# AN ANALYSIS OF THE DECISION-MAKING PROCESS OF THE FARM FIRM AS RELATED TO THE CONSTRUCTION OF ON-THE-FARM GRAIN STORAGE FACILITIES

by

Layton S. Thompson

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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If the individual farmer stores grain it is because he thinks it profits him to do so. He may profit from storage because of price and income-equalization benefits, because storage enables him to make more efficient use of his productive resources, including family labor, and because storage on the farm may save his crop from deterioration at times when commercial storage space is not available.

The stated purpose of this dissertation was to develop a method of analysis which would be useful to the Montana farm enterpriser in the process of deciding how much, if any, grain storage space it would profit him to construct on his own farm. The theoretical model which constitutes the design for the undertaking is derived from the law of variable proportions. The optimum use of the variable factor (storage facilities) will be achieved if it is combined with a fixed quantity of other factors (typical farm layout) up to a point where marginal revenue productivity is just equal to the price of the factor. Revenue productivity of the variable input (storage space) is defined as annual net income from the farm with storage space as compared with (in excess of) net income from the farm with no storage space. The price of the variable input, termed annual "use cost" of the bins, is made up of interest, depreciation, insurance and property taxes on the bins.

Peculiar characteristics of Montana related to grain storage are (1) its dry, cool climate, (2) wide variations in crop yields, (3) very limited diversification of crops, (4) distance from the farm to elevators,

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(5) quality of wheat which results in premiums for protein, and (6) a harvest season which is at the "end of the line". Among recent trends and developments which affect the need for storage space are (1) the use of the combine for harvesting grains, (2) the increased burden of the federal net income tax, (3) price support loans of the Commodity Credit Corporation, (4) the stepped-up program of the Pure Food and Drug Administration to prevent contamination of wheat, and (5) the tendency of the Montana market to shift to the west coast.

A single enterprise spring wheat farm in Roosevelt County, Montana, was used to demonstrate the use of the method. A total of six budgets were constructed, using six levels of storage facilities, and holding other production factors constant. Storage benefits reflected in the budgets are gains from seasonal price movements, tax savings from equalizing annual incomes, and savings from reduction in cash outlay for handling wheat. Using 1951 levels of costs and prices received, it was concluded that it would profit the farmer in Roosevelt County to invest in farm storage facilities up to an amount equal to two average crops of wheat.

Results differ if different price level assumptions are used. Also, possible benefits from price speculation, conditioning of grain, maintenance of reserves, and better marketing of protein are not reflected in the budgets but are treated in the discussion.

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# CHAPTER I

# DELINEATION OF THE PROBLEM

## Storage Is Included in the Definition of Production

Storage of farm commodities is as old as civilization. There are records of various storage problems, storage devices and storage programs dating back many centuries. The Biblical story of Joseph and the seven good years and seven lean years is one of the most familiar.

There are reports of storehouses built by early settlers of this country and used to provide for protection against shortages during the long winters or to carry over supplies in case of a bad harvest. The problems of such a frontier society were certainly very real, but probably were less complex and more easy to understand than those of our times.

There are still fluctuations in the production of farm commodities, as well as fluctuations in the need for these commodities, but the alternatives for adjustment are numerous and varied due to modern technology. For example, with modern means of transportation, is it wiser to store reserves of a commodity on a particular farm or in a particular community, state, or nation, than to depend upon shipping commodities into a drought area from regions where the elements have been more kind? Is it better to preserve vegetable crops grown seasonally in Illinois, or to depend upon a supply of these from California or from South of the equator during the rest of the year? With modern methods of processing and preserving, commodities may be stored in raw form, in processed form ready for final consumption, or at some intermediate stage. The development of substitutes may make it less imperative that the supply of a given commodity be available.

The storage function, which is said by the textbooks to create time utility, fits into both the fields of production economics and marketing. Textbooks in marketing list storage as one of the marketing functions.[1] But elementary texts in principles of economics define creation of form utility, place utility, time utility, and ownership utility as production. Goods in storage often undergo a change in form, and storage affects the conditions under which change of ownership takes place.

If a reserve of a given commodity in some form and at some place is desirable, decisions are made concerning who is to perform this function, how much will be stored and for what period of time. Some of these decisions involve public policy. Group action with regard to reserves may include devices for stabilizing the flow of commodities to market. The "ever-normal-granary" program, patterned after a program developed in China many hundreds of years ago, is of this nature. So were the central storehouses of early United States history. Recently there has been much discussion of "strategic reserves" of storable commodities to be accumulated as a source of strength in case of war.

