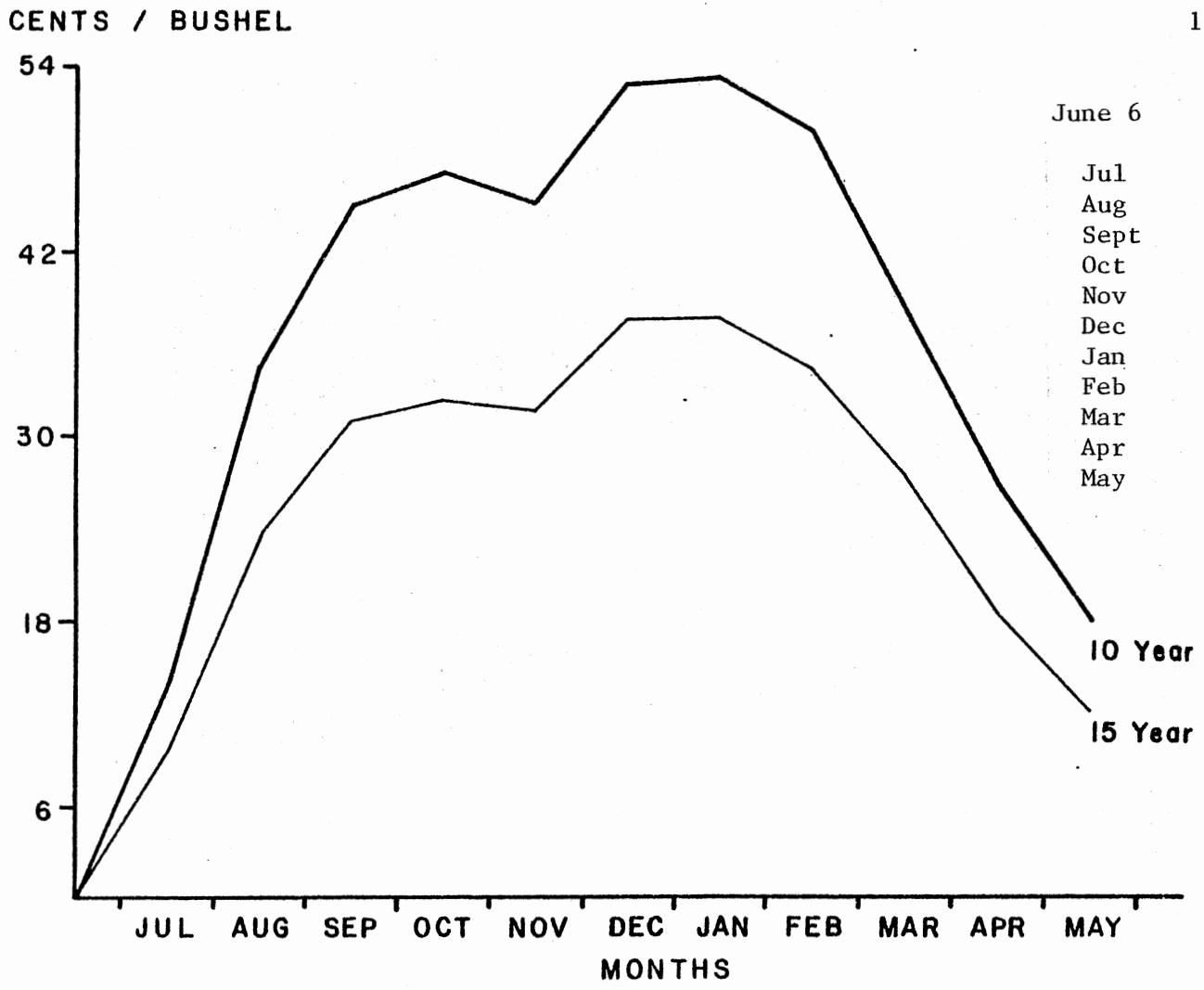
Figure 6. Index of Average Wheat Prices in Oklahoma, Crop Years 1965 to 1979.

January. October wheat prices are on the average between 16 and 19 percent above the June price level. Wheat prices in December and January on the average are 2 percent higher than wheat prices in October. Whether or not the 2 percent difference is enough to cover the additional two months of storage is discussed later in this chapter.

Figure 7 shows the average wheat price spread between June and selected months over the last ten and fifteen years in Oklahoma. Again, the same basic pattern of peaking in December and January is shown. However, in the ten year average the June-January price spread is one-half a cent greater than the June-December price spread. The average price spread between June and January over the last ten and fifteen years has been 53.20 cents and 37.40 cents, respectively. The June-December price spread over the last ten and fifteen years has averaged 52.70 cents and 37.33 cents, respectively.

A word of caution is issued with respect to interpreting average price spreads. Remember these are average price spreads, the actual price spread may deviate greatly from these averages.

Table XVII shows the actual price spread between June and selected months for the last fifteen years. Price spreads have been both positive and negative over that fifteen year period. The June-December price spread was negative three out of fifteen years and ranged from a negative 102 cents per bushel to a postitive 244 cents per bushel. The June-January price spread was also negative three out of fifteen years, and ranged from a negative price spread of 93 cents per bushel to a positive price spread of 293 cents per bushel. At the bottom of Table XVIII the average ten year and fifteen year price spreads are shown, as-well-as the standard deviation and coefficient of variation for each monthly average



June 6	10 Year Avg.	15 Year Avg.
	Price Spreads	
	Dollars	
Jul	13.90	9.80
Aug	34.50	23.93
Sept	44.90	31.13
Oct	47.20	32.40
Nov	45.00	31.73
Dec	52.70	37.33
Jan	53.20	37.40
Feb	49.80	34.40
Mar	38.40	27.80
Apr	27.30	18.60
May	18.30	12.53

Figure 7. Average Price Spread Between June and Selected Month, Ten and Fifteen Year Averages, Oklahoma, Crop Years 1965 to 1979.

TABLE XVII

ACTUAL PRICE SPREAD BETWEEN JUNE AND SELECTED MONTHS, OKLAHOMA WHEAT PRICES, CROP YEARS 1965 TO 1979

Crop Year	Price Spread Between June and										
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
	Cents Per Bushel										
1965/66	4.00	16.00	14.00	15.00	20.00	19.00	21.00	21.00	22.00	21.00	25.00
1966/67	18.00	17.00	17.00	-1.00	4.00	9.00	1.00	-9.00	6.00	-3.00	-3.00
1967/68	-8.00	-9.00	-12.00	-8.00	-10.00	-8.00	-6.00	-6.00	-6.00	-20.00	-21.00
1968/69	-3.00	-5.00	-6.00	0.00	2.00	1.00	1.00	0.00	0.00	-4.00	-3.00
1969/70	-3.00	-5.00	5.00	8.00	10.00	12.00	12.00	12.00	11.00	12.00	7.00
1970/71	1.00	7.00	21.00	21.00	23.00	22.00	22.00	21.00	19.00	20.00	24.00
1971/72	-8.00	-10.00	-12.00	-9.00	-10.00	-6.00	-7.00	-6.00	-6.00	-2.00	-2.00
1972/73	5.00	32.00	60.00	71.00	69.00	116.00	123.00	61.00	85.00	95.00	95.00
1973/74	8.00	198.00	228.00	188.00	196.00	244.00	293.00	316.00	236.00	151.00	91.00
1974/75	59.00	55.00	55.00	121.00	107.00	112.00	52.00	28.00	-7.00	-7.00	-37.00
1975/76	52.00	86.00	96.00	91.00	52.00	35.00	49.00	76.00	71.00	56.00	41.00
1976/77	4.00	-43.00	-52.00	-84.00	-98.00	-102.00	-93.00	-91.00	-103.00	-113.00	-131.00
1977/78	7.00	6.00	20.00	33.00	53.00	55.00	56.00	60.00	72.00	88.00	88.00
1978/79	-2.00	4.00	11.00	26.00	28.00	24.00	24.00	31.00	30.00	31.00	40.00
1979/80[a]	13.00	10.00	22.00	14.00	30.00	27.00	13.00	2.00	-13.00	-46.00	-26.00
10 Year Average	13.90	34.50	44.90	47.20	45.00	52.70	53.20	49.80	38.40	27.30	18.30
Standard Deviation	22.72	67.41	75.98	74.96	75.87	90.82	100.47	104.70	88.52	75.68	70.53
Coefficient of Variation %	61.19	51.18	59.09	82.97	59.31	58.02	52.95	47.56	43.38	36.07	25.95
15 Year Average	9.80	23.93	31.13	32.40	31.73	37.33	37.40	34.40	27.80	18.60	12.53
Standard Deviation	19.93	56.62	65.51	64.06	64.13	76.42	84.00	87.18	72.88	62.58	56.88
Coefficient of Variation %	49.18	42.27	48.26	50.58	49.49	48.85	44.52	39.46	38.15	29.72	21.66

Source: Oklahoma Agricultural Statistics, USDA, ESCS 1978 and previous years, Current Farm Economics, Oklahoma State University, Volume 53, Number 1, March 1980.

[a]April and May 1980 Wheat Prices Supplied by Statistical Reporting Service, USDA, Oklahoma City and Washington D.C.

TABLE XVIII

AVERAGE RETURNS PER BUSHEL TO ON-FARM STORAGE OF WHEAT IN OKLAHOMA, BASED ON TEN YEAR AVERAGE PRICE SPREADS, ASSUMING ZERO OPPORTUNITY COST ON CAPITAL TO HOLD WHEAT, 1980[a]

Storage Systems	Storage in June with Removal in									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel (¢/bu.)									
2,000	(58.45)	(38.62)	(29.00)	(27.47)	(35.17)	(28.24)	(28.51)	(32.68)	(44.85)	(56.72)
3,000	(42.01)	(21.94)	(12.06)	(10.29)	(17.70)	(10.53)	(10.56)	(14.48)	(26.41)	(38.04)
5,000	(29.57)	(9.29)	.80	2.79	(4.37)	3.02	3.20	(.51)	(12.22)	(23.63)
7,000	(27.82)	(7.45)	2.71	4.78	(2.30)	5.17	5.43	1.80)	(9.84)	(21.17)
10,000	(23.21)	(2.76)	7.48	9.63	2.59	10.14	10.48	6.92	(4.63)	(15.89)
20,000	(19.92)	.56	10.85	13.03	6.03	13.62	14.00	10.48	(1.03)	(12.25)
30,000	(16.51)	3.99	14.28	16.48	9.49	17.09	17.49	13.98	2.48	(8.72)
40,000	(13.91)	6.61	16.93	19.14	12.22	19.83	20.25	16.77	5.28	(5.90)
60,000	(10.99)	9.56	19.90	22.14	15.24	22.89	23.33	19.87	8.42	(2.74)
80,000	(9.96)	10.58	20.93	23.18	16.28	23.93	24.38	20.93	9.47	(1.68)
Category Two	Cents Per Bushel (¢/bu.)									
10,000	(21.20)	(.76)	9.49	11.63	4.60	12.14	12.49	8.93	(2.63)	(13.88)
20,000	(18.53)	1.96	12.24	14.42	7.43	15.01	15.39	11.88	.36	(10.86)
30,000	(14.90)	5.60	15.89	18.09	11.11	18.70	19.10	15.60	4.09	(7.11)
40,000	(13.09)	7.43	17.75	19.96	13.04	20.65	21.07	17.59	6.10	(5.08)
60,000	(10.43)	10.11	20.46	22.70	15.80	23.44	23.98	20.43	8.97	(2.18)
80,000	(9.59)	10.96	21.31	23.55	16.66	24.30	24.75	21.30	9.84	(1.31)
Catetory Three	Cents Per Bushel (¢/bu.)									
30,000	(25.36)	(4.86)	5.43	7.63	.65	8.24	8.64	5.14	(6.37)	(17.57)
40,000	(21.84)	(1.32)	9.00	11.21	4.25	11.87	12.29	8.80	(2.68)	(13.86)
60,000	(16.83)	3.71	14.06	16.30	9.40	17.04	17.49	14.03	2.58	(8.58)
80,000	(14.79)	5.76	16.11	18.36	11.46	19.11	19.55	16.10	4.65	(6.51)

[a]Numbers in parenthesis indicate negative returns to storage.

price spread. The standard deviation and coefficient of variation are measures of absolute variation, that is, it is a measure of the actual amount of variation about the mean. The coefficient of variation is a measure of the variation about the mean, relative to the mean. The coefficient of variation is the standard decision expressed as a percentage of the mean. The smaller the coefficient of variation the more stable the data, in contrast, the larger the coefficient the more volatile the data. The coefficients of variation in Table XVII are fairly large indicating that the average price spread between June and selected months has been fairly volatile.

Table XVII and Figure 7 show that wheat price spreads based on ten year average wheat prices range from a low of 14 cents per bushel for storage in June with removal in July, to a high of 53 cents per bushel for storage in June with removal in January. Wheat price spreads based on fifteen year average wheat prices range from a low of 10 cents per bushel for storage in June with removal in July, to a high of 37 cents per bushel for storage in June with removal in January. The largest average wheat price spreads, based on ten and fifteen year average prices, occur in January. The question now is whether or not wheat prices increase enough during the crop year to cover all storage costs. The following section of analysis compares the average price spread between June and various months with the average total costs of storing wheat on-farm for the same months.

Returns From On-Farm Wheat Storage

Average storage returns for each storage system is determined by subtracting average total storage costs from the appropriate average

wheat price spread. Storage returns based on ten year average and fifteen year average price spreads before subtracting opportunity cost of capital are shown in Tables XVIII and XIX, respectively. Average returns to holding wheat for various lengths of time using ten year average price spreads are shown in Table XX. These average returns to holding wheat takes into consideration the opportunity cost of capital. Returns to holding wheat using the fifteen year average wheat price spreads were not calculated because in all cases returns turned out to be negative. Note, there is a difference between returns to holding wheat in on-farm storage and returns to on-farm wheat storage. The returns to holding wheat in on-farm considers the opportunity cost of capital while the returns to on-farm wheat storage assumes the opportunity cost of capital is zero.

Average Returns to On-Farm Storage Systems. As indicated above, a distinction is made between returns to on-farm storage systems and returns to holding wheat in on-farm storage. Average returns to the various storage systems under study are shown in Tables XVIII and XIX. Average returns to storage shown in Table XVIII are computed using the average wheat price spreads over the last ten yers, while returns shown in Table XIX are based on average price spreads over the last fifteen years.

Storage in June with removal in January results in the greatest returns to storage for all storage systems under consideration. The 2,000 and 3,000 bushel storage systems never show a positive return. Storage in June with removal in either July or April results in a loss for all storage systems under consideration. Based on average price

TABLE XIX

AVERAGE RETURNS TO ON-FARM STORAGE OF WHEAT IN OKLAHOMA, BASED ON FIFTEEN YEAR AVERAGE MID-MONTH WHEAT PRICE SPREADS, ASSUMING ZERO OPPORTUNITY COST ON CAPITAL TO HOLD WHEAT, 1980[a]

Storage Systems	Storage in June with Removal in									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel									
2,000	(62.55)	(49.19)	(42.77)	(42.27)	(48.44)	(43.61)	(44.31)	(48.08)	(55.45)	(65.42)
3,000	(46.11)	(32.51)	(25.83)	(25.09)	(30.97)	(25.90)	(26.36)	(29.88)	(37.01)	(46.74)
5,000	(33.67)	(19.86)	(12.97)	(12.01)	(17.64)	(12.35)	(12.60)	(15.91)	(22.82)	(32.33)
7,000	(31.92)	(18.02)	(11.06)	(10.02)	(15.57)	(10.20)	(10.37)	(13.60)	(20.44)	(29.87)
10,000	(27.31)	(13.33)	(6.29)	(5.17)	(10.68)	(5.23)	(5.32)	(8.48)	(15.23)	(24.59)
20,000	(24.02)	(10.01)	(2.92)	(1.77)	(7.24)	(1.75)	(1.80)	(4.92)	(11.63)	(20.95)
30,000	(20.61)	(6.58)	.51	1.68	(3.78)	1.72	1.69	(1.42)	(8.12)	(17.42)
40,000	(18.01)	(3.96)	3.16	4.34	(1.05)	4.46	4.45	1.37	(5.32)	(14.60)
60,000	(15.09)	(1.01)	6.13	7.34	1.97	7.52	7.53	4.47	(2.18)	(11.44)
80,000	(14.06)	.01	7.16	8.38	3.01	8.56	8.59	5.53	(1.13)	(10.38)
Category Two	Cents Per Bushel									
10,000	(25.30)	(11.33)	(4.28)	(3.17)	(8.67)	(3.23)	(3.31)	(6.47)	(13.23)	(22.58)
20,000	(22.63)	(8.61)	(1.53)	(.31)	(5.84)	(.36)	(.41)	(3.52)	(10.24)	(19.56)
30,000	(19.00)	(4.97)	2.12	3.29	(2.16)	3.33	3.30	.20	(6.51)	(15.81)
40,000	(17.19)	(3.14)	3.98	5.16	(.23)	5.28	5.27	2.19	(4.50)	(13.78)
60,000	(14.53)	(.46)	6.69	7.90	2.53	8.07	8.09	5.03	(1.63)	(10.88)
80,000	(13.69)	.39	7.54	8.75	3.39	8.93	8.95	5.90	(.76)	(10.01)
Category Three	Cents Per Bushel									
30,000	(29.46)	(15.43)	(8.34)	(7.17)	(12.62)	(7.13)	(7.16)	(10.26)	(16.97)	(26.27)
40,000	(25.94)	(11.89)	(4.77)	(3.59)	(9.02)	(3.50)	(3.15)	(6.60)	(13.28)	(22.56)
60,000	(20.93)	(6.86)	.29	1.50	(3.87)	1.67	1.69	(1.37)	(8.02)	(17.28)
80,000	(18.89)	(4.81)	2.34	3.56	(1.81)	3.74	3.75	.70	(5.95)	(15.21)

[a]Numbers in parenthesis indicate negative returns to storage.

TABLE XX

AVERAGE RETURNS TO HOLDING WHEAT IN ON-FARM STORAGE SYSTEMS IN OKLAHOMA, USING TEN YEAR AVERAGE PRICE SPREAD, OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT IS INCLUDED AND COMPUTED USING AN ANNUAL INTEREST RATE OF 15 PERCENT AND $4.00 PER BUSHEL WHEAT, 1980[a]

Storage Systems	Storage in June with Removal in									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel									
2,000	(63.45)	(48.62)	(44.00)	(47.47)	(60.17)	(58.24)	(63.51)	(72.68)	(89.85)	(106.72)
3,000	(47.01)	(31.94)	(27.06)	(30.29)	(42.70)	(40.53)	(45.56)	(54.48)	(71.41)	(88.04)
5,000	(34.57)	(19.29)	(14.20)	(17.21)	(29.37)	(26.98)	(31.80)	(40.51)	(57.22)	(73.63)
7,000	(32.82)	(17.45)	(12.29)	(15.22)	(27.30)	(24.83)	(29.57)	(38.20)	(54.84)	(71.17)
10,000	(28.21)	(12.76)	(7.52)	(10.37)	(22.41)	(19.86)	(24.52)	(33.08)	(49.63)	(65.89)
20,000	(24.92)	(7.44)	(4.15)	(6.97)	(18.97)	(16.38)	(21.00)	(29.52)	(46.03)	(62.95)
30,000	(21.51)	(6.01)	(.72)	(3.52)	(15.51)	(12.91)	(17.51)	(26.02)	(42.52)	(58.72)
40,000	(18.91)	(3.39)	1.43	(.86)	(12.78)	(10.17)	(14.75)	(23.23)	(39.72)	(55.90)
60,000	(15.99)	(.44)	4.90	2.14	(9.76)	(7.11)	(11.67)	(20.13)	(36.58)	(52.74)
80,000	(14.96)	.58	5.93	3.18	(8.72)	(6.07)	(10.62)	(19.07)	(35.53)	(51.68)
Category Two	Cents Per Bushel									
10,000	(26.20)	(10.76)	(5.51)	(8.37)	(20.40)	(17.86)	(22.51)	(31.07)	(47.63)	(63.38)
20,000	(23.63)	(8.04)	(2.76)	(5.58)	(17.57)	(14.99)	(19.61)	(28.12)	(44.64)	(60.86)
30,000	(19.90)	(4.40)	.89	(1.91)	(13.89)	(11.30)	(15.90)	(24.40)	(40.91)	(57.11)
40,000	(18.09)	(2.51)	2.75	(.04)	(11.96)	(9.35)	(13.93)	(22.41)	(38.90)	(55.08)
60,000	(15.43)	.11	5.46	2.70	(9.20)	(6.56)	(11.11)	(19.57)	(36.03)	(52.18)
80,000	(14.59)	.96	6.31	3.55	(8.34)	(5.70)	(10.25)	(19.70)	(35.16)	(51.31)
Category Three	Cents Per Bushel									
30,000	(30.36)	(14.86)	(9.57)	(12.37)	(24.35)	(21.76)	(26.36)	(34.86)	(51.37)	(67.57)
40,000	(26.84)	(11.32)	(6.00)	(8.79)	(20.75)	(18.13)	(22.71)	(31.20)	(47.68)	(63.86)
60,000	(21.83)	(6.29)	(.94)	(3.70)	(15.60)	(12.96)	(17.21)	(25.97)	(42.42)	(58.58)
80,000	(14.79)	(4.24)	1.11	(1.64)	(13.54)	(10.89)	(15.45)	(23.90)	(40.35)	(56.51)

[a]Numbers in parenthesis indicate negative returns to storage.

spreads over the last ten years, returns to storage ranged from a minus 58.45 cents per bushel to a positive 24.75 cents per bushel. When average returns are computed using the average price spread over the last fifteen years, returns range from a minus 62.55 cents per bushel to a positive 8.95 cents per bushel. The greatest returns are associated with Category Two storage systems, that is, storage systems which use three-phase electric motors and a portable auger. Average returns to Category Three storage systems range from five to ten cents per bushel below the returns of comparable storage systems which handle wheat with a portable auger.