But most of the storage of farm commodities, both to provide adequate supplies from one harvest to the next and to offset fluctuations in crop

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[1]See, for example, Paul D. Converse and H. W. Huegy, The Elements of Marketing, Prentice-Hall Inc., New York, 1942, Chapter 4.

yields from year to year, is done by private firms--producers, processors, merchants, and consumers. The well developed kit of analytical tools used in the field of production economics is available for use in a study of storage including the concept of the importance of decisions of firms with respect to the allocation of resources.

## Storage and Decisions of the Farm Firm

Among the decisions which a Montana farm operator makes is whether or not he should invest in on-the-farm storage facilities for grains or forage. And if the decision is in the affirmative, then how much should he invest and what kinds of structures are best?

A series of "Rural Progress Meetings" was held in Montana in the winter and spring of 1952. These meetings were sponsored by the Montana Agricultural Extension Service. County meetings of farmers were first held in almost all of the counties in the state, and then seven district meetings were held which were attended by farmer representatives from the counties within each district. One of the important problems stressed in many of the counties, especially those where grain production is important, was the need for more grain storage facilities and improved grain storage facilities, and recommendations concerning storage were made at several of the district meetings.[2]

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[2]Montana Extension Service, What the People Said, Montana Extension Service Bulletin No. 274, 1952, pp. 27, 52, 63, 75, 84, 93, 107.

Many Montana farmers have built or are building on-the-farm storage structures[3] but there is no consensus among farmers or among those who seek to advise farmers as to whether or not investments in farm storage facilities can be economically justified.

It is the purpose of this treatise to develop a method of analysis which will be useful to the farm enterpriser in the process of deciding how much, if any, storage space it will profit him to construct on his own farm. The emphasis in the following chapters is on analytical rather than statistical procedure. The decision concerning whether or not to build storage structures is a long term decision involving expectations covering a considerable span of time. It involves a weighing of costs and benefits to be expected over the lifetime of the structures.

The general hypothesis to be tested is as follows: under certain conditions of costs, yield variability, prices of grain, farm organization, and availability of storage space off the farm, it will pay the farm operator to construct storage facilities on his farm up to a point which can be approximately determined by the method to be developed.

This treatise is limited to a consideration of the problem of the Montana farmer who produces wheat to sell. The method would apply to other cash grains, but a somewhat different approach would be required for a pattern of operations which includes farm feeding. Montana can

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[3] *Infra.*, Chapter IV, pp. 58-61.

be taken as representative of the cool, semi-arid, Northern Great Plains Region.[4]

Also, the model used is simplified by the assumption that the farm operator is the owner of the land and all other working capital. The landlord-tenant type of operation poses some problems of responsibility although basically the same costs and approximately the same benefits apply.

## Goals, or Motives, of Farm Storage

According to classical economics, profits were considered to be the compelling motive in private enterprise. In that phase of the study of economics to which the term "the economics of the firm" is applied, it is assumed that the enterpriser combines resources in such a way that he will maximize profits. And according to classical formulations, when each firm in a perfectly competitive economy attains the goal of maximum profits, then the most satisfactory allocation of resources has been achieved both from the standpoint of the individual firm and of society.

In more recent times the classical approach has been modified in such a way that man's chief business is now considered to be the maximization of satisfactions. This concept is broad enough to include as one of the goals of the enterpriser the quest for security. It is now recognized

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[4]This analysis was made as a part of a Montana Agricultural Experiment Station project entitled, "The Economics of Grain and Forage Storage in Montana". The title of the project is comprehensive enough to include an inquiry of broad scope. In order to reduce this analysis to manageable proportions it was necessary to set certain boundaries for the undertaking.

that the enterpriser is willing to buy some assurance that the firm will continue to exist at the expense of some monetary returns over the long run. In other words, the enterpriser attempts both to maximize money income and to minimize uncertainty.

Farm survival, then, is one of the ends, or goals. Schickele defines the farm survival end as follows: "To manage production, inventories, cash reserves and access to outside funds (through insurance and credit) so as to minimize the probability of a risk loss large enough to render the farmer insolvent."[5] Because of the great variability of crop yields in Montana and other Northern Great Plains states, the issue of survival of the firm is of considerable importance.

Inventory management involves storage. Inventory management may be for the purpose of better merchandizing in order to increase monetary returns, it may provide more efficient use of productive resources, but it may also be one of the means of minimizing the probability of risk loss large enough to render the farmer insolvent. Some farmers like to hold some part of their reserves in the form of wheat in the bin.[6] To these farmers, the feeling of security which they obtain from having reserves in the bin is one of the benefits to be gained from on-the-farm storage. Although it may not be possible to assess a dollars and cents value to this benefit, nevertheless it must be incorporated in this analysis.

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[5]Rainer Schickele, "Farmers Adaptation to Income Uncertainty", Journal of Farm Economics, Vol. XXXII, No. 3 (August 1950), p. 363.

[6]*Infra.*, Chapter IV, p. 56.

From the standpoint of society, a different set of goals might be listed. In a report entitled "Reserve Levels for Storable Farm Products", Wells, Fox, and Wilcox suggest the following three main purposes of storage from the social point of view: (1) To provide normal working stocks, (2) To offset variations in production, and (3) To stabilize prices and offset variations in demand, including provision for meeting war and defense emergencies.[7]

It is possible that in his quest for a combination of greater profits and greater security for the firm, the goals of the individual farmer may not be always consistent with these broader social goals. And even if there were no inconsistencies, it is also possible that some publicly sponsored program may be necessary, or at least desirable, to assist in the attainment of either private or social goals, or both. In this analysis related to the decisions of the farm firm, however, certain assumptions about government programs are made, or they are treated simply as independent variables. The relation of private and public goals is another (possibly fruitful) field for study.

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[7]Senate Document No. 130, Reserve Levels for Storable Farm Products, 82nd Congress, 2nd Session, U. S. Govt. Printing Office, 1952, p. 1.

## CHAPTER II

## STORAGE BY THE FARM FIRM AND ECONOMICS THEORY

### Preliminary Methodological Notes

This study adheres to the standard basic procedures which are considered to be good research techniques. The report is organized with the aim of taking the reader through the methodological steps in their logical order although, as any experienced researcher knows, the several steps are rarely taken independently, one of another. Although the hypothesis is a theoretical solution of the problem on which the researcher is working, and is to be used as a guide for selecting data, it often happens that when some factual information is obtained, the researcher is stimulated to go back and restate the problem and formulate a new hypothesis which in turn may require him to select new data. Nevertheless, the effective worker will have the various steps in mind as he proceeds.

The five steps are (1) selecting and formulating the problem, (2) formulating the hypothesis or hypotheses (theoretical solutions), (3) selecting and organizing data, (4) testing the hypothesis by means of the data, and (5) drawing useful inferences from the results.[1]

Chapter I of this report is devoted to step number one--formulating the problem. Also in Chapter I, a general hypothesis is stated as a part

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[1]For two excellent short discussions of these steps, see Earl O. Heady, "Implications of Particular Economics in Agricultural Economics Methodology", Journal of Farm Economics, Vol. XXXI, No. 4, Part 2, (November 1949), pp. 837-850, and John D. Black and Henry J. Vaux, "Research Methodology in the Economics of Forestry", Research in the Economics of Forestry, Charles Lathrop Pack Forestry Foundation, Washington, D.C., 1953, pp. 18-29.

of the process of choosing a phase of the study of the economics of grain and forage storage which is manageable. The central purpose of Chapter II is to construct a theoretical model which furnishes the design for the entire analytical procedure. Chapter III examines other work already done or in progress on the economics of storage in the Northern Great Plains Region in the light of our problem and hypothesis. Chapters IV, V, and VI treat the selecting and organization of data, Chapters VII and VIII present some budgets to test the hypothesis and Chapter IX is devoted to the problem of inference.

## The Theoretical Model

The chief purpose of theoretical models is to help the researcher understand what he is doing. They constitute analytical tools. A common criticism is that use of theoretical models must wait until the economist teams up with physical scientists to make available physical production functions. There is a possibility that some of these production functions may be corralled, including one for grain storage, and that ways may be found to make some practical uses of the results. However, the chief purpose of the model is not to serve as a formula such that if data are fed in, the answers will come out tied in neat bundles. Its chief purpose is to help the researcher to think.