When opportunity cost of capital is included in the cost of storage it no longer becomes profitable to hold wheat past October. That is, assuming wheat is priced at $4.00 per bushel and the annual rate of interest is 15 percent. When opportunity cost of capital is added to monthly average storage costs, storage in June with removal in January is no longer the most profitable length of storage. Considering opportunity costs of capital, the most profitable alternative is storage in June with removal in September. Average returns to holding wheat in on-farm storage systems range from a negative 106.72 cents per bushel to a positive 6.31 cents per bushel.

For the interested reader, Tables XXI, XXII and XXIII present average annual returns to holding wheat with opportunity cost of capital being calculated using annual interests of 9 percent, 12 percent, and 18 percent, respectively. Wheat prices are still assumed to be $4.00 per bushel.

Evaluation of the On-Farm Storage System

Investment

The capital requirements necessary to invest in an on-farm storage

TABLE XXI

AVERAGE RETURNS TO HOLDING WHEAT IN ON-FARM STORAGE SYSTEMS, OKLAHOMA, TEN YEAR AVERAGE PRICE SPREADS, OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT IS INCLUDED AND COMPUTED USING AN ANNUAL INTEREST RATE OF 9 PERCENT, $4.00 PER BUSHEL WHEAT PRICES, 1980[a]

Storage Systems	Storage in June With Removal in									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel									
2,000	(61.45)	(44.62)	(38.00)	(39.47)	(50.17)	(46.24)	(49.51)	(56.68)	(71.85)	(86.72)
3,000	(45.01)	(27.94)	(21.06)	(22.29)	(32.17)	(28.53)	(31.56)	(38.48)	(53.41)	(68.04)
5,000	(32.51)	(15.29)	(8.20)	(9.21)	(19.37)	(14.98)	(17.80)	(24.51)	(39.22)	(53.63)
7,000	(30.80)	(13.45)	(6.29)	(7.22)	(17.30)	(12.83)	(15.57)	(22.20)	(36.84)	(51.17)
10,000	(26.21)	(8.76)	(1.57)	(2.37)	(12.41)	(7.86)	(10.52)	(17.08)	(31.63)	(45.89)
20,000	(22.92)	(5.44)	1.85	1.03	(8.97)	(4.38)	(7.00)	(13.52)	(28.03)	(42.25)
30,000	(19.51)	(2.01)	5.28	4.48	(5.51)	(.91)	(3.51)	(10.02)	(24.52)	(38.72)
40,000	(16.91)	.61	7.93	7.14	(2.78)	1.83	(.75)	(7.23)	(21.72)	(35.90)
60,000	(13.99)	3.56	10.90	10.14	.24	4.89	2.33	(4.13)	(18.58)	(32.74)
80,000	(12.96)	4.58	11.93	11.18	1.28	5.93	3.38	(3.07)	(11.53)	(31.68)
Category Two	Cents Per Bushels									
10,000	(24.20)	(6.76)	.49	(.37)	(10.40)	(5.86)	(8.51)	(15.07)	(29.63)	(43.88)
20,000	(21.53)	(4.04)	3.24	2.42	(7.57)	(2.99)	(5.61)	(12.12)	(26.64)	(40.86)
30,000	(17.90)	(.40)	6.89	6.09	(3.89)	.70	(1.90)	(8.40)	(22.91)	(37.11)
40,000	(16.09)	1.43	8.75	7.96	(1.96)	2.65	.07	(6.41)	(20.90)	(35.08)
60,000	(13.43)	4.11	11.46	10.70	.80	5.44	2.89	(3.57)	(18.03)	(32.18)
80,000	(12.59)	4.96	12.31	11.55	1.66	6.30	3.75	2.70)	(17.16)	(31.31)
Category Three	Cents Per Bushels									
30,000	(28.36)	(10.86)	(3.57)	(4.37)	(14.35)	(9.76)	(12.36)	(18.86)	(33.37)	(47.57)
40,000	(24.84)	(7.22)	0.0	(.79)	(10.75)	(6.13)	(8.71)	(15.20)	(29.68)	(43.86)
60,000	(19.83)	(2.29)	5.06	4.30	(5.60)	(.96)	(3.51)	(9.97)	(24.42)	(38.58)
80,000	(17.79)	(.24)	7.11	6.36	(3.54)	1.11	(1.45)	(7.90)	(22.35)	(36.51)

[a]Numbers in parenthesis indicate negative returns to storage.

TABLE XXII

AVERAGE RETURNS TO HOLDING WHEAT IN ON-FARM STORAGE SYSTEMS, OKLAHOMA, TEN YEAR AVERAGE PRICE SPREADS, OPPORTUNITY OF CAPITAL TO HOLD WHEAT IS INCLUDED AND COMPUTED AND AN ANNUAL INTEREST OF TWELVE PERCENT, USING $4.00 PER BUSHEL WHEAT PRICE, 1980[a]

Storage Systems	Removal From Storage									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel									
2,000	(62.45)	(46.62)	(41.00)	(43.47)	(55.17)	(52.54)	(56.51)	(64.68)	(80.85)	(96.72)
3,000	(46.01)	(29.94)	(24.06)	(26.29)	(37.70)	(34.53)	(38.56)	(46.48)	(62.41)	(78.04)
5,000	(33.57)	(17.29)	(11.20)	(13.21)	(24.37)	(20.98)	(24.80)	(32.51)	(48.22)	(63.63)
7,000	(31.80)	(15.45)	(9.29)	(11.22)	(22.30)	(18.83)	(22.57)	(30.71)	(45.84)	(61.17)
10,000	(27.21)	(10.76)	(4.52)	(6.37)	(17.41)	(13.86)	(17.52)	(25.08)	(40.63)	(55.89)
20,000	(23.92)	(7.44)	(1.15)	(2.97)	(13.97)	(10.38)	(14.00)	(21.52)	(37.03)	(52.25)
30,000	(20.51)	(4.01)	2.28	.48	(10.51)	(6.91)	(10.51)	(18.02)	(33.52)	(48.72)
40,000	(17.91)	(1.39)	4.93	3.14	(7.79)	(4.17)	(7.75)	(15.23)	(30.72)	(45.90)
60,000	(14.99)	1.56	7.90	6.14	(4.76)	(1.11)	(4.67)	(12.13)	(27.58)	(42.74)
80,000	(13.96)	2.58	8.93	7.18	(3.72)	(.07)	(3.62)	(11.07)	(26.53)	(41.68)
Category Two	Cents Per Bushel									
10,000	(25.20)	(8.76)	(2.51)	(4.37)	(15.40)	(11.86)	(15.51)	(23.07)	(38.63)	(53.88)
20,000	(22.52)	(6.04)	.24	(1.58)	(12.27)	(8.99)	(12.61)	(20.12)	(35.64)	(50.86)
30,000	(18.90)	(2.40)	3.89	2.09	(8.89)	(5.30)	(8.90)	(16 40)	(31.91)	(47.11)
40,000	(17.09)	(.57)	5.75	3.95	(6.96)	(3.35)	(6.93)	(14.41)	(29.90)	(45.08)
60,000	(14.43)	2.11	8.46	6.70	(4.20)	(.56)	(4.11)	(11.57)	(27.03)	(42.18)
80,000	(13.59)	2.96	9.31	7.55	(3.34)	.30	(3.25)	(10.70)	(26.16)	(41.31)
Category Three	Cents Per Bushel									
30,000	(29.36)	(12.86)	(6.57)	(8.37)	(19.35)	(15.76)	(19.36)	(26.86)	(42.37)	(57.57)
40,000	(25.84)	(9.32)	(3.00)	(4.79)	(15.75)	(12.13)	(15.71)	(23.20)	(38.68)	(53.86)
60,000	(21.83)	(4.29)	2.06	.30	(10.60)	(6.96)	(10.51)	(17.97)	(33.42)	(48.58)
80,000	(18.79)	(2.24)	4.11	2.36	(8.54)	(4.89)	(8.45)	(15.90)	(31.35)	(46.51)

[a]Numbers in parenthesis indicate negative returns to storage.

TABLE XXIII

AVERAGE RETURNS TO HOLDING WHEAT IN ON-FARM STORAGE SYSTEM, OKLAHOMA, TEN YEAR AVERAGE PRICE SPREAD, OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT IS INCLUDED AND COMPUTED USING AN ANNUAL INTEREST RATE OF 18 PERCENT AT $4.00 PER BUSHEL WHEAT PRICES, 1980[a]

Storage Systems	Storage in June With Removal in									
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Category One	Cents Per Bushel									
2,000	(64.45)	(50.62)	(47.00)	(51.47)	(65.17)	(64.24)	(70.51)	(80.68)	(98.85)	(116.72)
3,000	(48.01)	(33.94)	(30.06)	(34.29)	(47.70)	(46.53)	(52.56)	(62.48)	(80.41)	(98.04)
5,000	(35.57)	(21.29)	(17.20)	(21.21)	(34.37)	(32.98)	(38.80)	(48.51)	(66.22)	(83.63)
7,000	(33.82)	(19.45)	(15.29)	(19.22)	(32.30)	(30.83)	(36.57)	(46.20)	(63.84)	(81.17)
10,000	(29.21)	(14.76)	(10.52)	(14.37)	(27.41)	(25.86)	(31.52)	(41.08)	(58.63)	(75.89)
20,000	(25.92)	(11.44)	(7.15)	(10.97)	(23.97)	(22.38)	(28.02)	(37.52)	(55.03)	(72.25)
30,000	(22.51)	(8.01)	(3.72)	(7.52)	(20.51)	(18.91)	(24.51)	(34.02)	(51.52)	(68.72)
40,000	(19.91)	(5.39)	(1.07)	(4.86)	(17.78)	(16.17)	(21.75)	(31.23)	(48.72)	(65.90)
60,000	(16.99)	(2.44)	1.90	(1.86)	(14.76)	(13.11)	(18.67)	(28.13)	(45.58)	(62.74)
80,000	(15.96)	(1.42)	2.93	(.82)	(13.72)	(12.07)	(17.62)	(27.07)	(44.53)	(61.68)
Category Two	Cents Per Bushel									
10,000	(27.20)	(12.76)	(8.51)	(12.37)	(25.40)	(23.86)	(29.51)	(39.07)	(56.63)	(73.88)
20,000	(24.53)	(10.04)	(5.76)	(9.58)	(22.57)	(20.99)	(26.61)	(36.12)	(53.64)	(70.86)
30,000	(20.90)	(6.40)	(2.11)	(5.91)	(18.89)	(17.30)	(22.90)	(32.40)	(49.91)	(67.11)
40,000	(19.09)	(4.57)	(.25)	(4.04)	(16.96)	(15.35)	(20.93)	(30.41)	(47.90)	(65.08)
60,000	(16.43)	(1.89)	2.46	(1.30)	(14.20)	(12.56)	(18.11)	(27.57)	(45.03)	(62.18)
80,000	(15.59)	(1.04)	3.31	(.45)	(13.34)	(11.70)	(17.25)	(26.70)	(44.16)	(61.31)
Category Three	Cents Per Bushel									
30,000	(31.36)	(16.86)	(12.57)	(16.37)	(29.35)	(27.76)	(33.36)	(42.86)	(60.37)	(77.57)
40,000	(27.84)	(13.32)	(9.00)	(12.79)	(25.75)	(24.13)	(29.71)	(39.20)	(56.68)	(73.86)
60,000	(22.83)	(8.29)	(3.94)	(7.70)	(20.60)	(18.96)	(24.51)	(33.97)	(51.42)	(68.58)
80,000	(20.79)	(6.24)	(1.89)	(5.64)	(18.54)	(16.89)	(22.45)	(31.90)	(49.35)	(66.51)

[a]Numbers in parenthesis indicate negative returns to storage.

system is substantial. For this reason it is important for each producer to carefully examine the profitability of such an investment in relation to the profitability of alternative investment opportunities. Two methods of evaulating investments are employed in this study. The two methods are: 1) payback period, and 2) interval rate of return.

Payback Period

The payback period is the length of time required for an investment to pay for itself. The payback period is determined by dividing the total capital outlay for an investment by the estimated annual cash-flow generated by that investment. Tables XXIV and XXV report the estimated payback period for the various storage systems under study when average price differentials between June and selected months are used to determine returns to on-farm storage. Table XXIV reports the estimated payback period for the various storage systems under study based on ten and fifteen year average price differentials between June and selected months. Annual cash-flows used to compute payback periods for storage systems in Table XXIV include only the actual out-of-pocket cost outlay for each storage system. That is, the opportunity cost of capital to hold wheat is assumed to be zero when making these computations. Table XXV reports the payback periods for each storage system when both storage costs and opportunity cost of capital are included in the computation. Opportunity cost of capital is computed at four different annual rates of interest; 9 percent, 12 percent, 15 percent and 18 percent. Payback periods are computed for storage in June with removal in September only, since, as shown in Tables XX through XXIII, this storage alternative yielded the most profitable returns when the opportunity cost of capital

TABLE XXIV

ESTIMATED PAYBACK PERIODS FOR ON-FARM STORAGE SYSTEMS IN OKLAHOMA, STORAGE IN JUNE WITH REMOVAL IN SELECTED MONTHS, BASED ON TEN AND FIFTEEN YEAR AVERAGE PRICE SPREADS, ASSUMING ZERO OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT, 1980

Storage Systems	10 Year Average Wheat Price Spread				15 Year Average Wheat Price Spread			
	Removal From Storage							
	Sep	Oct	Dec	Jan	Sep	Oct	Dec	Jan
	Years							
Category One								
2,000	*	*	*	*	*	*	*	*
3,000	*	*	*	*	*	*	*	*
5,000	235.9	67.6	62.5	59.0	*	*	*	*
7,000	69.3	39.3	36.3	34.6	*	*	*	*
10,000	21.3	16.6	15.7	15.2	*	*	*	*
20,000	13.3	11.1	10.6	10.3	*	*	*	*
30,000	9.1	7.9	7.6	7.4	253.7	77.0	75.2	76.6
40,000	6.9	6.1	5.9	5.7	36.8	26.8	26.1	26.1
60,000	5.1	4.6	4.5	4.4	16.7	13.9	13.6	13.6
80,000	4.7	4.2	4.1	4.0	13.6	11.6	11.4	11.4
Category Two								
10,000	15.7	12.8	12.3	11.9	*	*	*	*
20,000	11.2	9.5	9.1	8.9	*	*	*	*
30,000	7.8	6.9	6.6	6.5	58.5	37.7	37.2	37.6
40,000	6.3	5.6	5.4	5.3	28.1	21.7	21.2	21.2
60,000	4.8	4.4	4.2	4.2	14.8	12.6	12.3	12.3
80,000	4.5	4.1	3.9	3.9	12.7	10.9	10.7	10.7
Category Three								
30,000	34.7	24.7	22.9	21.8	*	*	*	*
40,000	18.6	15.0	14.1	13.6	*	*	*	*
60,000	10.0	8.6	8.2	8.0	483.1	93.4	83.9	82.9
80,000	8.0	7.0	6.7	6.6	54.7	36.0	34.3	34.2

*Negative Returns: Based on past 10 and 15 year average price spreads indicate that storage systems would not pay for themselves.

TABLE XXV

ESTIMATED PAYBACK PERIOD FOR ON-FARM STORAGE SYSTEMS IN OKLAHOMA, ASSUMING OPPORTUNITY COSTS OF CAPITAL COMPUTED AT USING $4.00 PER BUSHEL WHEAT AND SELECTED RATES OF INTEREST, BASED ON TEN YEAR AVERAGE PRICE, 1980

Storage Systems	Opportunity Costs at 9%	Opportunity Costs at 12%	Opportunity Costs at 15%	Opportunity Costs at 18%
	Remove From Storage			
	Sept.	Sept.	Sept.	Sept.
	Years			
Category One				
2,000	*	*	*	*
3,000	*	*	*	*
5,000	*	*	*	*
7,000	*	*	*	*
10,000	*	*	*	*
20,000	78.2	*	*	*
30,000	24.5	56.8	*	*
40,000	14.7	23.6	81.3	*
60,000	9.4	12.9	20.8	53.7
80,000	8.2	10.9	16.4	33.3
Category Two				
10,000	303.7	*	*	*
20,000	42.4	572.2	*	*
30,000	18.0	31.9	139.3	*
40,000	12.8	19.5	40.7	*
60,000	8.7	11.7	18.2	40.3
80,000	7.8	10.3	15.1	28.9
Category Three				
30,000	*	*	*	*
40,000	*	*	*	*
60,000	27.7	68.0	*	*
80,000	18.0	31.2	115.4	*

*Negative Returns: Based on past 10 and 15 year average price spreads indicate that storage systems would not pay for themselves.

was considered.

Some maximum acceptable payback period must be established to evaluate each investment alternative. Any investment alternative which exceeds this specified payback period should be rejected. Generally, a payback period of less than the investments average lifetime would be acceptable. Storage systems analyzed in this study have a life expectancy of 20 years, therefore any payback period less than 20 years is considered to be acceptable.

Estimated payback periods for these storage systems based on ten year average price differential between June and selected months ranges from 235.9 years to 3.9 years. When average price differentials are based on wheat prices over the last fifteen years, the estimated payback period for these storage systems range from 253.7 years to 10.7 years. Category Three storage systems require a longer payback period than comparable Category One and Two storage systems. The payback period for Category Three storage systems range from 34.7 years to 6.6 years, when the payback period is based on ten year average price differentials between June and selected months. Payback periods for Category Two storage systems range from 15.7 years to 3.9 years based on ten year average price differentials. Category Two storage systems, because of their lower investment requirements, show shorter payback periods than comparable Category One storage systems. The asterisk in Tables XXIV and XXV indicate negative return to storage. That is, based on the past ten and fifteen year average wheat price spreads in Oklahoma these storage systems would not pay for themselves. The 2,000 and 3,000 bushel storage systems are shown to be unprofitable under all storage alternatives.

As shown in Table XXIV, considering only ten year average price differentials between June and January, Category One storage systems of less than 10,000 bushels storage capacity have payback periods which exceed the storage systems average life expectancy. All Category Two storage systems, based on ten year average price differentials between June and January show payback periods of less than the average life expectancy of the system.

Table XXV shows the estimated payback period for the various storage systems given the opportunity cost of capital is included as an annual operating cost. The length of time necessary for a storage system to pay for itself increases considerably when the opportunity cost of capital is considered. The payback period necessary to cover the investment requirement of the 80,000 bushel Category Two storage system ranges from 7.8 years to 28.9 years when the opportunity cost of capital is computed at 9 percent and 18 percent, respectively, as compared to 4.7 years when the opportunity cost is not considered.

Internal Rate of Return

The internal rate of return is the interest rate that equates the present value of the expected future cash-flows to the initial cost outlay. The internal rate of return is a percentage figure which tells the producer the percent return he can expect from a capital investment. For an investment to be acceptable, the internal rate of return of that investment must be greater than the cost of capital on the rate of return which could be earned in alternative investments.

Table XXVI and XXVII report the before-tax internal rate of return for the various storage systems analyzed in this study. Again, average

TABLE XXVI

RATES OF RETURN ON ON-FARM STORAGE SYSTEMS IN OKLAHOMA, STORAGE IN JUNE WITH REMOVAL IN SELECTED MONTHS, BASED ON TEN YEAR AND FIFTEEN YEAR AVERAGE PRICE SPREADS, ASSUMING ZERO OPPORTUNITY COST OF CAPITAL TO HOLD WHEAT, 1980 CROP YEAR

	10 Year Average Wheat Price Spread				15 Year Average Wheat Price Spread			
	Storage in June with Removal in							
	Sep	Oct	Dec	Jan	Sep	Oct	Dec	Jan
	Percentage							
Category One								
2,000	*	*	*	*	*	*	*	*
3,000	*	*	*	*	*	*	*	*
5,000	*	*	*	*	*	*	*	*
7,000	*	*	*	*	*	*	*	*
10,000	*	*	*	*	*	*	*	*
20,000	.46	2.20	2.64	2.92	*	*	*	*
30,000	4.81	6.46	6.91	7.19	*	*	*	*
40,000	9.83	10.14	10.63	10.94	*	*	*	*
60,000	13.17	14.97	15.56	15.90	*	1.14	1.36	1.74
80,000	15.18	17.05	17.67	18.03	1.58	3.09	3.81	3.68
Category Two								
10,000	*	.73	1.13	1.40	*	*	*	*
20,000	2.30	3.99	4.43	4.70	*	*	*	*
30,000	6.77	8.40	8.85	9.13	*	*	*	*
40,000	9.84	11.55	12.06	12.37	*	*	*	*
60,000	14.35	16.19	16.79	17.15	.72	2.25	2.46	2.84
80,000	16.06	17.96	18.59	18.96	2.38	3.86	4.09	4.45
Category Three								
30,000	*	*	*	*	*	*	*	*
40,000	*	1.21	1.77	2.11	*	*	*	*
60,000	5.76	7.55	8.12	8.46	*	*	*	*
80,000	8.62	10.42	11.00	11.35	*	*	*	*

*Negative Returns: Based on past 10 and 15 year average price spreads indicate that storage systems would not pay for themselves.

TABLE XXVII

RATES OF RETURN ON ON FARM STORAGE SYSTEMS IN OKLAHOMA, INCLUDING OPPORTUNITY COSTS OF CAPITAL CALCULATED USING $4.00 PER BUSHEL WHEAT PRICES AND AN ANNUAL INTEREST RATE OF 9 PERCENT AND 12 PERCENT, STORAGE IN JUNE WITH REMOVAL IN SELECTED MONTHS, BASED ON TEN YEAR AVERAGE PRICE SPREADS, 1980

Storage Systems	Opportunity Costs Computed at 9 Percent Per Annum				Opportunity Costs Computed at 12 Percent Per Annum			
	Storage in June with Removal in							
	Sept	Oct	Dec	Jan	Sept	Oct	Dec	Jan
	Percentages							
Category One								
2,000	*	*	*	*	*	*	*	*
3,000	*	*	*	*	*	*	*	*
5,000	*	*	*	*	*	*	*	*
7,000	*	*	*	*	*	*	*	*
10,000	*	*	*	*	*	*	*	*
20,000	*	*	*	*	*	*	*	*
30,000	*	*	*	*	*	*	*	*
40,000	.33	*	*	*	*	*	*	*
60,000	5.12	4.33	*	*	1.82	*	*	*
80,000	6.98	6.21	*	*	3.84	1.60	*	*
Category Two								
10,000	*	*	*	*	*	*	*	*
20,000	*	*	*	*	*	*	*	*
30,000	*	*	*	*	*	*	*	*
40,000	1.74	.88	*	*	*	*	*	*
60,000	6.20	5.72	*	*	2.92	.73	*	*
80,000	7.76	6.97	.73	*	4.52	2.39	*	*
Category Three								
30,000	*	*	*	*	*	*	*	*
40,000	*	*	*	*	*	*	*	*
60,000	*	*	*	*	*	*	*	*
80,000	*	*	*	*	*	*	*	*

*Negative Returns: Based on past 10 and 15 year average price spreads indicate that storage systems would not pay for themselves.

price differentials between June and selected months are used to compute the return to on-farm wheat storage in Oklahoma. Table XXVI represents the rate of return for the various storage systems assuming that the opportunity cost of capital to hold wheat in storage is zero. Table XXVII presents the rate of earning by storing wheat in on-farm storage systems when the opportunity cost of capital to hold wheat is included as an annual operating cost. When the opportunity cost of capital is included in the rate of return computation we are actually determining the rate of return applicable to the investment condition or subject to accounting for the opportunity cost of holding wheat and requiring the storage facility to pay for such a cost. Although many producers may be interested in such a computation, it need not be considered in the decision process. Requiring a storage system to cover the opportunity cost of holding wheat may not be a valid assumption.

In each table an asterisk indicates a negative rate of return. When opportunity costs of capital to hold wheat are assumed to be zero, all storage systems of 7,000 or less bushels show negative rates of return. In Table XXVII, where opportunity costs of capital to hold wheat are included, all storage systems of 30,000 bushels or less show negative rates of return.

Table XXVI shows estimated rates of return for various storage systems based on ten year average price differentials between June and selected months, assuming zero opportunity costs of capital to hold wheat, range from negative returns of 18.96 percent. When price differentials are based on fifteen year average wheat price spreads the estimated rate of return for the various storage systems range from negative returns to returns of 4.45 percent. In general, the greatest re-

turns are reported for Category Two storage systems. Only one Category Two storage system shows a negative rate of return, that is, when ten year average price differentials are used.

When opportunity cost of capital is included in computing rates of return, as shown in Table XXVII, based on ten year average price spreads, only storage systems utilizing a portable auger and 40,000 bushels or larger have positive returns. The rates of return are not shown when opportunity costs are included and calculated at 15 percent and 18 percent annually, because the rate of return in all cases is negative.

To conclude this section of analysis, a brief discussion of the profitability of wheat production in Oklahoma is provided. Table XXVIII presents the average returns per acre above all costs except overhead, risk and management for both dryland and irrigated wheat production in Oklahoma. Production cost information and average wheat yields for both irrigated and dryland wheat production are based upon crop budgets developed by the Oklahoma State University Extension Service. Per acre returns are computed assuming wheat is valued at $4.00 per bushel and average yield per acre are 28 bushels for dryland wheat production and 55 bushels for irrigated wheat production. Average returns are further categorized according to the producers harvesting practices, that is, whether producer's own their own harvesting equipment or if they have their wheat custom harvested. Table XXVIII presents the total receipts, total costs and returns associated with wheat production in Oklahoma. Returns to dryland wheat production range from negative returns of 84 cents per acre for producers who own harvesting equipment to a positive $22.22 per acre for producers who have wheat custom harvested, the difference being made in the fixed cost category due to higher interest

TABLE XXVIII

ANNUAL RETURNS PER ACRE TO WHEAT PRODUCTION IN OKLAHOMA, 1980[a]

	Dry Land Wheat Production		Irrigated Wheat Production	
	Custom Harvested	Owned Harvest Equipment	Custom Harvested	Owned Harvest Equipment
Average Yield/Acre	28 bu	28 bu	55 bu	55 bu
Average Wheat Price (dollars per bushel)	4.00	4.00	4.00	4.00
	Dollars Per Acre			
TOTAL RECEIPTS	112.00	112.00	220.00	220.00
TOTAL OPERATING COSTS	73.64	75.04	118.80	179.30
TOTAL FIXED COSTS	16.24	37.80	37.40	87.45
TOTAL COSTS	89.88	112.84	156.20	266.75
RETURNS ABOVE ALL COSTS EXCEPT LAND, RISK, AND MANAGEMENT	22.12	(0.84)*	63.80	(46.75)*

[a]Source: Oklahoma Budget Generator, Department of Agricultural Economics, Oklahoma State University.

*Numbers in parenthesis indicate negative returns.

and depreciation costs. Note, these crop budgets do not consider tax advantages associated with investment for credit and accelerated depreciation methods. Returns to irrigated wheat production show a similar pattern as the returns to dryland farming. Returns range from a negative $46.75 per acre for producers who own harvesting equipment to $63.80 per acre for producers who have wheat custom harvested.

CHAPTER VI

SUMMARY AND CONCLUSIONS

As the interest in on-farm storage of wheat and other grains increases in Oklahoma, there is a growing need for information concerning the costs and potential returns of on-farm storage. The purpose of this thesis was to provide cost and return information to producers. Specifically, this thesis provides information concerning captial investment requirements, costs of owning and operating, and returns associated with twenty different on-farm storage systems.

Presented below are some of the basic assumptions upon which all results of this study are based. It was to assume that:

1) All storage systems are designed to minimize the labor requirements necessary to operate the storage system;

2) All construction of storage systems is done by a qualified construction firm;

3) All storage system investments are based on purchasing all new storage bins and equipment;

4) Each storage system is equipped with its' own unloading augers;

5) The investment requirements are based on list price quotations and do not consider possible discounting;

6) Only wheat is stored in these storage systems;

7) All costs are computed assuming six months of storage;

8) The straight-line method of depreciation is used to compute annual depreciation and all systems are assumed to have zero salvage value;

9) Returns are based on average price spreads between June and selected months and non-flexible marketing strategies; and

10) The producer can efficiently manage the wheat while in storage.

Other assumptions and the procedures utilized to compute the investment requirements, annual and monthly costs and returns are reviewed in detail within Chapter III. Keeping these assumptions in mind the following section of analysis presents the summary and conclusions of this study.

Summary and Results

The twenty on-farm storage systems studied were categorized into three groups depending upon the type of handling equipment and electric motors utilized. The first category of storage systems utilized a portable auger and single-phase electric motors. There are ten storage systems, ranging from 2,000 bushels of storage capacity to 80,000 bushels of storage capacity, within this category of storage systems. The second category of storage systems handles wheat using a portable auger, as does the first category of storage systems. However, instead of using single-phase electric motors, this category of storage systems used three-phase electric motors. There are six storage systems ranging in total storage capacity from 10,000 bushels to 80,000 bushels within this category of storage systems. The third category of storage systems consists of four storage systems ranging in total storage capacity from 30,000 to 80,000 bushels. This category of storage systems is differentiated from the other two categories by handling wheat with a bucket elevator

instead of a portable auger.

Average investment requirements for the Category Two of storage systems ranged from ten cents per bushel to two cents per bushel less than comparable Category One storage systems, and from 50 cents per bushel to 32 cents per bushel less than comparable Catagory Three storage systems. Total investment requirements for Category Two storage systems ranged from $16,424 ($1.49/bushel) to $77,422 ($.96/bushel) for the 10,000 bushel and 80,000 bushel storage systems, respectively. Total investment requirements for Category One storage systems ranged from $7,336 ($3.29/bushel) for the 2,000 bushel storage system to $79,022 ($.98/bushel) for the 80,000 bushel storage system. Category Three storage systems, which utilized a bucket elevator to handle wheat had total investment requirements that ranged from $62,417 ($1.88/bushel) to $103,799 ($1.28/bushel) for the 30,000 bushel and 80,000 bushel storage systems, respectively.

Annual and monthly total costs of owning and operating each storage system is based on the assumption that only wheat could be stored. If, however, other crops such as corn, grain sorghum, or soybeans were stored in these systems, the per bushel storage cost would decrease. Annual costs for each storage system was estimated at three levels of utilization -- 100 percent, 75 percent, and 50 percent. Category Two storage systems -- because of lower investment requirements -- had the lowest average total costs at all levels of utilization. At 100 percent utilization average total costs for Category Two storage systems ranged form 40.6 cents per bushel for the 10,000 bushel system to 28.4 cents per bushel for the 80,000 bushel system. Corresponding costs at 50 percent utilization are 68.9 cents

per bushel and 44.5 cents per bushel. Average annual total costs for Category One storage systems at 100 percent utilization range from 80.9 cents per bushel for the 2,000 bushel storage system to 28.8 cents per bushel for the 80,000 bushel storage system. Average annual total costs at 100 percent utilization for Category Three storage systems range from 44.5 cents per bushel to 33.6 cents per bushel for the 30,000 bushel and 80,000 bushel storage systems, respectively.

All categories of storage systems studied showed definite economies associated with larger size of operation, but one should be cautious when interpreting this finding. Economies of size indicate that per bushel costs can be reduced by expanding the storage systems capacity. However, if the additional capacity is not needed and the larger system is not utilized at full capacity, per bushel storage costs may actually increase to a point greater than the per bushel costs of a lower capacity system utilized at full capacity. All storage systems should be designed keeping in mind the producer's current needs and what his future needs may be. By keeping these two needs in mind, the storage system can be designed such to just accommodate the producers current need, but also so future expansion can easily take place with minimal additional investment required.

Monthly cost equations were developed for each storage system under study. Each cost equation includes: 1) an intercept, which represents costs that become fixed once the decision to store wheat is made, 2) a slope variable which represents costs that very directly with the length of time wheat is stored, and 3) a dummy variable which changes the intercept once grain has been in storage for five months. The dummy variable represents the cost associated with the

additional aeration required to cool grain to a safe storage temperature in the fall.

Once a producer has made the decision to store his wheat the additional cost of holding wheat another month is very small. Average monthly variable costs range from 77 cents per bushel per month to 5 cents per bushel per month for the 2,000 bushel and 80,000 bushel storage systems, respectively.

One important cost category which warrants mentioning in this summary is the opportunity cost associated with holding wheat in storage. The opportunity cost associated with holding wheat, whether it be in an on-farm storage system or commercial storage system, for six months -- assuming an annual interest rate of 9 percent and wheat is valued at $4.00 per bushel -- is 18 cents per bushel. For the purpose of this thesis, returns to on-farm storage were computed both with and without opportunity cost of holding wheat included.

Comparing monthly costs of owning and operating on-farm storage systems, assuming opportunity costs of holding wheat are zero, with 10 and 14 year average wheat price spreads indicate that, for most storage systems, storage in June with removal in January was the most profitable alternative. When opportunity costs were included in computing returns, the June-January alternative was no longer the best alternative. Given opportunity cost of holding wheat it was best to store wheat in June and remove the wheat from storage in September.

Payback periods for the feasible storage systems, given the ten year average price spread between June and January and zero opportunity costs of holding wheat, ranged from a low of 3.9 years for the 80,000 bushel Category Two storage system to a high of 59.0 years for the

5,000 bushel Category One storage system. Payback periods for the feasible storage systems, given the ten year average price spread of wheat between June and September and opportunity costs of holding wheat computed at 9 percent interest, ranged from 7.8 years to 303.7 years for the 80,000 bushel Category Two and 10,000 bushel Category Two storage systems, respectively.

The rate of return under all storage alternatives analyzed was negative for storage systems with less than 10,000 bushels of storage capacity. When the opportunity cost of holding wheat is included as a storage cost all storage systems with storage capacities of 30,000 bushels or less and all Category Three storage systems have negative rates of return.

Category Two storage systems under all storage alternatives showed the highest rate of return. Assuming zero opportunity costs and a 10 year average price spread between June and January the rate of return for Category Two storage systems ranged from 1.40 percent for the 10,000 bushel storage system to 18.96 percent for the 80,000 bushel storage system. Including the opportunity cost of holding wheat as a storage cost causes the rate of return for Category Two storage systems to decrease substantially. The June-January storage alternative yields negative returns for all Category Two storage systems when the opportunity cost of holding wheat is included as a storage cost. The rate of return for Category Two storage systems assuming opportunity costs at 9 percent and a 10 year average price spread between June and September ranged from 1.74 percent at 7.76 percent for the 40,000 bushel and 80,000 bushel storage systems, respectively. The rate of return for Category Two storage systems, assuming a 10 year average

June-September price spread, decreases by 82.32 and 51.68 percent for the 40,000 and 80,000 bushel storage systems, respectively, when an opportunity cost of 9 percent is included as a storage cost.

Conclusions

Based on the cost estimates and average wheat price spreads over the last ten and fifteen years in Oklahoma, this research indicates that on-farm storage of wheat in Oklahoma is potentially profitable. New on-farm storage systems with at least 5,000 bushels of storage capacity are needed to cover annual per bushel storage cost, according to findings based on an average price spread of 53 cents. However, storage systems with storage capacity of 30,000 bushels or greater are necessary to make an on-farm storage systems an economically feasible investment.

The average returns associated with Category Three storage systems, that is storage systems that use a bucket elevator to handle wheat, are lower than comparable storage systems that handle wheat with a portable auger. The substitution of a bucket elevator for the portable auger does not reduce annual handling charges enough to offset the increased investment requirement associated with the bucket elevator. Producers who have at their disposal sufficient labor and management personnel can earn greater returns from on-farm storage systems that utilize a portable auger to handle wheat. The bucket elevator does not appear to be economically feasible unless storage systems handle more than 80,000 bushels of wheat annually, that is given the underlying assumptions of this study.

Returns to on-farm wheat storage systems and conclusions of this study can be altered by changing some of the pivotal assumptions

which are made in the study. The implications of changing these assumptions are subjective in nature and beyond the scope of this study, however, it is important to review some of these assumptions and to discuss the implications of changing these assumptions. Some of these pivotal assumptions are discussed below.

Fixed costs can be reduced by not requiring each storage system to purchase its' own unloading equipment and by allowing each storage system to become more labor intensive rather than capital intensive. The economic gains from such a change depends upon how each producer values labor and if sufficient labor is available to move the unloading augers between storage bins. The exact implication of designing storage systems to be less capital intensive is directly tied to each producer's specific situation.

Requiring the smaller Category One storage systems to purchase a new portable auger substantially increases the investment requirement of these storage systems. An alternative for these smaller storage systems would be to allow these systems to either rent the portable auger or purchase a used portable auger. Such an alternative would help lower investment requirements and decrease fixed costs. Note, however, that variable costs would not be affected by this alternative.

It is assumed in this study that wheat producers follow a fixed non-flexible marketing plan of placing wheat in storage at harvest and holding it there for six months before selling. No other marketing strategies are considered. This assumption does not indicate the potential gains producers can achieve through alternative marketing strategies such as foreward pricing and hedging. Nor does the assumption consider the possibility of selling wheat directly to potential

buyers and receiving a premium price for consistently delivering high quality wheat. The proper use of such marketing alternatives could substantially increase the returns associated with on-farm wheat storage. The futures market can be used as a means of insuring against price risks.

It is assumed that all storage systems are constructed by a qualified construction firm. If the producer was allowed to perform some of the construction tasks, construction costs for the storage system could be decreased by some amount. The amount of savings depends on the amount of work the producer could perform and the opportunity cost of the producer's time.

Not considered in this study are the current tax incentives such as the investment tax credit and accelerated depreciation methods that are available to producers. Such incentives can provide a substantial stimulant to revenue for these producers earning taxable income. The exact benefits a producer receives from such tax incentives depends on the producers income tax bracket and his current income level.

Another program worth mentioning is the "Farmer Held Reserve Program". This program is designed to stabilize prices through the acquisition of stocks during years of excess supply and releasing of stocks during years of excess demand. Under this program producers are required to store grain either in on-farm or commercial storage facilities for three years or until the release level is reached. If the producer chooses to store programmed wheat in commercial storage, he, the producer, assumes the cost of storage during the loan period. Then when the loan is called, the producer is paid an amount specified by the Act to cover the cost of storage. On the other hand, if the

producer chooses to store wheat in his on-farm storage system the producer will receive the same payment to cover storage costs while grain is stored. However, by storing wheat on-farm, the producer does not have to meet monthly storage payments, other than the loan repayment schedule of the storage facility.

The purpose of this thesis was to provide information to producers interested in building new on-farm wheat storage systems in Oklahoma. The decision to investment in an on-farm storage system is not, however, a matter which should be based solely on wheat prices and storage costs. Many other economic and non-economic factors should be considered before such a decision is made. It is up to each individual producer to evaluate his own specific situation and make the investment decision accordingly. It is hoped, however, that this thesis provides information needed to help in the decision process.

Suggestions for Further Research

Much work remains to be done in the area of on-farm wheat storage in Oklahoma. A few of the areas where additional research is needed are:

1) Within the conclusion section of this study, a number of pivotal assumptions were discussed, however, additional research is needed in this area to determine the impact of changing these assumptions.

2) Additional analysis of alternative marketing strategies available to wheat producers, such as hedging and forward contracting should be completely analyzed. Such an analysis may want to incorporate the use of technical decision tools and fundamental economic analysis to determine the optimal marketing strategies a producer should utilize.

3) A location study of Oklahoma's grain storage system could be conducted to help optimize the location of not only on-farm storage systems, but commercial storage systems which, in

turn, would help to optimize transportation costs associated with grain storage. This study could also determine the necessary distance from a commercial storage facility before it becomes economically feasible to invest in an on-farm storage system.

4) An analysis of the localized basis -- the difference between the local cash price and the futures price -- for wheat could be utilized to determine the availability of storage in various areas of Oklahoma. The basis is an indicator of the strength of demand the grain trade has for taking delivery of the cash commodity. If the basis is traditionally narrow at harvest, that is, the cash price moves closer to the futures price, adequate storage is available in an area. A traditionally wide basis at harvest, that is, when the difference between the cash price and the futures price moves farther apart, indicates the lack of adequate storage in an area. This study of the localized basis provides an insight to transportation needs resulting from the misallocation of grain storage.

5) A study to quantify losses associated with on-farm storage is needed not only in Oklahoma but in other areas of the United States. Such a study would try to place a dollar value at the annual losses from insect and rodent damage, fungi, spoilage and shrink associated with on-farm storage.

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APPENDIXES

APPENDIX A

ON-FARM STORAGE SYSTEM LAYOUT

2,000 Bushel Category One Storage System

○ Plastic Dump Hopper

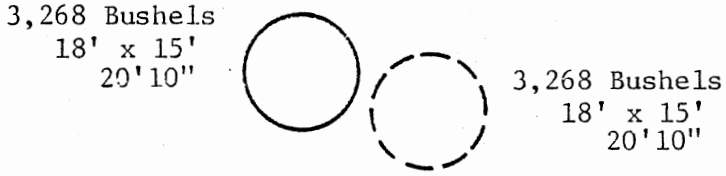
Portable Auger: 6" x 41'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

3,000 Bushel Category One Storage System



○ Plastic Dump Hopper

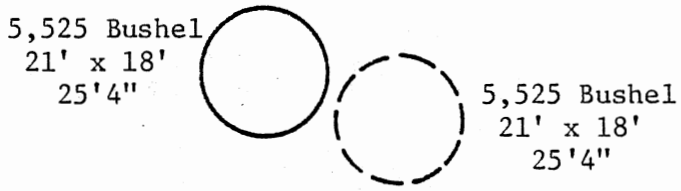
Portable Auger: 6" x 41'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

5,000 Bushel Category One Storage System



o Plastic Dump Hopper

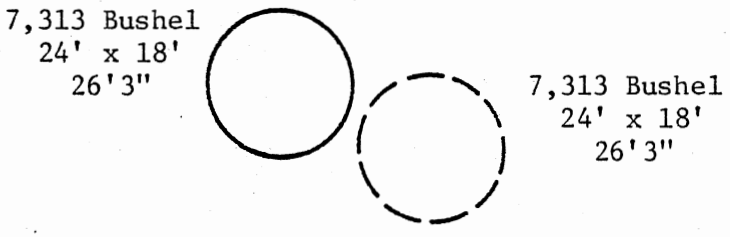
Portable Auger: 6" x 47'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

7,000 Bushel Category One Storage System



o Plastic Dump Hopper

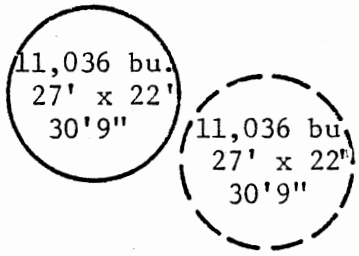
Portable Auger: 8" x 53'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

10,000 Bushel Category One and Two Storage Systems



○ Plastic Dump Hopper

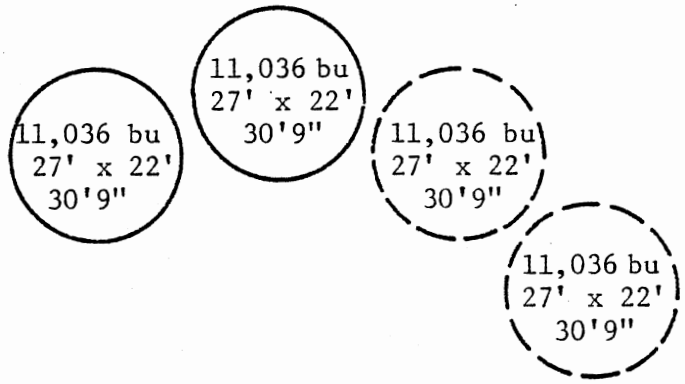
Portable Pit Auger: 8" x 62'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

20,000 Bushel Category One and Two Storage Systems



○ Concrete Dump Pit

Portable Pit Auger: 8' x 62"

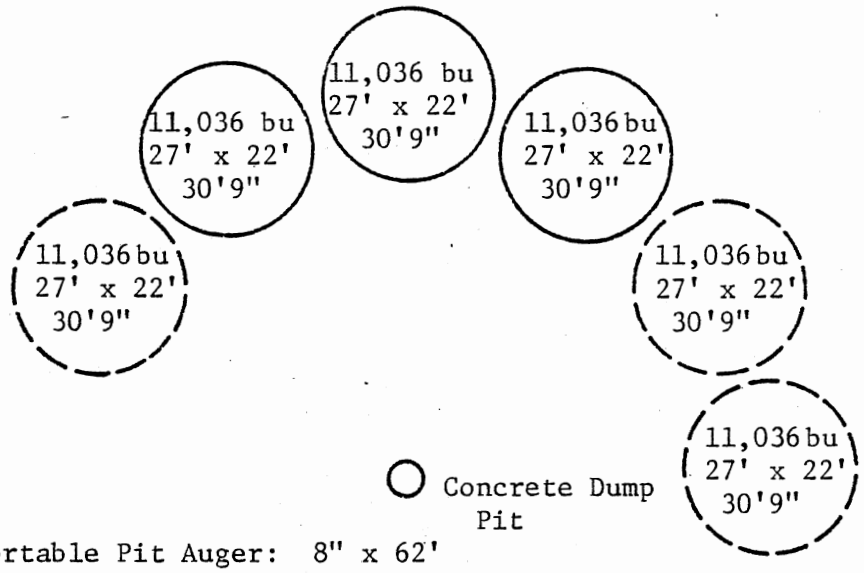
Low-Boy Auger: 8' x 42'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

30,000 Bushel Category One and Two Storage Systems



Portable Pit Auger: 8" x 62'

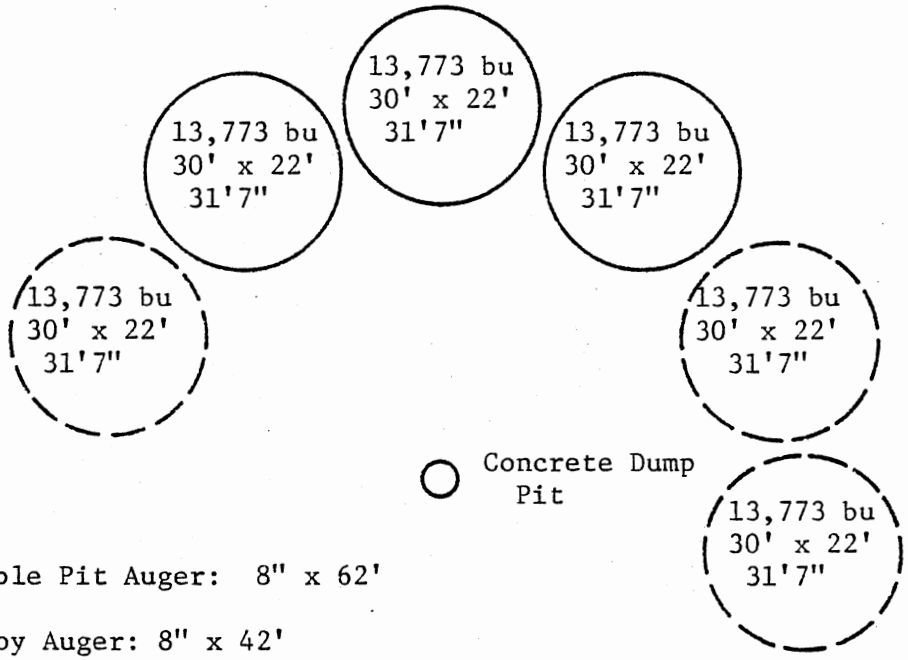
Low-Boy Auger: 8" x 42'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

40,000 Bushel Category One and Two Storage Systems



Portable Pit Auger: 8" x 62'

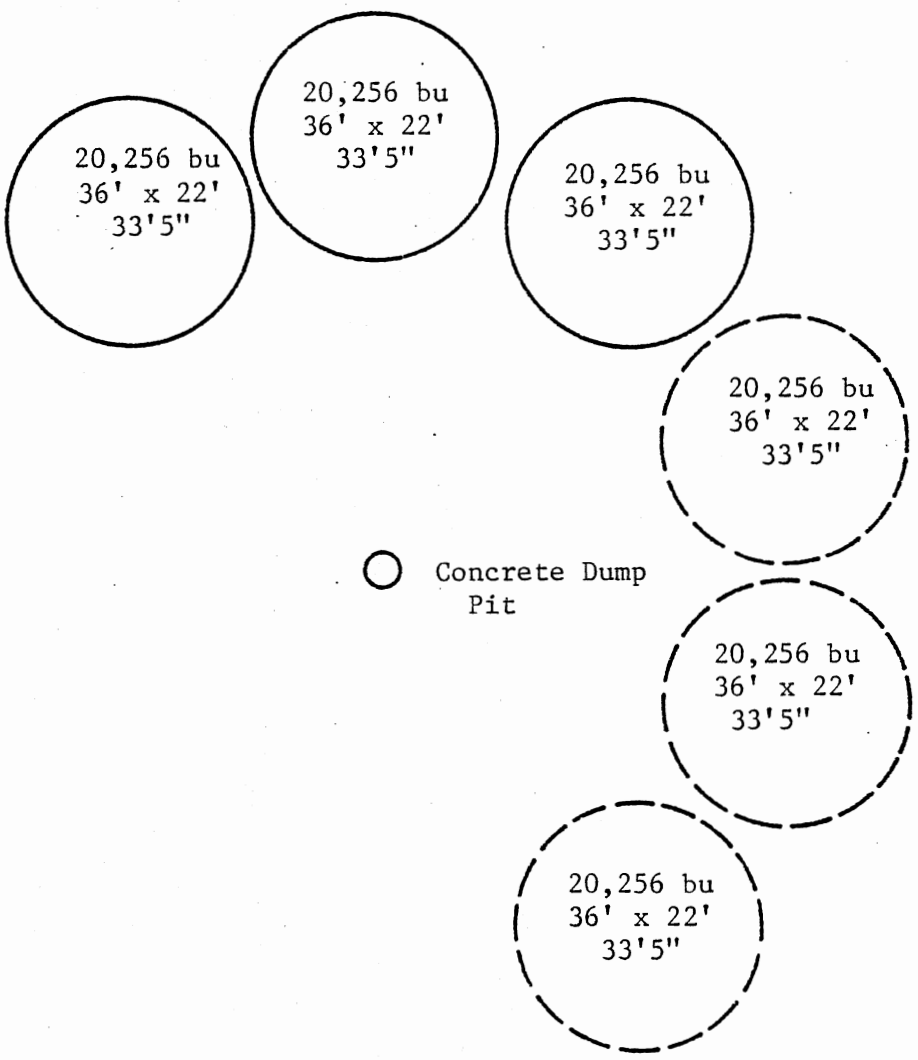
Low-Boy Auger: 8" x 42'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

60,000 Bushel Category One and Two Storage System



Portable Pit Auger: 8" x 62'

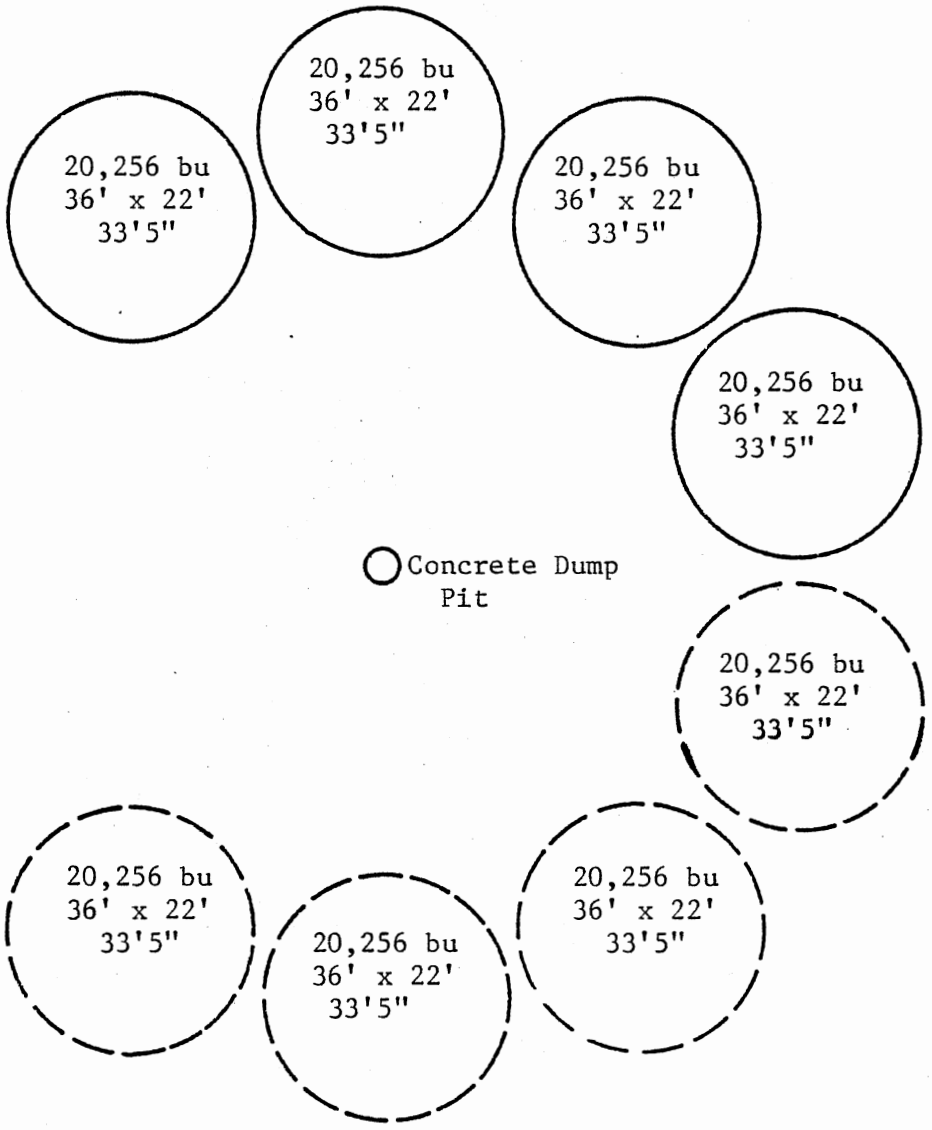
Low-Boy Auger: 8" x 42'

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

80,000 Bushel Category One and Two Storage Systems



Portable Pit Auger: 8" x 62'

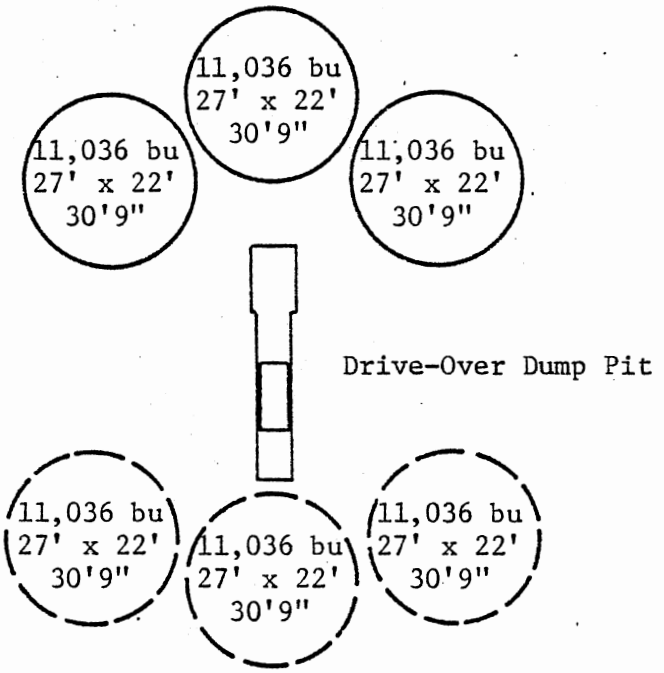
Low-Boy Auger: 8" x 42'

——— Current Storage System

– – – – Proposed Future Expansion

Scale 1/32" = 1'

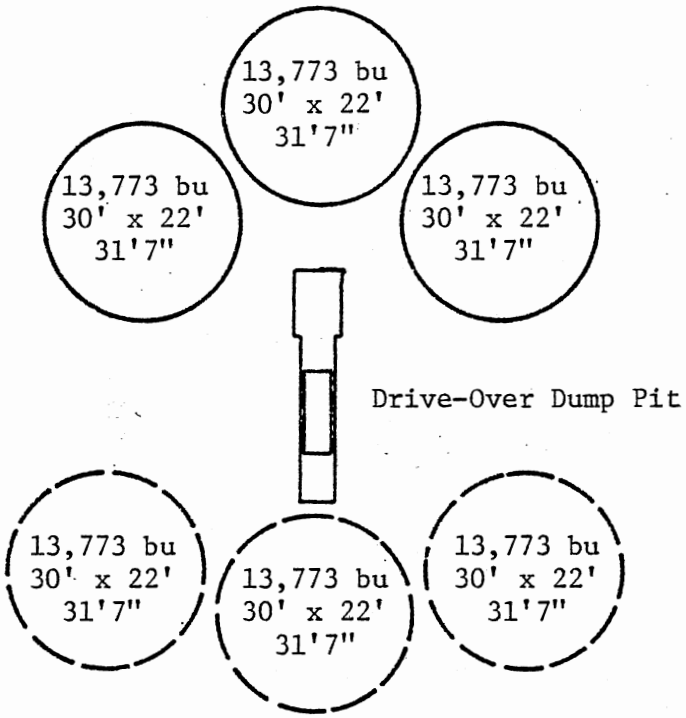
30,000 Bushel Category Three Storage System



Bucket Elevator: 75'
U-Trough Auger: 12" x 24'
Drive-Over Hopper: 42" x 120"

Current Storage System
Proposed Future Expansion
Scale 1/32" = 1'

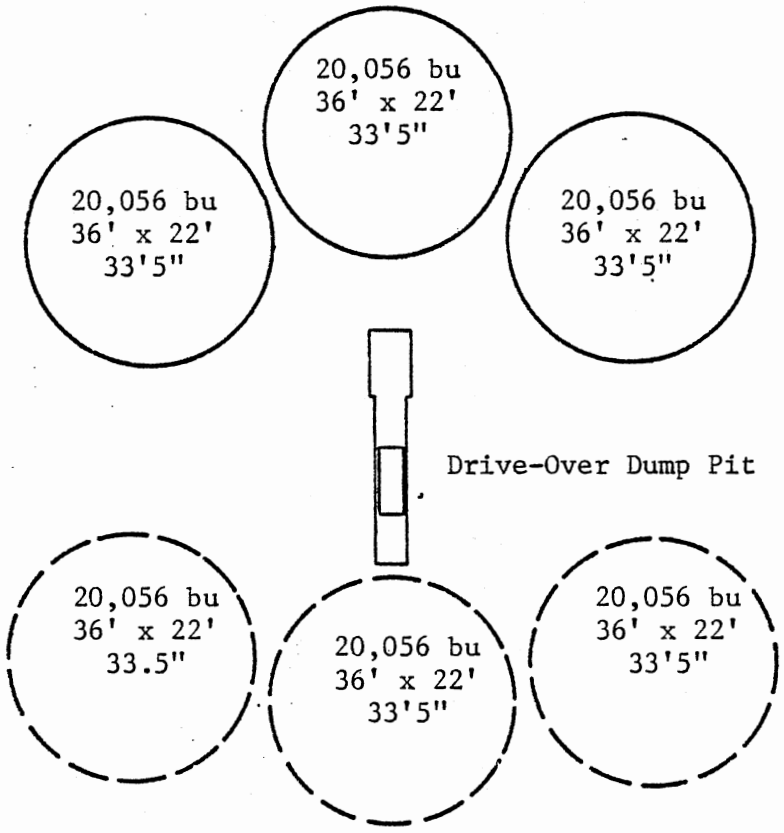
40,000 Bushel Category Three Storage System



Bucket Elevator: 80'
U-Trough Auger: 12" x 24'
Drive-Over Hopper: 42" x 120"

——— Current Storage System
– – – Proposed Future Expansion
Scale 1/32" = 1'

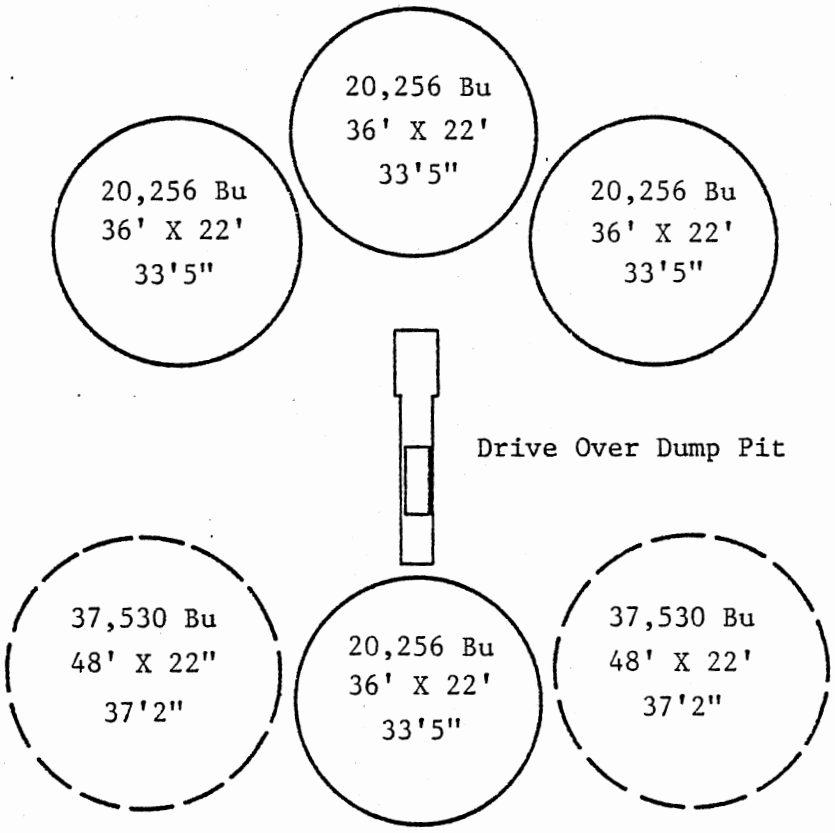
60,000 Bushel Category Three Storage System



Bucket Elevator: 85'
U-Trough Auger: 12" x 24'
Drive-Over Hopper: 42" x 120"

——— Current Storage System
— — — Proposed Future Expansion
Scale 1/32" = 1'

80,000 Bushel Category Three Storage System



Bucket Elevator: 85'

U-Trough Auger: 12" X 24'

Drive Over Hopper: 42" X 120"

——— Current Storage System

– – – Proposed Future Expansion

Scale 1/32" = 1'

APPENDIX B

DETAILED BREAKDOWN OF EACH ON-FARM STORAGE SYSTEM

2,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$2,157.00		
Total non-compacted Storage Capacity	2,232 bu.			
Bin Diameter	15'0"			
Eave height	15'0"			
Overall height	19'0"			
Foundation height	1'0"			
Foundation diameter	16'0"			
Height to eave (ground to eave)	16'0"			
Total bin height (ground to top)	20'0"			
Ladder				
Outside	11'0"	71.00		
Auger slat hood		17.00		
Total Storage Bin			$2,245.00	
Foundation			402.00	
Erection of bin			223.00	
TOTAL INVESTMENT STORAGE UNIT				$2,870.00
AERATION AND HANDLING EQUIPMENT				
Aeration Equipment				
Sub-floor		359.00		
Aeration fan (½h.p. - 14" diameter)		270.00		
Leg kit for 14" aeration fan		10.00		
Total Aeration Equipment			639.00	
Portable Auger				
Portable auger (6" x 41')	1000 bu/hr	1,147.00		
3 h.p. electric motor w/magnetic starter		503.00		

2,000 Bushel Category One Storage System (cont.)

ITEMS				
3' flex tube and 45' safety spout		$ 41.00		
Plastic dump hopper		57.00		
Tires and tubes		20.00		
Freight and assembly		87.00		
Total Portable Auger			$1,855.00	
Unloading Equipment				
Bin well and unloading tube				
6" tube and half gate	8'0"	90.00		
½" pipe for gate control	9'0"	8.00		
1" conduit for gate control	8'0"	6.00		
25 - Degree Unloading Kit				
25-degree unloading tube (6" dia.)			337.00	
Horizontal flight for 25-degree unloader (6" dia.)	8'9"	36.00		
2 h.p. electric motor w/ magnetic starter		414.00		
Bin Sweep Auger				
Bin sweep auger (6" dia.)	7'0"	109.00		
½ h.p. electric motor w/ magnetic starter		130.00		
Auger Installation		48.00		
Total Unloading Equipment			1,178.00	
Electrical Wiring			750.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$4,422.00
LAND REQUIREMENT: (1/12 acre)				44.00
TOTAL INVESTMENT				$7,336.00
PER BUSHEL INVESTMENT				$3.29

3,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$2,570.00		
Total non-compacted storage capacity	3,268 bu.			
Bin diameter	18'0"			
Eave height	15'0"			
Overall height	19"0"			
Foundation height	1'0"			
Foundation diameter	19'0"			
Height to eave (ground to eave)	16'0"			
Total bin height (ground to top)	20'10"			
Ladder				
Outside	11'0"	71.00		
Auger slat hood		17.00		
Total Storage Bin			$2,658.00	
Foundation			567.00	
Erection of Bin			327.00	
TOTAL INVESTMENT STORAGE UNIT				$3,552.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
Sub-floor		359.00		
Aeration fan (½ h.p.-14" dia.)		270.00		
Leg kit for 14" aeration fan		20.00		
Total Aeration Equipment			639.00	
Portable Auger				
Portable auger (6" x 41')	1000 bu/hr	1,147.00		
3 h.p. electric motor w/ magnetic starter		503.00		
3' Flex tube and 45° safety spout		41.00		
Plastic dump hopper		57.00		
Tires and tubes		20.00		
Freight and assembly		87.00		
Total Portable Auger			1,855.00	
Unloading Equipment				
Bin well and unloading tube				
6" tube and half gate	10'0"	102.00		
6" band-on intermediate well w/half gate		35.00		
½" pipe for gate control	11'0"	10.00		
1" pipe for gate control to intermediate well	5'6"	8.00		
1" conduit for gate control	4'6"	3.00		
1½" conduit for gate control to intermediate well	4'6"	4.00		

3,000 Bushel Capacity One Storage System (continued)

ITEMS				
25-Degree Unloading Kit				
25-degree unloading tube (6" dia.)		$ 337.00		
Horizontal flight for 25-degree unloader (6" dia.)	3'9"	44.00		
2 h.p. electric motor w/magnetic starter		414.00		
Bin Sweep Auger				
Bin sweep auger (6" dia.)	8'6"	116.00		
3/4h.p. electric motor w/magnetic starter		156.00		
Auger Installation		50.00		
Total Unloading Equipment			$1,279.00	
Electrical Wiring			781.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$4,554.00
LAND REQUIREMENT: (1/12 acre)				44.00
TOTAL INVESTMENT				$8,150.00
PER BUSHEL INVESTMENT				$2.49

5,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$3,628.00		
Total non-compacted storage capacity	5,525 bu.			
Bin diameter	21'0"			
Eave height	18'0"			
Overall height	24'4"			
Foundation height	1'0"			
Foundation diameter	22'0"			
Height to eave (ground to eave)	19'0"			
Total bin height (ground to top)	25'4"			
Ladder				
Outside	14'8"	88.00		
Auger slat hood		17.00		
Total Storage Bin			$3,733.00	
Foundation			760.00	
Erection of Bin			553.00	
TOTAL INVESTMENT STORAGE UNIT				$5,046.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
Sub-floor		361.00		
Aeration fan (½ h.p.-14" dia.)		270.00		
Leg kit for 14" aeration fan		10.00		
Total Aeration Equipment			641.00	
Portable Auger				
Portable auger (6" x 47')	1000 bu/hr	1,373.00		
5 h.p. electric motor w/ magnetic starter		559.00		
3' Flex tube and 45° safety spout		41.00		
Plastic dump hopper (6" dia.)		57.00		
Tires and tubes		20.00		
Freight and assembly		96.00		
Total Portable Auger			2,146.00	
Unloading Equipment				
Bin well and unloading tube				
6" tube and half gate	11'0"	106.00		
6" band-on intermediate well w/half gate		35.00		
½" pipe for gate control	12'0"	11.00		
1" pipe for gate control to intermediate well	6'6"	10.00		
1" conduit for gate control	5'6"	4.00		
1½" conduit for gate control to intermediate well	5'6"	5.00		

5,000 Bushel Capacity One Storage System (continued)

ITEMS				
25-Degree Unloading Kit				
25-degree unloadi-g tube (6" dia.)		$ 337.00		
Horizontal flight for 25-degree unloader (6" dia.)	11'9"	49.00		
3 h.p. electric motor w/magnetic starter		503.00		
Bin Sweep Auger				
Bin sweep auger (6" dia.)	10'0"	127.00		
3/4 h.p. electric motor w/magnetic starter		156.00		
Auger Installation		51.00		
Total Unloading Equipment			$1,394.00	
Electrical Wiring			1,156.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$5,337.00
LAND REQUIREMENT: (1/12 acre)				44.00
TOTAL INVESTMENT				$10,427.00
PER BUSHEL INVESTMENT				$1.89

7,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$4,393.00		
Total non-compacted storage capacity	7,313 bu.			
Bin diameter	24'0"			
Eave height	18'0"			
Overall height	25'3"			
Foundation height	1'0"			
Foundation diameter	25'0"			
Height to eave (ground to eave)	19'0"			
Total bin height (ground to top)	26'3"			
Ladder				
Outside	14'8"	88.00		
Auger slat hood		17.00		
Total Storage Bin			$4,498.00	
Foundation			982.00	
Erection of Bin			731.00	
TOTAL INVESTMENT STORAGE UNIT				$6,211.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
Sub-floor		389.00		
Aeration fan (½ h.p.-14" dia.)		270.00		
Leg kit for 14" aeration fan		10.00		
Total Aeration Equipment			669.00	
Portable Auger				
Portable auger (8' x 53')	2000 bu/hr	2,130.00		
7½ h.p. electric motor w/ magnetic starter		923.00		
3' Flex tube and 45° safety spout		66.00		
Plastic dump hopper (8' dia.)		57.00		
Tires and tubes		20.00		
Freight and assembly		104.00		
Total Portable Auger			3,300.00	
Unloading Equipment				
Bin well and unloading tube				
8" tube and half gate	12'6"	160.00		
8" band-on intermediate well w/half gate		35.00		
½" pipe for gate control	13'6"	12.00		
1" pipe for gate control to intermediate well	7'0"	10.00		
1" conduit for gate control	6'0"	4.00		
1½" conduit for gate control to intermediate well	6'0"	6.00		

7,000 Bushel Capacity One Storage System (continued)

ITEMS				
25-Degree Unloading Kit				
25-degree unloading tube (8" dia.)		$ 484.00		
Horizontal flight for 25-degree unloader (8" dia.)	13'4"	131.00		
3 h.p. electric motor w/magnetic starter		503.00		
Bin Sweep Auger				
Bin sweep auger (8" dia.)	11'6"	177.00		
1½ h.p. electric motor w/magnetic starter		346.00		
Auger Installation		79.00		
Total Unloading Equipment			$1,947.00	
Electrical Wiring			1,563.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$7,479.00
LAND REQUIREMENT: (1/10 acre)				52.00
TOTAL INVESTMENT				$13,742.00
PER BUSHEL INVESTMENT				$1.88

10,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$6,213.00		
Total non-compacted storage capacity	11,036 bu.			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	30'9"			
Ladder				
Outside	18'4"	102.00		
Inside	18'4"	99.00		
Auger slat hood		17.00		
Total Storage Bin			$6,431.00	
Foundation			1,232.00	
Erection of Bin			1,104.00	
TOTAL INVESTMENT STORAGE UNIT				$ 8,767.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
Sub-floor		389.00		
Aeration fan (1½ h.p.-14" dia.)		338.00		
Leg kit for 14" aeration fan		10.00		
Total Aeration Equipment			737.00	
Portable Auger				
Portable auger (8" x 62")	2000 bu/hr	2,616.00		
10 h.p. electric motor w/ magnetic starter		1,166.00		
3' Flex tube and 45° safety spout (8" dia.)		66.00		
Plastic dump hopper		57.00		
Tires and tubes		20.00		
Freight and assembly		117.00		
Total Portable Auger			4,042.00	
Unloading Equipment				
Bin well and unloading tube				
8" tube and half gate	14'0"	173.00		
8" band-on intermediate well w/half gate		35.00		
½" pipe for gate control	15'0"	13.00		
1" pipe for gate control to intermediate well	7'9"	11.00		
1" conduit for gate control	6'9"	5.00		
1½" conduit for gate control to intermediate well	6'9"	7.00		

10,000 Bushel Capacity One Storage System (continued)

ITEMS				
25-Degree Unloading Kit				
25-degree unloading tube (8" dia.)		$ 484.00		
Horizontal flight for 25-degree unloader (8" dia.)	14'10"	146.00		
3 h.p. electric motor w/magnetic starter		503.00		
Bin Sweep Auger				
Bin sweep auger (8" dia.)	13'0"	187.00		
1½ h.p. electric motor w/magnetic starter		346.00		
Auger Installation		82.00		
Total Unloading Equipment			$1,992.00	
Electrical Wiring			2,000.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$ 8,771.00
LAND REQUIREMENT: (1/10 acre)				52.00
TOTAL INVESTMENT				$17,590.00
PER BUSHEL INVESTMENT				$1.59

20,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (2-11,036 bushel bins)		$12,426.00		
Total non-compacted storage capacity	22,072 bu			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	80'9"			
Ladder				
2-Outside	18'4"	204.00		
2-Inside	18'4"	198.00		
2-Auger slat hoods		34.00		
Total Storage Bin			$12,862.00	
Foundation			2,463.00	
Erection of Bins			2,207.00	
TOTAL INVESTMENT STORAGE UNIT				$17,532.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
2-Subfloors		778.00		
2-Aeration fans (1½ h.p.-14"dia.)		676.00		
2-Leg kits for 14" aeration fans		20.00		
Total Aeration Equipment			1,474.00	
Portable Auger				
Portable Pit Auger (8"x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		1,166.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,989.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
2 - 8" tubes and half gates	14'0"	346.00		
2 - 8" band-on intermediate wells w/half gates		70.00		
½" pipe for gate control	30'0"	27.00		
1" pipe for gate control to intermediate well	15'6"	23.00		
1" conduit for gate control	13'6"	9.00		
1½" conduit for gate control to intermediate well	13'6"	13.00		

20,000 Bushel Category One Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$ 1,844.00		
2-horizontal flights for low boy auger (3" dia.)		292.00		
2-flange clamps (8" dia.)		84.00		
7½ h.p. electric motor w/magnetic starter		923.00		
Bin Sweep Auger				
2-bin sweep augers (8" dia.)		374.00		
2 - 1½ h.p. electric motors w/ magnetic starter		692.00		
Installation of Augers		251.00		
Total Unloading Equipment			$ 4,898.00	
Electrical Wiring			2,938.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$14,299.00
LAND REQUIREMENT: (1/5 acre)				104.00
TOTAL INVESTMENT				$31,935.00
PER BUSHEL INVESTMENT				$1.45

30,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 11,036 bushel bins)		$18,639.00		
Total non-compacted storage capacity	33,108 bu.			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	30'9"			
Ladder				
3 -Outside	18'4"	306.00		
3 -Inside	18'4"	297.00		
3 -Auger slat hoods		51.00		
Total Storage Bin			$19,293.00	
Foundation			3,695.00	
Erection of Bins			3,311.00	
TOTAL INVESTMENT STORAGE UNIT				$26,299.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-Subfloors		1,167.00		
3-Aeration fans (1½ h.p.-14"dia.)		1,014.00		
3-Leg kits for 14" aeration fans		30.00		
Total Aeration Equipment.			2,211.00	
Portable Auger				
Portable Pit Auger (8" x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		1,166.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,989.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3 -8" tubes and half gates	14'0"	419.00		
3 -8" band-on intermediate wells w/half gates		105.00		
½" pipe for gate control	45'0"	41.00		
1" pipe for gate control to intermediate well	23'4"	34.00		
1" conduit for gate control	20'4"	14.00		
1½" conduit for gate control to intermediate well	20'4"	20.00		

30,000 Bushel Category One Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 42')		$ 1,844.00		
3 -horizontal flights for low boy auger (8" dia.)	14'10"	438.00		
3 -flange clamps (8" dia.)		51.00		
7½ h.p. electric motor w/magnetic starter		923.00		
Bin Sweep Auger				
3 -bin sweep augers (8" dia.)	13'0"	561.00		
3 - 1½ h.p. electric motors w/ magnetic starter		1,038.00		
Instaliation of Augers		284.00		
Total Unloading Equipment			$ 5,872.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$16,385.00
LAND REQUIREMENT: (3/10 acre)				157.00
TOTAL INVESTMENT				$42,841.00
PER BUSHEL INVESTMENT				41.29

40,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 13,773 bushel bins)		$21,834.00		
Total non-compacted storage capacity	41,319 bu.			
Bin diameter	30'0"			
Eave height	22'0"			
Overall height	30'7"			
Foundation height	1'0"			
Foundation diameter	31'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	31'7"			
Ladder				
3 -Outside	18'4"	306.00		
3 -Inside	18'4"	297.00		
3 -Auger slat hoods		51.00		
Total Storage Bin			$22,488.00	
Foundation			4,529.00	
Erection of Bins			4,132.00	
TOTAL INVESTMENT STORAGE UNIT				$31,149.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3 -Subfloors		1,269.00		
3 -Aeration fans (1½ h.p.-14"dia.)		1,014.00		
3 -Leg kits for 14" aeration fans		30.00		
Total Aeration Equipment			2,313.00	
Portable Auger				
Portable Pit Auger (8" x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		1,166.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,989.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3 - 8" tubes and half gates	15'6"	558.00		
6 - 8" band-on intermediate wells w/half gates		210.00		
½" pipe for gate control	48'0"	43.00		
1" pipe for gate control to intermediate well	33'0"	49.00		
1" conduit for gate control	15'0"	11.00		
1½" conduit for gate control to intermediate well	30'0"	29.00		

40,000 Bushel Category One Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$1,844.00		
3-horizontal flights for low boy auger (8" dia.)		483.00		
3-flange clamps (8" dia.)		51.00		
7½ h.p. electric motor w/magnetic starter		923.00		
Bin Sweep Auger				
3-bin sweep augers (8" dia.)		594.00		
3-1½ h.p. electric motors w/ magnetic starter		1,038.00		
Installation of Augers		292.00		
Total Unloading Equipment			$ 6,125.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$16,740.00
LAND REQUIREMENT: (3/10acre)				157.00
TOTAL INVESTMENT				$48,046.00
PER BUSHEL INVESTMENT				$1.16

60,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 20,256 bushel bins)		$30,066.00		
Total non-compacted storage capacity	60,768 bu.			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	33'5"			
Ladder				
3 -Outside	18'4"	306.00		
3 -Inside	18'4"	297.00		
3 -Auger slat hoods		51.00		
Total Storage Bin			$30,714.00	
Foundation			6,452.00	
Erection of Bins			6,077.00	
TOTAL INVESTMENT STORAGE UNIT				$43,243.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3 -Subfloors		2,517.00		
3 -Aeration fans (1½ h.p.-14"dia.)		1,014.00		
3 -Leg kits for 14" aeration fans		30.00		
3 -Round Gravity Roof Vents		300.00		
Total Aeration Equipment			3,361.00	
Portable Auger				
Portable Pit Auger (8"x62')	2000 bu/hr	3,661.00		
10 h.p. electric motor w/magnetic starter		1,166.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,989.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3 -8" tubes and half gates	18'6"	630.00		
3 -8" band-on intermediate wells w/half gates		210.00		
½" pipe for gate control	60'0"	54.00		
1" pipe for gate control to intermediate well	39'0"	57.00		
1" conduit for gate control	18'0"	13.00		
1½" conduit for gate control to intermediate well	36'0"	35.00		

60,000 Bushel Category One Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$ 1,844.00		
3-horizontal flights for low boy auger (8" dia.)	19'4"	573.00		
3-flange clamps (8" dia.)		51.00		
7½ h.p. electric motor w/magnetic starter		923.00		
Bin Sweep Auger				
3-bin sweep augers (8" dia.)	17'6"	657.00		
3 - 1½ h.p. electric motors w/ magnetic starter		1,038.00		
Installation of Augers		307.00		
Total Unloading Equipment			$ 6,392.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$18,555.00
LAND REQUIREMENT: (½ acre)				261.00
TOTAL INVESTMENT				$62,059.00
PER BUSHEL INVESTMENT				$1.02

80,000 Bushel Category One Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (4-20,256 bushel bins)		$40,080.00		
Total non-compacted storage capacity	81,024 bu			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	33'5"			
Ladder				
4-Outside	18'4"	408.00		
4-Inside	18'4"	396.00		
4-Auger slat hoods		68.00		
Total Storage Bin			$40,952.00	
Foundation			8,602.00	
Erection of Bins			8,102.00	
TOTAL INVESTMENT STORAGE UNIT				$57,656.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
4-Subfloors		3,356.00		
4-Aeration fans (1½ h.p.-14"dia.)		1,256.00		
4-Leg kits for 14" aeration fans		40.00		
4-Round Gravity Roof Vents		400.00		
Total Aeration Equipment.			5,052.00	
Portable Auger				
Portable Pit Auger (8"x62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		1,166.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,989.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
4 -8" tubes and half gates	18'6"	840.00		
8 -8" band-on intermediate wells w/half gates		230.00		
½" pipe for gate control	80'0"	72.00		
1" pipe for gate control to intermediate well	52'0"	76.00		
1" conduit for gate control	24'0"	17.00		
1½" conduit for gate control to intermediate well	48'0"	47.00		

80,000 Bushel Category One Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 42')		$ 1,844.00		
4-horizontal flights for low boy auger (8" dia.)	19'4"	764.00		
4-flange clamps (8" dia.)		68.00		
7½ h.p. electric motor w/magnetic starter		923.00		
Bin Sweep Auger				
4-bin sweep augers (8" dia.)	17'6"	876.00		
4-1½ h.p. electric motors w/ magnetic starter		1,038.00		
Installation of Augers		348.00		
Total Unloading Equipment			$ 7,193.00	
Electrical Wiring			3,688.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$21,018.00
LAND REQUIREMENT: (2/3 acre)				348.00
TOTAL INVESTMENT				$79,022.00
PER BUSHEL INVESTMENT				$.98

10,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin		$6,213.00		
Total non-compacted storage capacity	11,036 bu			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'0"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	28'0"			
Total bin height (ground to top)	30'9"			
Ladder				
Outside	18'4"	102.00		
Inside	18'4"	99.00		
Auger slat hood		17.00		
Total Storage Bin			$6,431.00	
Foundation			1,232.00	
Erection of Bin			1,104.00	
TOTAL INVESTMENT STORAGE UNIT				$ 8,767.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
Sub-floor		389.00		
Aeration fan (1½h.p.-14" dia.)		314.00		
Leg kit for 14" aeration fan		10.00		
Total Aeration Equipment			713.00	
Portable Auger				
Portable auger (8" x 62')	2000 bu/hr	2,616.00		
10 h.p. electric motor w/ magnetic starter		424.00		
3' Flex tube and 45° safety spout (8" dia.)		66.00		
Plastic dump hopper		57.00		
Tires and tubes		20.00		
Freight and assembly		117.00		
Total Portable Auger			3,300.00	
Unloading Equipment				
Bin well and unloading tube				
8" tube and half gate	14'0"	173.00		
8" band-on intermediate well w/half gate		35.00		
½" pipe for gate control	15'0"	13.00		
1" pipe for gate control to intermediate well	7'9"	11.00		
1" conduit for gate control	6'9"	5.00		
1½" conduit for gate control to intermediate well	6'9"	7.00		

10,000 Bushel Capacity Two Storage System (continued)

ITEMS				
25-Degree Unloading Kit				
25-degree unloading tube (8" dia.)		$ 484.00		
Horizontal flight for 25-degree unloader (8" dia.)	14'10"	146.00		
3 h.p. electric motor w/magnetic starter		241.00		
Bin Sweep Auger				
Bin sweep auger (8" dia.)	13'0"	187.00		
1½ h.p. electric motor w/magnetic starter		208.00		
Auger Installation		82.00		
Total Unloading Equipment			$1,592.00	
Electrical Wiring			2,000.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$ 7,605.00
LAND REQUIREMENT: (1/10 acre)				52.00
TOTAL INVESTMENT				$16,424.00
PER BUSHEL INVESTMENT				$1.49

20,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (2 - 11,036 bushel bins)		$12,426.00		
Total non-compacted storage capacity	22,072 bu.			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	30'9"			
Ladder				
2 -Outside	18'4"	204.00		
2 -Inside	18'4"	198.00		
2 -Auger slat hoods		34.00		
Total Storage Bin			$12,862.00	
Foundation			2,463.00	
Erection of Bins			2,207.00	
TOTAL INVESTMENT STORAGE UNIT				$17,532.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
2 -Subfloors		778.00		
2 -Aeration fans (1½ h.p.-14"dia.)		628.00		
2 -Leg kits for 14" aeration fans		20.00		
Total Aeration Equipment			1,426.00	
Portable Auger				
Portable Pit Auger (8" x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		424.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,247.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
2 -8" tubes and half gates	14'0"	346.00		
2 -8" band-on intermediate wells w/half gates		70.00		
½" pipe for gate control	30'0"	27.00		
1" pipe for gate control to intermediate well	15'6"	23.00		
1" conduit for gate control	13'6"	9.00		
1½" conduit for gate control to intermediate well	13'6"	13.00		

20,000 Bushel Category Two Storage System (continued).

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$ 1,844.00		
2 -horizontal flights for low boy auger (8" dia.)		292.00		
2 -flange clamps (8" dia.)		34.00		
7½ h.p. electric motor w/magnetic starter		367.00		
Bin Sweep Auger				
2 -bin sweep augers (8" dia.)	13'0"	374.00		
2 - 1½ h.p. electric motors w/ magnetic starter		416.00		
Installation of Augers		251.00		
Total Unloading Equipment			$ 4,066.00	
Electrical Wiring			2,938.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$12,677.00
LAND REQUIREMENT: (1/5 acre)				104.00
TOTAL INVESTMENT				$30,313.00
PER BUSHEL INVESTMENT				$1.37

30,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 11,036 bushel bins)		$18,639.00		
Total non-compacted storage capacity	33,108 bu.			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	30'9"			
Ladder				
3 -Outside	18'4"	306.00		
3 -Inside	18'4"	297.00		
3-Auger slat hoods		51.00		
Total Storage Bin			$19,293.00	
Foundation			3,695.00	
Erection of Bins			3,311.00	
TOTAL INVESTMENT STORAGE UNIT				$26,299.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3 -Subfloors		1,167.00		
3 -Aeration fans (1½ h.p.-14"dia.)		942.00		
3 -Leg kits for 14" aeration fans		30.00		
Total Aeration Equipment			2,139.00	
Portable Auger				
Portable Pit Auger (8" x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		424.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,247.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3 -8" tubes and half gates	14'0"	519.00		
3 -8" band-on intermediate wells w/half gates		105.00		
½" pipe for gate control	45'0"	41.00		
1" pipe for gate control to intermediate well	23'4"	34.00		
1" conduit for gate control	20'4"	14.00		
1½" conduit for gate control to intermediate well	20'4"	20.00		

30,000 Bushel Category Two Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 42')		$ 1,844.00		
3-horizontal flights for low boy auger (8" dia.)	14'10"	438.00		
3-flange clamps (8" dia.)		57.00		
7½ h.p. electric motor w/magnetic starter		367.00		
Bin Sweep Auger				
3-bin sweep augers (8" dia.)		561.00		
3-1½ h.p. electric motors w/ magnetic starter		624.00		
Installation of Augers		284.00		
Total Unloading Equipment			$ 4,902.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$14,601.00
LAND REQUIREMENT: (3/10 acre)				157.00
TOTAL INVESTMENT				$41,057.00
PER BUSHEL INVESTMENT				$1.24

40,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 13,773 bushel bins)		$21,834.00		
Total non-compacted storage capacity	41,319 bu.			
Bin diameter	30'0"			
Eave height	22'0"			
Overall height	30'7"			
Foundation height	1'0"			
Foundation diameter	31'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	31'7"			
Ladder				
3 -Outside	18'4"	306.00		
3 -Inside	18'4"	297.00		
3-Auger slat hoods		51.00		
Total Storage Bin			$22,488.00	
Foundation			4,529.00	
Erection of Bins			4,132.00	
TOTAL INVESTMENT STORAGE UNIT				$31,149.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-Subfloors		1,269.00		
3-Aeration fans (1½ h.p.-14"dia.)		942.00		
3-Leg kits for 14" aeration fans		30.00		
Total Aeration Equipment			2,241.00	
Portable Auger				
Portable Pit Auger (8" x62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		424.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,247.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3 -8" tubes and half gates	15'6"	558.00		
6 -8" band-on intermediate wells w/half gates		210.00		
¼" pipe for gate control	48'0"	43.00		
1" pipe for gate control to intermediate well	33'0"	49.00		
1" conduit for gate control	15'0"	11.00		
1¼" conduit for gate control to intermediate well	30'0"	29.00		

40,000 Bushel Category Two Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$ 1,844.00		
3 -horizontal flights for low boy auger (8" dia.)		483.00		
3 -flange clamps (8" dia.)		51.00		
7½ h.p. electric motor w/magnetic starter		367.00		
Bin Sweep Auger				
3 -bin sweep augers (8" dia.)		594.00		
3 - 1½ h.p. electric motors w/ magnetic starter		624.00		
Installation of Augers		292.00		
Total Unloading Equipment			$ 5,155.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$14,956.00
LAND REQUIREMENT: (3/10acre)				157.00
TOTAL INVESTMENT				$46,262.00
PER BUSHEL INVESTMENT				$1.12

60,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 20,256 bushel bins)		$30,060.00		
Total non-compacted storage capacity	60,768 bu.			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	28'0"			
Total bin height (ground to top)	33'5"			
Ladder				
3-Outside	18'4"	306.00		
3-Inside	18'4"	276.00		
3-Auger slat hoods		51.00		
Total Storage Bin			$30,714.00	
Foundation			6,452.00	
Erection of Bins			6,077.00	
TOTAL INVESTMENT STORAGE UNIT				$43,243.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-Subfloors		2,517.00		
3-Aeration fans (1½ h.p.-14"dia.)		942.00		
3-Leg kits for 14" aeration fans		30.00		
3-Round Gravity Roof Vents		300.00		
Total Aeration Equipment			3,789.00	
Portable Auger				
Portable Pit Auger (8" x 62)	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		424.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,247.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3-8" tubes and half gates	18'6"	630.00		
3-8" band-on intermediate wells w/half gates		210.00		
½" pipe for gate control	60'0"	54.00		
1" pipe for gate control to intermediate well	39'0"	57.00		
1" conduit for gate control	18'0"	13.00		
1½" conduit for gate control to intermediate well	36'0"	35.00		

60,000 Bushel Category Two Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 46')		$ 1,844.00		
3-horizontal flights for low boy auger (8" dia.)		573.00		
3-flange clamps (8" dia.)		51.00		
7½ h.p. electric motor w/magnetic starter		367.00		
Bin Sweep Auger				
3-bin sweep augers (8" dia.)		657.00		
3- 1½h.p. electric motors w/ magnetic starter		624.00		
Installation of Augers		307.00		
Total Unloading Equipment			$ 5,422.00	
Electrical Wiring			3,313.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$16,771.00
LAND REQUIREMENT: (½ acre)				261.00
TOTAL INVESTMENT				$60,275.00
PER BUSHEL INVESTMENT				$.99

80,000 Bushel Category Two Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (4 - 20,256 bushel bins)		$40,080.00		
Total non-compacted storage capacity	81,024 bu			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	33'5"			
Ladder				
4 -Outside	18'4"	408.00		
4 -Inside	18'4"	396.00		
4 -Auger slat hoods		68.00		
Total Storage Bin			$40,952.00	
Foundation			8,602.00	
Erection of Bins			8,102.00	
TOTAL INVESTMENT STORAGE UNIT				$57,656.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
4 -Subfloors		3,356.00		
4-Aeration fans (1½ h.p.-14"dia.)		1,256.00		
4-Leg kits for 14" aeration fans		40.00		
4-Round Gravity Roof Vents		400.00		
Total Aeration Equipment			5,052.00	
Portable Auger				
Portable Pit Auger (8" x 62')	2000 bu/hr	3,566.00		
10 h.p. electric motor w/magnetic starter		424.00		
Tires and tubes		40.00		
Freight and assembly		117.00		
Concrete dump pit		100.00		
Total Portable Auger			4,247.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
4 -8" tubes and half gates	18'6"	840.00		
4 -8" band-on intermediate wells w/half gates		280.00		
½" pipe for gate control	80'0"	72.00		
1" pipe for gate control to intermediate well	52'0"	76.00		
1" conduit for gate control	24'0"	17.00		
1½" conduit for gate control to intermediate well	48'0"	47.00		

80,000 Bushel Category Two Storage System (continued)

ITEMS				
Low Boy Auger Kit				
Low boy auger (8" x 42')		$ 1,844.00		
4-horizontal flights for low boy auger (8" dia.)		764.00		
4-flange clamps (8" dia.)		68.00		
7½ h.p. electric motor w/magnetic starter		367.00		
Bin Sweep Auger				
4-bin sweep augers (8" dia.)		876.00		
4-1½ h.p. electric motors w/ magnetic starter		832.00		
Installation of Augers		348.00		
Total Unloading Equipment			$ 6,431.00	
Electrical Wiring			3,688.00	
TOTAL INVESTMENT AERATION AND HANDLING EQUIPMENT				$19,418.00
LAND REQUIREMENT: (2/3 acre)				348.00
TOTAL INVESTMENT				$77,422.00
PER BUSHEL INVESTMENT				$.96

30,000 Bushel Category Three Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3 - 11, 036 bushel bins)		$18,639.00		
Total non-compacted storage capacity	33,108 bu.			
Bin diameter	27'0"			
Eave height	22'0"			
Overall height	29'9"			
Foundation height	1'0"			
Foundation diameter	28'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	30'9"			
Ladder				
3-Outside		306.00		
3-Inside		297.00		
3-Auger slat hoods		51.00		
Total Storage Bins			$19,293.00	
Foundation			3,695.00	
Erection of Bins			3,311.00	
TOTAL INVESTMENT STORAGE UNIT				$26,299.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-Sub-floors		1,176.00		
3-Aeration fans (1½ h.p.-14" dia.)		942.00		
3-Leg kits for 14" aeration fan		30.00		
Total Aeration Equipment			2,139.00	
Bucket Elevator and Dump Pit				
75' Bucket Elevator	3000 bu/hr	7,061.00		
10 h.p. electric motor w/ magnetic starter		424.00		
Backstop		215.00		
3-Attach Brackets for guy cable		96.00		
8"-8 way spout distributor		815.00		
Head adapter for 8" distributor		84.00		
Pipe control for distributor		90.00		
1" pipe for connection between control and distributor (75')		110.00		
80' of 3/16" control cable		17.00		
Ladder, cage and platform kit for 75' elevator; Kit includes:		2,087.00		
1-head service platform				
7-10'ladder sections				
2-5' ladder sections				
3-2½' entrance cage assemblies				
1-7' safety cage assembly				
3-10' safety cage assemblies				
2-rest stations				
Standard work platform for 8-way distributor		196.00		
Extra hopper		61.00		
Inlet hopper cover		9.00		

30,000 Bushel Category Three Storage System (continued)

ITEMS		
Belt bar splice		$ 5.00
Plyethylene cups		225.00
180' of 8" 14 gauge galvanized spouting (9-20' sections)		73.00
15-3/16" x 8" angle ring spouting flanges		144.00
9-8" flange clamps		46.00
3-Adj. spiders 2'-3' span for 8" spouting		249.00
6-truss anchors for 8" spouting		108.00
700' of 3/8" galvanized cable for spouting support		329.00
12-5/8" turnbuckles for spouting support		228.00
24-3/8" calbe thumbles for spouting support		13.00
48-3/8" galvanized cable for spouting support		36.00
1000' of 3/8" galvanized cable for elevator supporting		470.00
12-5/8" turnbuckles for elevator support		228.00
24-3/8" cable thumbles for elevator support		13.00
48-3/8" cable clamps for elevator support		36.00
4-12' x 6" pipes for anchoring elevator		120.00
12-½" x 8" eye bolts for anchoring cable		22.00
100' of 8" 14 gauge galvanized spouting for dump spout to trucks (5-20' sections)		41.00
8" adjustable dead head for dump spout		94.00
8" adjustable elbow segment for dump spout		30.00
3-3/16" angle ring spouting flanges for dump spout		29.00
4-8" flange clamps for dump spout		21.00
166' of 2" x ¼" angle iron for support of dump spout		216.00
Drive-over dump pit		
24' x 12" u-trough auger with pusher drive		912.00
Gear reducer drive - 80 rpm	2536 bu/hr	821.00
5-h.p. electric motor w/ magnetic starter		261.00
2-interval wood bearings		110.00
2-support feet		14.00
Pit hopper for 12" u-trough		405.00

30,000 Bushel Category Three Storage System (continued)

ITEMS				
Pit hopper grate 6-3½" x 42" sections		$ 654.00		
30' of 1" angle iron		12.00		
123 board feet of redwood for dump pit		123.00		
Erection of elevator and spouting		4,759.00		
Dump pit and elevator foundation		1,380.00		
Concrete slab for drive-over pit		660.00		
Concrete for anchor posts		53.00		
Total Bucket Elevator and Dump Pit			$24,205.00	
Unloading Equipment				
Bin well and unloading tube kit				
3-8" tubes w/half gate bin well	14'0"	519.00		
3-8" band-on intermediate wells w/ half gate		210.00		
½" pipe for gate control	45'0"	41.00		
1" pipe for gate control to intermediate well	23'4"	34.00		
1" conduit for gate control	20'4"	14.00		
1½" conduit for gate control to intermediate well	20'4"	20.00		
25-degree unloading kit				
1-25-degree unloader (8"dia.)		484.00		
1-horizontal flight for 25-degree unloader (8" dia.)	14'0"	146.00		
1-3 h.p. electric motor w/magnetic starter		241.00		
Variable height unloader				
2-variable height coupler box w/ stand		324.00		
2-8" x 11' utility grain augers		716.00		
2-horizontal flights for variable height auger (8" dia.)	14'0"	292.00		
2-support stands for 8" variable height auger		146.00		
2-5 h.p. electric motors w/magnetic starter		522.00		
Bin Sweep Auger				
3-bin sweep augers (8" dia.)	13'0"	561.00		
3-1½ h.p. electric motors w/ magnetic starter		624.00		
Installation of Augers		425.00		
Total Unloading Equipment			5,319.00	
Electrical Wiring			4,063.00	
TOTAL AERATION AND HANDLING EQUIPMENT				$35,726.00
LAND REQUIREMENT: (3/4 acre)				392.00
TOTAL INVESTMENT				$62,417.00
PER BUSHEL INVESTMENT				$1.88

40,000 Bushel Category Three Storage System

ITEMS				
STORAGE UNIT:				
Storage Bin (3-13,773 bushel bins)		$21,834.00		
Total non-compacted storage capacity	41,319 bu.			
Bin diameter	30'0"			
Eave height	22'0"			
Overall height	30'7"			
Foundation height	1'0"			
Foundation diameter	31'0"			
Height to eave (ground to eave)	23'0"			
Height to top (ground to top)	31'7"			
Ladders				
3-Outside	18'4"	306.00		
3-Inside	18'4"	297.00		
3-Auger slat hoods		51.00		
Total Storage Bin			$22,488.00	
Foundation			4,529.00	
Erection of Bins			4,132.00	
TOTAL INVESTMENT STORAGE UNIT				$31,149.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-Subfloors		1,269.00		
3-Aeration fans (1½ h.p.-14" dia.)		942.00		
3-Leg kits for 14" aeration fans		30.00		
Total Aeration Equipment			2,241.00	
Bucket Elevator and Dump Pit				
30' Bucket elevator	3000 bu/hr	7,346.00		
10 h.p. electric motors w/ magnetic starter		424.00		
Backstop		214.00		
3-Attach brackets for guy cables		96.00		
8"-8 way spout distributor		815.00		
Head adapter for 8" distributor		84.00		
Pipe control for distributor		90.00		
1" pipe for connection between control and distributor (80')		118.00		
85' of 3/16" control cable for distributor control		18.00		
Ladder, cage and platform kit for 80' elevator		2,235.00		
Kit Includes:				
1-Head service platform				
7-10' ladder sections				
1-6' ladder section				
2-5' ladder sections				
3-2½' entrance cage assemblies				
1-7' safety cage assembly				
4-10' safety cage assemblies				

40,000 Bushel Category Three Storage System (continued)

ITEMS				
2-rest stations				
Standard work platform for 8-way distributor		$ 196.00		
Extra hopper		61.00		
Inlet hopper cover		9.00		
Belt bar splice		5.00		
Polyethylene cups		240.00		
200' of 8" 14 gauge galvanized spouting (10-20' sections)		81.00		
15-3/16" x 8" angle ring spouting flanges		144.00		
9-8" flange clamps		46.00		
3-Adj. spiders 2'-3' span for 8" spout		249.00		
6-truss anchors for 8" spouting		108.00		
700' of 3/8" galvanized cable for spouting support		329.00		
12-5/8" turnbuckles for spouting support		228.00		
24-3/8" cable thumbles for spouting support		13.00		
48-3/8" cable clamps for spouting support		36.00		
1000' of 3/8" galvanized cable for elevator support		470.00		
12-5/8" turnbuckles for elevator support		228.00		
24-3/8" cable thumbles for elevator support		13.00		
48-3/8" cable clamps for elevator support		36.00		
4-12' x 6" pipes for anchoring elevator		120.00		
12-½" x 8" eye bolts for anchoring elevator		22.00		
120' of 8" 14 gauge galvanized spouting for dump spout to trucks (6-20' sections)		49.00		
8" adjustable dead head for dump spout		94.00		
8" adjustable elbow segment for dump spout		30.00		
3-3/16" angle ring spouting flanges		29.00		
4-8" flange clamps		21.00		
166' of 2" x ¼" angle iron to support dump spout		216.00		
Drive-over dump pit				
24' x 12" u-trough auger with pusher drive		912.00		
Gear reducer drive-80 rpm	2537 bu/hr	821.00		
5 h.p. electric motor w/ magnetic starter		261.00		

40,000 Bushel Category Three Storage System (continued)

ITEMS				
2-Internal wood bearings		$ 110.00		
2-support feet		14.00		
Pit hopper for 12" u-trough		405.00		
Pit hopper grate (6-3½ x 42' sections)		654.00		
30' of 1" angle iron		12.00		
123 board feet of redwood for dump pit		123.00		
Erection of elevator and spouting		5,118.00		
Dump pit and elevator foundation		1,380.00		
Concrete slab for drive-over pit		660.00		
Concrete for anchor posts		53.00		
Total Bucket Elevator and Dump Pit			$25,037.00	
Unloading Equipment				
Bin Well and Unloading Tube Kit				
3-8" tubes w/half gate bin wells	15'6"	558.00		
6-8" band-on intermediate wells w/half gate		210.00		
½" pipe for gate control	48'0"	43.00		
1" pipe for gate control to intermediate wells	33'0"	49.00		
1" conduit for gate control	15'0"	11.00		
1½" conduit for gate control to intermediate well	30'0"	29.00		
Variable height unloading auger				
3-variable height coupler boxes w/stand		486.00		
3-8" x 11' utility grain augers		1,074.00		
3-hroizontal flights for variable height auger (8" dia.)	16'4"	483.00		
3-support stands for 8" unloader		219.00		
3-5 h.p. electric motors w/ magnetic starter		783.00		
Bin Sweep Augers				
3-bin sweep augers (8" dia.)	14'0"	594.00		
3-1½ h.p. electric motors w/ magnetic starter		624.00		
Installation of augers		436.00		
Total Unloading Equipment			5,599.00	
Electrical Wiring			4,875.00	
TOTAL AERATION AND HANDLING EQUIPMENT				$37,752.00
LAND REQUIREMENT: (3/4 acre)				392.00
TOTAL INVESTMENT				$69,293.00
PER BUSHEL INVESTMENT				$1.68

60,000 Bushel Category Three Storage System

ITEMS				
STORAGE UNIT:				
Storage Bins (3-20,256 bushel bins)		$30,060.00		
Total non-compacted storage capacity	60,768 bu.			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	33'5"			
Ladder				
3-Outside	18'4"	306.00		
3-Inside	18'4"	297.00		
3-Auger slat hoods		51.00		
Total Storage Bin			$30,714.00	
Foundation			6,452.00	
Erection of Bins			6,077.00	
TOTAL INVESTMENT STORAGE UNIT				$43,243.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
3-sub-floors		2,517.00		
3-Aeration fans (1½ h.p.-14" dia.)		942.00		
3-Leg kits for 14" aeration fans		30.00		
3-Round gravity roof vents		300.00		
Total Aeration Equipment			3,789.00	
Bucket Elevator and Dump Pit				
85' Bucket Elevator	3000 bu/hr	7,917.00		
15 h.p. electric motor w/ magnetic starter		563.00		
Backstop		282.00		
3-Attach brackets for guy cable		96.00		
8"-8 way spout distributor		815.00		
Head adapter for 8" distributor		84.00		
Pipe control for distributor		90.00		
1" pipe for connection between control and distributor	80'0"	125.00		
90' of 3/16" control cable for distributor control		19.00		
Ladder, cage and platform kit for 85' elevator		2,257.00		
Kit Includes:				
1-head service platform				
8-10' ladder sections				
2-5' ladder sections				
3-2½' entrance cage assemblies				
1-7' safety cage assembly				
4-10' safety cage assemblies				
2-rest stations				

60,000 Bushel Category Three Storage System (continued)

ITEMS					
Standard work platform for 8-way distributor		$ 196.00			
Extra hopper		61.00			
Inlet hopper cover		9.00			
Belt bar splice		5.00			
Polyethylene cups		255.00			
240' of 8" 14 gauge galvanized spouting (12-20' sections)		97.00			
15-3/16" x 6" angle ring spouting flanges		144.00			
9-8" flange clamps		46.00			
3-Adj. spiders 2'-3' span for 8" spouting		249.00			
6-truss anchors for 8" spouting		108.00			
800' of 3/8" galvanized cable for spouting support		376.00			
12-5/8" turnbuckles for spouting support		228.00			
24-3/8" cable thumbles for spouting support		13.00			
48-3/8" cable clamps for spouting support		36.00			
1100' of 3/8" galvanized cable for elevator support		517.00			
12-5/8" turnbuckles for elevator support		228.00			
24-3/8" cable thumbles for elevator support		13.00			
48-3/8" cable clamps for elevator support		36.00			
4-12' x 6" pipe for anchoring elevator		120.00			
12-½" x 8" eye bolts for anchoring elevator		22.00			
140' of 8" 14 gauge galvanized spouting for dump spout to trucks (7-20' sections)		57.00			
8" adjustable dead head		94.00			
1-8" adjustable elbow segment		30.00			
3-3/16" angle ring spouting flanges		29.00			
4-8" flange clamps		21.00			
166' of 2" x ¼" angle iron to support down spout		216.00			
Drive-over Dump Pit					
24'x12" u-trough auger with pusher drive		912.00			
Gear reducer drive - 80 rpm	2537 bu/hr	821.00			
5-h.p. electric motor w/ magnetic starter		261.00			
2-internal wood bearings		110.00			
2-support feet		14.00			

60,000 Bushel Category Three Storage System (continued)

ITEMS				
Pit hopper for 12" u-trough		$ 405.00		
Pit hopper grate (6-3½" x 42" sections)		654.00		
30' of 1" angle iron for dump pit		12.00		
123 board feet of redwood for covering pit		123.00		
Erection of elevator and spouting		5,303.00		
Dump pit and elevator foundation		1,380.00		
Concrete slab for drive-over pit		660.00		
Concrete for anchor posts		53.00		
Total Bucket Elevator and Dump Pit			$26,161.00	
Unloading Equipment				
Bin well and Unloading tube kit				
3-8" tubes w/half gate bin wells	18'6"	630.00		
6-8" band-on intermediate wells w/half gates		210.00		
½" pipe for gate control	60'0"	54.00		
1" pipe for gate control to intermediate wells	39'0"	57.00		
1" conduit for gate control	18'0"	13.00		
1½" conduit for gate control to intermediate wells	36'0"	35.00		
Variable Height Unloader				
3-8" variable height coupler boxes w/stand		486.00		
1-8" x 11' utility grain auger		358.00		
2-8" x 16' utility grain augers		884.00		
3-support stands for 8" dia. unloaders		219.00		
3-horizontal flights for variable height unloader (8" dia.)	19'4"	573.00		
3-5 h.p. electric motors w/ magnetic starter		783.00		
Bin sweep augers				
3-bin sweep augers (8" dia.)	17'6"	657.00		
3-1½ h.p. electric motors w/ magnetic starter		624.00		
Installation of augers		468.00		
Total Unloading Equipment			6,051.00	
Electrical Wiring			5,500.00	
TOTAL AERATION AND HANDLING EQUIPMENT				$41,501.00
LAND REQUIREMENT: (3/4 acre)				392.00
TOTAL INVESTMENT				$85,136.00
PER BUSHEL INVESTMENT				$1.40

80,000 Bushel Category Three Storage System

ITEMS				
STORAGE UNIT:				
Storage Bins (4-20,256 bushel bins)		$40,080.00		
Total non-compacted storage capacity	81,024 bu.			
Bin diameter	36'0"			
Eave height	22'0"			
Overall height	32'5"			
Foundation height	1'0"			
Foundation diameter	37'0"			
Height to eave (ground to eave)	23'0"			
Total bin height (ground to top)	33'5"			
Ladders				
4-Outside	18'4"	408.00		
4-Inside	18'4"	396.00		
4-Auger slat hoods		68.00		
Total Storage Bin			$40,952.00	
Foundation			8,602.00	
Erection of Bins			8,102.00	
TOTAL INVESTMENT STORAGE UNIT				$57,656.00
AERATION AND HANDLING EQUIPMENT:				
Aeration Equipment				
4-Sub-floors		3,356.00		
4-Aeration fans (1½ h.p.-14" dia.)		1,256.00		
4-Leg kits for 14" aeration fan		40.00		
4-Round gravity roof vents		400.00		
Total Aeration Equipment			5,052.00	
Bucket Elevator and Dump Pit				
85' Bucket Elevator		7,916.00		
15 h.p. electric motor w/ magnetic starter		563.00		
Bucket Stop		282.00		
3-attach brackets for guy cable		96.00		
8"-8 way spout distributor		815.00		
head adapter for 8" distributor		84.00		
Pipe control for distributor		90.00		
1" pipe for connection between control and distributor	80'0"	125.00		
3/16" galvanized cable for distributor control	90'0"	19.00		
Ladder, cage and platform kit for 85' elevator		2,257.00		
Kit Includes:				
1-head service platform				
8-10' ladder sections				
2-5' ladder sections				
3-2½' entrance cage assemblies				
1-7' safety cage assembly				
4-10' safety cage assemblies				
2-rest stations				

80,000 Bushel Category Three Storage System (continued)

ITEMS				
Standard work platform for 8-way distributor		$ 196.00		
Extra hopper		61.00		
Inlet hopper cover		9.00		
Belt bar splice		5.00		
Polyethylene cups		255.00		
280' of 8" 14 gauge galvanized spouting (14-29' sections)		113.00		
20-3/16" x 8" angle ring spouting flanges		192.00		
12-8" flange clamps		62.00		
4-adj. spiders 2'-3' span for 8" spouting		332.00		
8-truss anchors for 8" spouting		144.00		
1000' of 3/8" galvanized cable for spouting support		470.00		
16-5/8" turnbuckles for spouting support		304.00		
32-3/8" cable thumbles for spouting support		17.00		
64-3/8" cable clamps for spouting support		47.00		
1100' of 3/8" galvanized cable for elevator support		517.00		
12-5/8" turnbuckles for elevator support		228.00		
24-3/8" cable thumbles for elevator support		13.00		
48-3/8" cable clamps for elevator support		36.00		
4-12' x 6" pipes for anchoring elevator		120.00		
12-½" x 8" eye bolts for anchoring elevator		21.00		
140' of 8" 14 gauge galvanized spouting for dump spout to trucks (7-20' sections)		57.00		
8" adjustable dead head		94.00		
8" adjustable elbow segment		30.00		
3-3/16" agnle ring spouting flanges		29.00		
4-8" flange clamps		21.00		
166' of 2" x ¼" angle iron to support down spout		216.00		
Drive-Over Dump pit				
24' x 12" u-trough auger with pusher drive		912.00		
Gear reducer drive - 80 rpm		821.00		
5 h.p. electric motor w/ magnetic starter		261.00		
2-internal wood bearings		110.00		
2-support feet		14.00		
Pit hopper for 62" u-trough		405.00		

80,000 Bushel Category Three Storage System (continued)

ITEMS				
Pit hopper grate (6-3½" x 42" sections)		$ 654.00		
30' of 1" angle iron for dump pit		12.00		
123 board feet of redwood for covering pit		123.00		
Erection of elevator and spouting		5,311.00		
Dump pit and elevator foundation		1,380.00		
Concrete slab for drive-over pit		660.00		
Concrete for anchor posts		53.00		
Total Bucket Elevator and Dump Pit			$26,552.00	
Unloading Equipment				
Bin well and Unloading Tube Kit				
4-8" tubes w/half gate bin wells	18'6"	840.00		
8-8" band-on intermediate wells w/half gates		280.00		
½" pipe for gate control	80'0"	72.00		
1" pipe for gate control to intermediate wells	52'0"	76.00		
1" conduit for gate control	24'0"	17.00		
1½" conduit for gat control to intermediate wells	48'0"	47.00		
Variable height unloader				
4-8" variable height coupler boxes w/stand		648.00		
2-8" utility grain augers	11'0"	716.00		
2-8" utility grain augers	16'0"	884.00		
4-support stands for 8" variable height augers		292.00		
1-8" winch kit for variable height auger		73.00		
4-horizontal flights for variable height unloader (8" dia.)		764.00		
4-5 h.p. electric motors w/ magnetic starters		1,044.00		
Bin Sweep Augers				
4-bin sweep augers (8" dia.)		876.00		
4-1½ h.p. electric motors w/ magnetic starters		832.00		
Installation of augers		561.00		
Total Unloading Equipment			8,022.00	
Electrical Wiring			6,125.00	
TOTAL AERATION AND HANDLING EQUIPMENT				$45,751.00
LAND REQUIREMENT: (3/4 acre)				392.00
TOTAL INVESTMENT				$103,799.00
PER BUSHEL INVESTMENT				$1.28

APPENDIX C

ANNUAL TOTAL AND PER BUSHEL COSTS OF ON-FARM WHEAT STORAGE

TABLE XXIX

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non-Compacted Storage Capacity, in bushels, 100 Percent Utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($) [Percentage Figures Bracketed]									
Fixed Costs										
Depreciation										
Building	143.50	177.60	252.30	210.55	438.35	876.60	1,314.95	1,557.45	2,162.15	2,883.80
Equipment	442.20	455.40	533.70	747.90	877.10	1,429.90	1,638.50	1,674.00	1,855.50	2,101.80
Percent of TFC	[48.22]	[47.65]	[47.05]	[45.02]	[46.88]	[46.16]	[45.21]	[44.69]	[43.90]	[43.36]
Insurance										
Grain Bins	28.70	35.52	50.46	62.11	87.67	175.32	262.99	311.49	432.43	576.56
Handling Equipment	88.44	91.08	106.74	149.58	175.42	285.98	327.70	334.80	371.10	420.36
Percent of TFC	[9.64]	[9.53]	[9.41]	[9.94]	[9.38]	[9.23]	[9.04]	[8.94]	[8.78]	[8.68]
Interest on Investment										
Storage System	473.98	526.89	674.90	889.85	1,139.97	2,069.02	2,774.46	3,112.79	4,016.87	5,113.81
Land	2.86	2.86	2.86	3.38	3.38	6.76	10.21	10.21	16.97	22.62
Percent of TFC	[39.25]	[39.88]	[40.56]	[41.95]	[40.75]	[41.55]	[42.62]	[43.20]	[44.08]	[44.08]
Property Taxes										
Storage System	34.86	38.76	49.64	65.45	83.85	152.19	204.08	228.97	295.47	376.16
Land	.21	.21	.21	.25	.25	.50	.75	.75	1.25	1.66
Percent of TFC	[2.39]	[2.93]	[2.98]	[3.08]	[3.00]	[3.00]	[3.13]	[3.18]	[3.24]	[3.28]
TOTAL ANNUAL FIXED COSTS	1,214.75	1,328.32	1,670.81	2,129.07	2,805.99	4,995.77	6,533.64	5,230.46	9,151.74	11,495.77
Variable Costs										
Grain Insurance	71.42	104.58	176.80	234.02	353.15	706.30	1,059.46	1,322.21	1,944.58	2,592.77
Percent of TVC	[12.07]	[14.17]	[16.46]	[17.37]	[18.57]	[19.46]	[20.16]	[20.83]	[21.69]	[21.91]
Grain Handling										
Labor	23.02	33.71	56.98	37.71	56.91	113.83	170.74	213.08	313.38	417.84
Electricity	.81	1.20	3.27	3.01	5.79	13.80	20.70	25.85	38.01	50.68
Percent of TVC	[4.02]	[4.73]	[5.61]	[3.02]	[3.30]	[3.52]	[3.64]	[3.77]	[3.92]	[3.97]
Aeration										
Labor	96.00	96.00	96.00	96.00	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	5.40	5.40	5.40	5.40	16.20	32.40	48.60	48.60	48.60	64.80
Percent of TVC	[17.13]	[13.74]	[9.44]	[7.53]	[5.90]	[4.86]	[4.58]	[3.79]	[2.68]	[2.58]
Insect Control										
Labor	24.00	24.00	24.00	24.00	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	17.68	25.51	43.04	56.65	35.22	170.54	255.77	320.40	465.70	621.02
Percent of TVC	[7.04]	[6.71]	[6.24]	[5.99]	[5.74]	[6.02]	[6.24]	[6.12]	[6.00]	[6.07]

TABLE XXIX

(CONTINUED)

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in Bushels, 100 Percent Utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
Variable Costs (Continued)	Dollars ($) [Percentage Figures Bracketed]									
Maintenance										
Storage Bins	14.35	17.76	25.23	31.06	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	132.66	136.62	160.11	224.37	263.13	428.97	491.55	502.20	556.65	630.54
Percent of TVC	[24.84]	[20.92]	[17.25]	[18.96]	[16.14]	[14.23]	[11.85]	[10.36]	[8.62]	[7.78]
Interest on Operating Capital	27.87	31.75	41.38	49.62	74.88	119.02	165.27	191.38	256.16	331.67
Percent of TVC	[4.71]	[4.30]	[3.85]	[3.69]	[3.94]	[3.28]	[3.14]	[3.01]	[2.86]	[2.81]
Shrinkage										
Moisture Loss	156.24	228.76	386.75	511.91	772.52	1,545.04	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	22.32	32.68	55.25	73.13	110.86	220.72	331.08	413.19	607.68	810.24
Percent of TVC	[30.17]	[35.43]	[41.15]	[43.43]	[46.42]	[48.64]	[50.39]	[52.06]	[54.23]	[54.86]
TOTAL ANNUAL VARIABLE COSTS	591.77	737.97	1,074.21	1,346.88	1,902.01	3,630.28	5,256.23	6,348.99	8,964.74	11,815.72
TOTAL ANNUAL COSTS	1,806.52	2,066.29	2,745.02	3,475.95	4,708.00	8,626.05	11,789.87	13,579.45	18,116.48	23,311.49

TABLE XXX

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 75 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Noncompacted Storage Capacity, in Bushels, 75 Percent Utilization	1,674	2,451	4,144	5,485	8,277	16,554	24,831	30,989	45,576	60,769
Fixed Costs	Dollars ($)									
Depreciation										
Building	143.50	177.50	252.30	210.55	438.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	442.20	455.40	533.70	747.90	877.10	1,429.90	1,638.50	1,674.00	1,855.50	2,101.80
Insurance										
Grain Bins	28.70	35.52	50.46	62.11	87.67	175.32	262.99	311.49	432.43	576.56
Handling Equipment	88.44	91.08	106.74	149.58	175.42	285.98	327.70	334.80	371.10	420.36
Interest on Investment										
Storage System	473.98	526.89	674.90	889.85	1,139.97	2,069.02	2,774.46	3,112.79	4,016.37	5,113.81
Land	2.86	2.86	2.86	3.38	3.38	6.76	10.21	10.21	16.97	22.62
Property Taxes										
Storage System	34.86	38.76	49.64	65.45	33.85	152.19	204.08	228.97	295.47	376.16
Land	.21	.21	.21	.25	.25	.50	.75	.75	1.25	1.60
TOTAL ANNUAL FIXED COSTS	1,214.75	1,328.32	1,670.81	2,129.07	2,805.99	4,995.77	6,533.64	7,230.46	9,151.74	11,495.77
Variable Costs										
Grain Insurance	53.57	78.43	132.61	175.52	264.86	529.73	794.59	991.58	$1,458.43	$1,944.58
Grain Handling										
Labor	17.26	25.27	42.72	28.30	42.71	85.42	128.13	159.89	235.17	313.56
Electricity	.60	.91	2.44	2.25	4.30	10.43	15.64	19.52	25.71	33.28
Aeration										
Labor	96.00	96.00	96.00	96.00	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	5.40	5.40	5.40	5.40	16.20	32.40	48.60	48.60	48.60	64.80

TABLE XXX

(CONTINUED)

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in Bushels, 75 Percent Utilization	1,674	2,451	4,144	5,485	8,277	16,554	24,931	30,989	45,576	60,768
Variable Costs (continued)	Dollars ($)									
Insect Control										
Labor	24.00	24.00	24.00	24.00	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	13.50	19.38	32.68	42.56	64.54	129.16	189.94	240.68	351.76	469.11
Maintenance and Repairs										
Storage Bin	14.35	17.76	25.23	31.06	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	132.66	136.62	160.11	224.87	263.13	428.97	491.55	502.20	556.65	630.54
Interest on Inventory	26.10	29.12	36.92	44.32	57.11	102.63	141.79	162.06	212.36	374.06
Shrinkage										
Moisture Loss	117.18	171.57	290.08	383.95	579.39	1,158.78	1,738.17	2,169.09	3,190.32	4,253.76
Invisible Loss	16.74	24.51	41.44	54.35	82.77	165.54	248.31	309.87	455.76	607.68
TOTAL ANNUAL VARIABLE COSTS	517.36	628.97	889.63	1,112.58	1,538.85	2,922.72	4,192.22	5,023.24	7,015.00	9,215.65
TOTAL ANNUAL COSTS	1,732.10	1,957.29	2,560.44	1,241.65	4,344.84	7,918.49	10,725.86	12,253.70	16,166.74	20,711.42

TABLE XXXI

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 50 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in Bushels, 50 Percent Utilization	1,116	1,634	2,763	3,657	5,518	11,036	16,554	20,660	30,394	40,512
	Dollars ($)									
Fixed Costs										
Depreciation										
Building	143.50	177.50	252.30	210.55	438.35	876.60	1,314.95	1,557.45	2,162.15	$2,882.80
Equipment	442.20	455.40	533.70	747.90	877.10	1,429.90	1,638.50	1,674.00	1,855.50	2,101.80
Insurance										
Grain Bins	28.70	35.52	50.46	62.11	87.67	175.32	262.99	314.45	432.43	576.56
Handling Equipment	88.44	91.08	106.74	149.58	175.42	285.98	327.70	334.80	371.10	420.36
Interest on Investment										
Storage System	473.98	526.89	674.90	839.85	1,139.97	2,069.02	2,774.46	3,112.79	4,016.87	5,113.81
Land	2.86	2.86	2.86	3.38	3.38	6.76	10.21	10.21	16.97	22.62
Property Taxes										
Storage System	34.86	38.76	49.64	65.45	83.85	152.19	204.08	228.97	295.47	376.16
Land	.21	.21	.21	.25	.25	.50	.75	.75	1.25	1.66
TOTAL ANNUAL FIXED COSTS	1,214.75	1,328.32	1,670.81	2,129.07	2,805.99	4,995.77	6,533.64	7,230.46	9,151.74	11,495.77
Variable Costs										
Grain Insurance	35.71	52.29	88.42	117.02	176.58	353.15	529.73	661.12	972.29	1,296.38
Grain Handling										
Labor	11.51	16.85	28.49	37.70	56.89	113.78	170.67	213.00	313.26	417.68
Electricity	.40	.59	.99	1.32	1.99	3.97	5.96	7.44	10.94	14.58
Aeration										
Labor	96.00	96.00	96.00	96.00	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	5.40	5.40	5.40	5.40	16.20	32.40	48.60	48.60	48.60	64.80

TABLE XXXI

(CONTINUED)

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in Bushels, 50 Percent Utilization	1,116	1,634	2,763	3,657	5,518	11,036	16,554	20,660	30,394	40,512
	Dollars ($)									
Variable Costs (continued)										
Insect Control										
Labor	24.00	24.00	24.00	24.00	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	9.61	13.26	23.32	29.23	43.81	87.77	129.37	163.21	237.46	317.18
Maintenance and Repairs										
Storage Bins	14.35	17.75	25.23	31.06	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	132.66	136.62	160.11	224.37	263.13	428.97	491.55	502.20	556.65	630.54
Interest on Operating Capital	24.31	26.52	32.44	40.56	51.21	91.49	123.99	140.07	180.18	230.51
Shrinkage										
Moisture Loss	78.12	114.38	193.41	255.99	386.26	772.52	1,158.78	1,446.20	2,126.88	2,835.84
Invisible Loss	11.16	16.34	27.63	36.57	55.18	110.36	165.54	206.60	303.84	405.12
TOTAL ANNUAL VARIABLE COSTS	443.23	520.00	704.44	899.22	1,215.09	2,274.07	3,219.69	3,808.19	5,230.32	6,836.91
TOTAL ANNUAL COSTS	1,657.98	1,848.32	2,375.25	3,028.29	4,021.08	7,269.84	9,753.33	11,038.65	14,385.06	18,332.68

TABLE XXXII

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEM, SELECTED CAPACITY, 100 PERCENT UTILIZATION OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Cents Per Bushel (¢/bu.)									
Fixed Costs										
Depreciation										
Building	6.429	5.435	4.567	2.879	3.972	3.972	3.972	3.769	3.558	3.558
Equipment	19.812	13.935	9.660	10.227	7.948	6.475	4.949	4.051	3.053	2.594
Insurance										
Grain Bins	1.286	1.087	.913	.849	.794	.794	.794	.754	.712	.712
Handling Equipment	3.962	2.787	1.932	2.045	1.590	1.296	.990	.810	.611	.519
Interest on Investment										
Storage System	21.236	16.123	12.215	12.168	10.330	9.374	8.380	7.534	6.610	6.311
Land	.128	.188	.052	.046	.031	.031	.031	.025	.028	.028
Property Taxes										
Storage System	1.562	1.186	.989	.895	.760	.690	.616	.554	.486	.464
Land	.009	.006	.004	.003	.002	.002	.002	.002	.002	.002
TOTAL FIXED COSTS/BUSHEL	54.424	40.647	30.241	29.113	25.426	22.634	19.734	17.499	15.060	14.188
Variable Costs										
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling										
Labor	1.031	1.031	1.031	.516	.516	.516	.516	.516	.516	.516
Electricity	.036	.037	.059	.041	.052	.063	.063	.063	.063	.063

TABLE XXXII

(CONTINUED)

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	2,232	3,268	5,525	7,313	11,036	22,072	33,108	41,319	60,768	81,024
	Cents Per Bushel (c/bu.)									
Variable Costs (continued) (continued)										
Aeration										
Labor	4.301	2.938	1.738	1.313	.870	.652	.580	.465	.316	.296
Electricity	.242	.165	.098	.074	.147	.147	.147	.118	.080	.080
Insect Control										
Labor	1.075	.734	.434	.328	.217	.217	.217	.174	.118	.118
Chemicals	.792	.781	.779	.775	.772	.773	.773	.775	.776	.776
Maintenance and Repair										
Storage Bins	.643	.543	.457	.425	.397	.397	.397	.377	.356	.356
Equipment	5.944	4.181	2.898	3.068	2.384	1.944	1.485	1.215	.916	.778
Interest on Operating Capital	1.249	.971	.749	.679	.583	.539	.499	.463	.422	.410
Shrinkage										
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	26.513	22.581	19.443	18.419	17.138	16.448	15.877	15.366	14.753	14.583
TOTAL COST/BUSHEL	80.937	63.228	49.684	47.532	43.564	39.082	35.609	32.865	29.813	28.771
OPPORTUNITY COST/BUSHEL	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
TOTAL COST OF STORING WHEAT FOR SIX MONTHS/BUSHEL	110.937	93.228	79.684	77.532	72.564	69.082	65.609	62.865	59.813	58.771

TABLE XXXIII

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEM, SELECTED CAPACITY, 75 PERCENT UTILIZATION OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity									
	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	1,674	2,451	4,144	5,435	8,277	16,554	24,331	30,989	45,576	60,768
	Cents Per Bushel (¢/bu.)									
TOTAL FIXED COSTS/BUSHEL	72.566	54.195	40.319	33.816	33.901	30.179	26.312	23.332	20.080	18,917
Variable Costs										
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling										
Labor	1.031	1.031	1.031	.516	.516	.516	.516	.516	.516	.516
Electricity	.036	.037	.059	.041	.052	.063	.063	.063	.063	.056
Aeration										
Labor	5.735	3.917	2.317	1.750	1.160	.870	.773	.620	.421	.395
Electricity	.323	.220	.130	.098	.196	.196	.196	.157	.107	.107
Insect Control										
Labor	1.434	.979	.579	.438	.290	.290	.29	.232	.153	.158
Chemicals	.806	.791	.789	.776	.780	.780	.765	.777	.772	.772
Maintenance and Repair										
Storage Bin	.857	.725	.609	.566	.530	.530	.530	.503	.474	.474
Equipment	7.925	5.574	4.091	4.901	3.178	2.591	1.980	1.621	1.221	1.038
Interest on Operating Capital	1.559	1.188	.891	.808	.690	.620	.571	.523	.466	.451
Shrinkage										
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	30.906	25.662	21.468	20.284	18.592	17.656	16.884	16.212	15.391	15.167
TOTAL COSTS/BUSHEL	103.472	79.857	61.787	54.100	52.493	47.835	43.196	39.544	35.471	34.083

TABLE XXXIV

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY ONE ON-FARM STORAGE SYSTEM, SELECTED CAPACITY, 50 PERCENT UTILIZATION OKLAHOMA, 1980

	2,000	3,000	5,000	7,000	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	1,116	1,634	2,763	3,657	5,518	11,036	16,554	20,660	30,334	40,512
	Cents Per Bushel (¢/bu.)									
TOTAL FIXED COSTS/BUSHEL	108.849	81.293	60.471	58.219	50.852	45.268	39.469	34.997	30.120	28.376
Variable Costs										
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling										
Labor	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031
Electricity	.036	.036	.036	.036	.036	.036	.036	.036	.036	.036
Aeration										
Labor	3.602	5.375	3.474	2.625	1.740	1.305	1.16	.929	.632	.592
Electricity	.484	.330	.195	.148	.294	.294	.294	.235	.160	.160
Insect Control										
Labor	2.151	1.469	.369	.656	.435	.435	.435	.348	.237	.237
Chemicals	.861	.812	.808	.799	.794	.795	.782	.790	.782	.783
Maintenance and Repair										
Storage Bin	1.286	1.087	.913	.849	.794	.794	.794	.754	.712	.712
Equipment	11.887	8.361	5.795	6.135	4.769	3.887	2.969	2.431	1.832	1.556
Investment in Operating Capital	2.178	1.623	1.174	1.109	.928	.829	.749	.678	.593	.569
Shrinkage										
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	39.716	31.824	25.495	24.389	22.021	20.606	19.450	18.432	17.215	16.876
TOTAL COSTS/BUSHEL	148.562	113.117	85.966	82.808	72.873	65.874	58.919	53.429	47.344	45.252

TABLE XXXV

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	11,036	22,072	33,108	41,319	60,768	81,024
	Dollars ($) [Percentage Figures Bracketed]					
Fixed Costs						
Depreciation						
Building	438.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	760.50	1,267.70	1,460.10	1,495.60	1,677.10	1,941.80
Percent of TFC	[46.38]	[45.74]	[46.26]	[44.30]	[43.56]	[43.13]
Insurance						
Grain Bins	87.67	175.32	262.99	311.49	432.43	576.56
Handling Equipment	152.10	253.54	292.02	299.12	335.42	388.36
Percent of TFC	[9.28]	[9.15]	[9.25]	[8.86]	[8.71]	[8.62]
Interest on Investment						
Storage System	1,064.18	1,963.59	2,658.50	2,996.83	3,900.91	5,009.81
Land	3.38	6.76	10.21	10.21	16.97	22.62
Percent of TFC	[41.30]	[42.03]	[44.49]	[43.63]	[44.45]	[44.96]
Property Taxes						
Storage System	78.28	144.44	195.55	220.44	286.94	368.51
Land	.25	.50	.75	.75	1.25	1.66
Percent of TFC	[3.04]	[3.09]	[3.27]	[3.21]	[3.27]	[3.31]
TOTAL ANNUAL FIXED COSTS	2,584.71	4,688.45	5,998.77	6,891.89	8,813.17	11,192.12
Variable Costs						
Insurance on Grain	353.15	706.30	1,059.46	1,322.21	1,944.58	2,592.77
Percent of TVC	[18.68]	[19.48]	[20.16]	[20.83]	[21.69]	[22.05]
Grain Handling						
Labor	56.91	113.83	170.76	213.08	313.38	417.84
Electricity	5.79	13.80	25.85	25.85	38.01	50.68
Percent of TVC	[3.32]	[3.52]	[3.64]	[3.76]	[3.92]	[3.98]

TABLE XXXV

(CONTINUED)

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	11,036	22,072	33,108	41,319	60,768	81,024
Variable Costs (continued)	Dollars ($) [Percentage Figures Bracketed]					
Aeration						
Labor	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	16.20	32.40	48.60	48.60	48.60	64.80
Percent of TVC	[5.93]	[4.87]	[4.58]	[3.79]	[2.68]	[2.59]
Insect Control						
Labor	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	85.23	170.54	255.71	320.40	465.70	621.02
Percent of TVC	[5.78]	[6.03]	[6.23]	[6.18]	[6.00]	[6.10]
Maintenance and Repair						
Storage Bins	43.34	87.66	131.50	155.75	216.22	233.23
Equipment	263.13	423.97	491.55	502.20	556.65	630.54
Percent of TVC	[16.21]	[14.11]	[11.85]	[10.36]	[8.62]	[7.34]
Interest on Operating Capital	64.33	119.02	165.27	191.38	256.16	331.37
Percent of TVC	[3.40]	[3.28]	[3.14]	[3.01]	[2.86]	[2.82]
Shrinkage						
Moisture Loss	772.52	1,545.04	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	110.36	220.72	331.08	413.19	607.68	810.24
Percent of TVC	[46.69]	[48.71]	[50.39]	[52.06]	[54.23]	[55.12]
TOTAL ANNUAL VARIABLE COSTS	1,890.96	3,625.28	5,256.19	6,348.99	8,964.74	11,760.17
TOTAL ANNUAL COSTS	4,475.67	8,313.73	11,254.96	13,240.88	17,777.91	22,952.29

TABLE XXXVI

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 75 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	8,277	16,554	24,831	30,989	45,576	60,768
	Dollars ($)					
Fixed Costs						
Depreciation						
Building	438.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	760.50	1,267.70	1,460.10	1,495.60	1,677.10	1.941.80
Insurance						
Grain Bins	87.67	175.32	262.99	311.49	432.43	576.56
Handling Equipment	152.10	253.54	292.02	299.12	335.42	388.36
Interest on Investment						
Storage System	1,064.18	1,963.59	2,658.50	2,996.83	3,900.91	5,009.81
Land	3.38	6.76	10.21	10.21	16.97	22.62
Property Taxes						
Storage System	78.28	144.44	195.55	220.44	286.94	368.51
Land	.25	.50	.75	.75	1.25	1.66
TOTAL ANNUAL FIXED COSTS	2,584.71	4,688.45	5,998.77	6,891.89	8,813.17	11,192.12
Variable Costs						
Insurance on Grain	264.86	529.73	794.59	991.58	1,458.43	1,944.58
Grain Handling						
Labor	42.71	85.42	128.13	159.89	235.17	313.56
Electrical	4.30	10.43	15.64	19.52	25.71	33.28
Aeration						
Labor	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	16.20	32.40	48.60	48.60	48.60	64.80

TABLE XXXVI

(CONTINUED)

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels	8,277	16,554	24,831	30,989	45,576	60,768
Percent Utilization						
Variable Costs (continued)	Dollars ($)					
Insect Control						
Labor	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	64.54	129.16	189.94	240.68	351.76	469.11
Maintenance and Repair						
Storage Bins	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	263.13	428.97	491.55	502.20	556.65	630.54
Interest on Operating Capital	57.11	102.63	141.79	162.06	212.38	274.06
Shrinkage						
Moisture Loss	579.39	1,158.78	1,738.17	2,169.09	3,190.32	4,253.76
Invisible Loss	82.77	165.54	248.31	309.87	455.76	607.68
TOTAL ANNUAL VARIABLE COSTS	1,538.85	2,922.72	4,192.22	5,023.24	7,015.00	9,215.65
TOTAL ANNUAL COSTS	4,123.56	7,611.17	10,190.99	11,915.13	15,828.17	20,407.77

TABLE XXXVII

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, 50 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	5,518	11,036	16,554	20,660	30,384	40,512
	Dollars ($)					
Fixed Costs						
Depreciation						
Building	438.35	876.60	1,314.95	1,557.45	2,162.15	2,882.80
Equipment	760.50	1,267.70	1,460.10	1,495.60	1,677.10	1,941.80
Insurance						
Grain Bins	87.67	175.32	262.99	311.49	432.43	576.56
Handling Equipment	152.10	253.54	292.02	299.12	335.42	388.36
Interest on Investment						
Storage System	1,064.18	1,963.59	2,658.50	2,996.83	3,900.91	5,009.81
Land	3.38	6.76	10.21	10.21	16.97	22.62
Property Taxes						
Storage System	78.28	144.44	195.55	220.44	286.94	368.51
Land	.25	.50	.75	.75	1.25	1.66
TOTAL ANNUAL FIXED COSTS	2,584.71	4,688.45	5,998.77	6,891.89	8,813.17	11,192.12
Variable Costs						
Insurance on Grain	176.58	353.15	529.73	661.12	972.29	1,296.38
Grain Handling						
Labor	56.89	113.78	170.67	213.00	313.26	417.68
Electricity	1.99	3.97	5.96	7.44	10.94	14.58
Aeration						
Labor	96.00	144.00	192.00	192.00	192.00	240.00
Electricity	16.20	32.40	48.60	48.60	48.60	64.80
Insect Control						
Labor	24.00	48.00	72.00	72.00	72.00	96.00
Chemicals	43.81	87.77	129.37	163.21	237.46	317.18
Maintenance and Repair						
Storage Bins	43.84	87.66	131.50	155.75	216.22	288.28
Equipment	263.13	428.97	491.55	502.20	556.65	630.54
Interest on Operating Capital	51.21	91.49	123.99	140.07	180.18	230.51
Shrinkage						
Moisture Loss	386.26	772.52	1,158.78	1,446.20	2,126.88	2,835.84
Invisible Loss	55.18	110.36	165.54	206.60	303.84	405.12
TOTAL ANNUAL VARIABLE COSTS	1,215.09	2,274.07	3,219.69	3,808.19	5,230.32	6,836.91

TABLE XXXVII

(CONTINUED)

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	5,518	11,036	16,554	20,660	30,384	40,512
	Dollars ($)					
TOTAL ANNUAL COST	3,799.80	6,962.52	9,218.46	10,700.08	14,043.49	18,029.03

TABLE XXXVIII

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	11,036	22,092	33,108	41,319	60,768	81,024
	Cents Per Bushel (c/bu.)					
TOTAL FIXED COSTS/ BUSHEL	23.421	21.242	18.119	16.68	14.503	13.813
Variable Costs						
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling						
Labor	.516	.516	.516	.516	.516	.516
Electricity	.052	.063	.063	.063	.063	.063
Aeration						
Labor	.870	.652	.580	.465	.316	.296
Electricity	.147	.147	.147	.118	.080	.080
Insect Control						
Labor	.217	.217	.217	.174	.118	.118
Chemicals	.772	.773	.773	.775	.766	.766
Maintenance and Repair						
Storage Bins	.397	.397	.397	.377	.356	.356
Equipment	2.384	1.944	1.485	1.215	.916	.778
Interest on Operating Capital	.583	.539	.499	.463	.422	.410
Shrinkage						
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	17.138	16.448	15.877	15.366	14.753	14.583
TOTAL COSTS/BUSHEL	40.559	37.690	33.996	32.046	29.256	28.396
OPPORTUNITY COSTS/BUSHEL	30.00	30.00	30.00	30.00	30.00	30.00
TOTAL COST OF STORING WHEAT FOR SIX MONTHS/BUSHEL	70.559	67.690	63.996	62.046	59.256	58.396

TABLE XXXIX

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 75 PERCENT UTILIZATION, OKLAHOMA 1980

Cost Item	Bushels of Storage Capacity					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	8,277	16,554	24,831	30,988	45,476	60,768
	Cents Per Bushel					
TOTAL FIXED COSTS/BUSHEL	31.228	28.322	24.158	22.240	19.337	18.418
Variable Costs						
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling						
Labor	.516	.516	.516	.516	.516	.516
Electricity	.052	.063	.063	.063	.056	.056
Aeration						
Labor	1.160	.870	.773	.620	.421	.395
Electricity	.196	.196	.196	.157	.107	.107
Insect Control						
Labor	.290	.290	.290	.232	.158	.158
Chemicals	.780	.780	.765	.777	.772	.772
Maintenance and Repair						
Storage Bins	.530	.530	.530	.503	.474	.474
Equipment	3.178	2.591	1.980	1.621	1.221	1.038
Interest on Operating Capital	.690	.620	.571	.523	.466	.451
Shrinkage						
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	18.592	17.656	16.884	16.212	15.391	15.167
TOTAL COSTS/BUSHEL	49.820	45.978	41.042	38.452	34.728	33.585

TABLE XXXX

ESTIMATED ANNUAL TOTAL COSTS PER BUSHEL OF OWNING AND OPERATING CATEGORY TWO ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 50 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage					
	10,000	20,000	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	5,518	11,036	16,554	20,660	30,384	40,512
	Cents Per Bushel					
TOTAL FIXED COSTS/BUSHEL	46.841	42.483	36.238	33.359	29.006	27.627
Variable Costs/						
Grain Insurance	3.20	3.20	3.20	3.20	3.20	3.20
Grain Handling						
Labor	1.031	1.031	1.031	1.031	1.031	1.031
Electricity	.036	.036	.036	.036	.036	.036
Aeration						
Labor	1.740	1.305	1.16	.929	.632	.592
Electricity	.294	.294	.294	.235	.160	.160
Insect Control						
Labor	.435	.435	.435	.348	.237	.237
Chemicals	.794	.795	.782	.790	.782	.783
Maintenance and Repair						
Storage Bin	.794	.794	.794	.754	.712	.712
Equipment	4.769	3.887	2.969	2.431	1.832	1.556
Interest on Operating Capital	.928	.829	.749	.678	.593	.569
Shrinkage						
Moisture Loss	7.00	7.00	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL VARIABLE COST/BUSHEL	22.021	20.606	19.450	18.432	17.215	16.876
TOTAL COST/BUSHEL	68.862	63.089	55.688	51.791	46.221	44.503

TABLE XXXXI

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	33,108	41,319	60,768	81,024
	Dollars ($) [Percentage Figures Bracketed]			
Fixed Costs				
Depreciation				
Building	2,336.80	2,640.10	3,276.80	3,997.45
Equipment	1,558.80	1,683.10	1,950.70	2,375.80
Percent of TFC	[42.09]	[42.01]	[41.96]	[42.11]
Insurance on Facility				
Grain Bins	262.99	311.49	432.43	576.56
Handling Equipment	720.50	769.68	836.00	921.02
Percent of TFC	[10.63]	[10.51]	[10.18]	[9.89]
Interest on Investment				
Storage System	4,051.06	4,526.15	5,527.80	6,740.96
Land	25.48	25.48	25.48	25.48
Percent of TFC	[44.04]	[44.23]	[44.58]	[44.71]
Property Taxes				
Storage System	297.98	332.93	406.61	495.84
Land	1.87	1.87	1.87	1.87
Percent of TFC	[3.24]	[3.25]	[3.28]	[3.29]
ANNUAL TOTAL FIXED COSTS	9,255.48	10,290.80	12,457.69	15,134.98
Variable Costs				
Insurance on Grain	1,059.46	1,322.21	1,944.58	2,592.17
Percent of TVC	[19.39]	[20.09]	[21.12]	[21.45]
Grain Handling				
Labor	113.09	141.13	207.57	276.75
Electricity	19.71	25.22	49.31	65.75
Percent of TVC	[2.43]	[2.53]	[2.79]	[2.83]
Aeration				
Labor	192.00	192.00	192.00	240.00
Electricity	48.60	48.60	48.60	64.80
Percent of TVC	[4.40]	[3.66]	[2.61]	[2.52]
Insect Control				
Labor	72.00	72.00	72.00	96.00
Chemicals	255.70	320.40	465.70	621.02
Percent of TVC	[6.00]	[5.96]	[5.84]	[5.93]

TABLE XXXXI

(CONTINUED)

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	33,108	41,319	60,768	81,024
Variable Costs (continued)	Dollars ($) [Percentage Figures Bracketed]			
Maintenance and Repair				
Storage Bins	131.50	155.75	216.22	288.28
Equipment	744.12	798.90	878.66	1,006.19
Percent of TVC	[16.03]	[14.51]	[11.89]	[10.71]
Interest on Operating Capital	178.33	298.18	273.22	350.55
Percent of TVC	[3.20]	[3.01]	[2.97]	[2.90]
Shrinkage				
Moisture Loss	2,317.56	2,892.33	4,253.76	5,671.68
Invisible Loss	331.08	413.19	607.68	810.24
Percent of TVC	[48.48]	[50.24]	[52.79]	[53.64]
TOTAL ANNUAL VARIABLE COSTS	5,463.15	6,579.91	9,209.30	12,083.43
TOTAL ANNUAL COSTS	14,718.63	16,870.71	21,666.99	27,218.41

TABLE XXXXII

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 75 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	24,831	30,989	45,576	60,768
	Dollar ($)			
Fixed Costs				
Depreciation				
Building	2,336.30	2,640.10	3,276.80	3,997.45
Equipment	1,558.80	1,683.10	1,950.70	2,375.80
Insurance on Facility				
Grain Bins	262.99	311.49	432.43	576.56
Handling Equipment	720.50	769.68	836.00	921.02
Interest on Investment				
Storage System	4,051.06	4,526.15	5,527.80	6,740.96
Land	25.48	25.48	25.48	25.48
Property Taxes				
Storage System	297.98	332.93	406.61	495.84
Land	1.87	1.87	1.87	1.87
TOTAL ANNUAL FIXED COSTS	9,255.48	10,290.80	12,457.69	15,134.98
Variable Costs				
Insurance on Grain	794.59	991.65	1,458.43	1,944.58
Grain Handling				
Labor	84.92	105.98	155.87	207.83
Electricity	14.90	18.90	36.92	49.22
Aeration				
Labor	192.00	192.00	192.00	240.00
Electricity	48.60	48.60	48.60	64.80
Insect Control				
Labor	72.00	72.00	72.00	96.00
Chemicals	189.94	240.68	351.76	469.11
Maintenance and Repair				
Storage Bins	131.50	155.75	216.22	288.28
Equipment	744.12	798.90	878.66	1,006.19
Interest on Operating Costs	157.43	180.36	231.07	294.72
Shrinkage				
Moisture Loss	1,738.17	2,169.23	3,190.32	4,253.76
Invisible Loss	248.31	309.89	455.76	607.68

TABLE XXXXII

(CONTINUED)

Cost Item	Bushels of Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	24,831	30,989	45,576	60,768
	Dollars ($)			
TOTAL ANNUAL VARIABLE COSTS	4,416.48	5,283.94	7.287.61	9,522.17
TOTAL ANNUAL COSTS	13,671.96	15,574.74	19,745.30	24,657.15

TABLE XXXXIII

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 50 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	16,554	20,660	30,384	40,512
	Dollars ($)			
Fixed Costs				
Depreciation				
Building	2,336.80	2,640.10	3,279.80	3,997.45
Equipment	1,558,80	1,683.10	1,950.70	2,375.80
Insurance on Facility				
Grain Bins	262.99	311.49	432.43	576.56
Handling Equipment	726.50	769.68	836.00	921.02
Interest on Investment				
Storage System	4,051.06	4,526.15	5,527.80	6,740.96
Land	25,48	25.48	25.48	25.48
Property Taxes				
Storage System	297.98	332.93	406.61	495.84
Land	1.87	1.87	1.87	1.87
TOTAL ANNUAL FIXED COSTS	9,255.48	10,290.80	12,457.69	15,134.98
Variable Costs				
Insurance on Grain	529.73	661.12	972.29	1,296.38
Grain Handling				
Labor	56.61	70.66	103.91	138.55
Electricity	9.93	12.60	24.61	32.81
Aeration				
Labor	192.00	192.00	192.00	240.00
Electricity	48.60	48.60	48.60	64.80
Insect Control				
Labor	72.00	72.00	72.00	96.00
Chemicals	129.37	163.21	237.46	317.18
Maintenance and Repair				
Storage Bins	131.50	155.75	216.22	288.28
Equipment	744.12	798.90	878.66	1,006.19
Interest on Operating Capital	131.50	152.06	189.90	239.43

TABLE XXXXIII

(CONTINUED)

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	16,554	20,630	30,384	40,512
Variable Costs (continued)	Dollars ($)			
Shrinkage				
Moisture Loss	1,158.78	1,446.20	2,126.88	2,835.84
Invisible Loss	165.54	206.60	303.84	405.12
TOTAL ANNUAL VARIABLE COSTS	3,369.68	3,979.70	5,366.37	6,960.58
TOTAL ANNUAL COSTS	12,625.16	14,270.50	17,824.06	22,095.56

TABLE XXXXIV

ESTIMATED ANNUAL TOTAL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 100 PERCENT UTILIZATION, OKLAHOMA 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 100 Percent Utilization	33,108	41.319	60,768	81,024
	Cents Per Bushel (c/bu.)			
TOTAL FIXED COSTS/BUSHEL	27.955	24.906	20.50	18.68
Variable Costs				
Grain Insurance	3.20	3.20	3.20	3.20
Grain Handling				
Labor	.342	.342	.342	.342
Electricity	.060	.061	.081	.081
Aeration				
Labor	.580	.465	.316	.296
Electricity	.147	.118	.080	.080
Insect Control				
Labor	.217	.174	.118	.118
Chemicals	.772	.775	.766	.766
Maintenance and Repair				
Storage Bins	.397	.377	.356	.356
Equipment	2.248	1.933	1.446	1.242
Interest on Operating Capital	.539	.480	.450	.433
Shrinkage				
Moisture Loss	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	16.501	15.925	15.155	14.913
TOTAL COSTS/BUSHEL	44.456	40.831	35.655	33.593
Opportunity Costs/Bushel	30.00	30.00	30.00	30.00
TOTAL COSTS OF STORING WHEAT FOR SIX MONTHS/BUSHEL	74.456	70.831	65.655	63.593

TABLE XXXXV

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 75 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 75 Percent Utilization	24,831	30,989	45,576	60,768
	Cents Per Bushel (¢/bu.)			
TOTAL FIXED COSTS/BUSHEL	37.274	33.208	27.334	24.906
Variable Costs				
Grain Insurance	3.20	3.20	3.20	3.20
Grain Handling				
Labor	.342	.342	.342	.342
Electricity	.060	.061	.081	.081
Aeration				
Labor	.773	.620	.421	.395
Electricity	.196	.157	.107	.107
Insect Control				
Labor	.290	.232	.158	.158
Chemicals	.765	.777	.772	.772
Maintenance and Repair				
Storage Bins	.530	.503	.474	.474
Equipment	2.997	2.578	1.928	1.656
Interest on Operating Capital	.634	.582	.507	.485
Shrinkage				
Moisture Loss	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	17.786	17.051	15.990	15.670
TOTAL COSTS/BUSHEL	55.060	50.259	43.324	40.576

TABLE XXXXVI

ESTIMATED ANNUAL TOTAL PER BUSHEL COSTS OF OWNING AND OPERATING CATEGORY THREE ON-FARM STORAGE SYSTEMS, SELECTED CAPACITY, 50 PERCENT UTILIZATION, OKLAHOMA, 1980

Cost Item	Bushels of Storage Capacity			
	30,000	40,000	60,000	80,000
Rated Non Compacted Storage Capacity, in bushels, 50 Percent Utilization	16,554	20,660	30,384	40,512
	Cents Per Bushel (¢/bu.)			
TOTAL FIXED COSTS/BUSHEL	55.911	49.810	41.001	37.359
Variable Costs				
Grain Insurance	3.20	3.20	3.20	3.20
Grain Handling				
Labor	.342	.342	.342	.342
Electricity	.060	.061	.081	.081
Aeration				
Labor	1.160	.929	.632	.592
Electricity	.294	.235	.160	.160
Insect Control				
Labor	.435	.348	.237	.237
Chemicals	.782	.790	.782	.783
Maintenance and Repair				
Storage Bins	.794	.754	.712	.712
Equipment	4.495	3.867	2.892	2.484
Interest on Operating Capitol	.794	.736	.625	.591
Shrinkage				
Moisture Loss	7.00	7.00	7.00	7.00
Invisible Loss	1.00	1.00	1.00	1.00
TOTAL VARIABLE COSTS/BUSHEL	20.356	19.263	17.662	17.182
TOTAL COSTS/BUSHEL	76.267	69.073	58.663	54.541

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