The theory associated with the firm operating under conditions of perfect competition is the most appropriate for many of the problems of farm management. It is roughly appropriate for the problem to which this treatise is addressed, the decision of the farm owner-operator with regard to construction of storage facilities on the farm. Resources used for storage processes are relatively mobile. The number of farmers involved in storage activities is so large that an individual farmer affects neither the price of resources used for storage processes nor the price of the product. There is a homogeneous product, and entry into the field is not restricted.[2]

According to the theory of the firm operating under competitive conditions, it is the function of the firm (farm) to make the decisions which will allocate productive resources in a socially desirable manner. The laws of production have become synonymous with the principles of resources allocation. "The agricultural production economist has a set of universal principles explaining (providing the logic for) the most efficient use of resources (a) within farms, (b) between farms, (c) between agricultural regions, (d) between agriculture and other industries, and (e) over time."[3]

One concept which is a fundamental part of theory which applies to production economics is the law of variable proportions. It forms the basis for the theoretical model which is used in this study. The law is stated as follows: <u>In a given state of the arts, if the quantity of one productive service is increased by equal increments, the quantities</u>

[2]To the extent that the price of the storage service or the prices of resources used in the storage process are influenced by private monopoly or by government interference, the ability of the firm to allocate resources in a socially desirable manner is modified. The desirability of government premiums for storage services must be judged by some criteria other than market forces.

[3]Earl O. Heady, "Applications of Recent Economic Theory in Agricultural Production Economics", <u>Journal of Farm Economics</u>, Vol. XXXII, No. 4, Part 2 (November 1950), p. 1126.

of the other productive services remaining fixed, the resulting increments of product will decrease after a point.[4]

Some implications of this principle which are not always kept in mind when it is being discussed should be reviewed at this point. (1) The law is essentially technological, indicating only the relationships between inputs of physical things (e.g., man-hours) and the output of physical things (e.g., bushels of corn). (2) It is a static principle, allowing for changes in the proportions of productive services but not for any changes in methods of production, or "state of the arts". (3) The principle relates to what is commonly termed "short-run" adjustments of the firm. It permits changes in output technologically possible without altering the scale of the plant. Scale of plant can be used as synonymous with the size of the group of services (factors) which are fixed in amount. (4) To "increase the quantity of the variable service by equal increments" means in different experiments. A choice of factor combinations is implied, not a sequence. (5) The unit of productive service has two dimensions. It is the service of some physical or natural unit of resource

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[4]For good discussions of this principle and its implications, see Kenneth E. Boulding, Economic Analysis, Revised Edition, Harper and Brothers, New York, 1948, pp. 499-509; John M. Cassels, "On the Law of Variable Proportions", Readings in the Theory of Income Distribution, The Blakiston Company, Philadelphia, 1946, pp. 103-118; Frank H. Knight, Risk Uncertainty and Profit, Houghton Mifflin Company, Boston and New York, 1921, pp. 96-104; Fritz Machlup, "On the Meaning of the Marginal Product", Readings in the Theory of Income Distribution, The Blakiston Company, Philadelphia, 1946, pp. 158-174; George J. Stigler, The Theory of Price, First Edition, The Macmillan Company, New York, 1946, pp. 116-128; Jacob Viner, "Cost Curves and Supply Curves", Readings in Price Theory, Vol. VI, Edited by Stigler and Boulding, Richard D. Irwin, Inc., 1952, pp. 198-232.

through some unit of time (e.g., one acre of land for one year). (6) Marginal productivity of a productive service has sense only if the units of the service are homogeneous in respect to efficiency (e.g., diminishing returns are not due to hiring less efficient men). For certain purposes it is assumed that units of the productive service can be made as small as desired.

If productivity resulting from the use of the variable productive service is measured along the vertical axis of a graph and units of input of the variable is measured along the horizontal axis, the familiar total, average and marginal physical product curves can be plotted from physical productivity schedules.[5]

If the prices of the productive services and the price of the product are introduced, transition can be made from the physical productivity schedules and curves to two useful forms, described as follows: (1) With prices for productive services, the physical relationships can be transformed into the familiar four cost functions--average fixed cost, average variable cost, average total cost and marginal cost--each with respect to output. Economic solutions (optima) are then derived in terms of output by equating marginal cost of output with product price.

In portraying this form graphically, dollars per unit of output is measured on the vertical axis and units of output on the horizontal axis. In a perfectly competitive market, the sales curve of the firm is perfectly

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[5]See Kenneth Boulding, Economic Analysis, Revised Edition, Harper and Brothers, New York, 1948, figure 59, p. 505.

elastic. The marginal cost curve becomes the supply curve of the product for this particular firm.[6]

(2) With product price, the physical relationships can be transformed into the "value productivity" functions which express average and marginal revenue productivity each with respect to input. Economic solutions (optima) are then derived in terms of input by equating marginal revenue productivity of input with price of input.[7]

In portraying this form graphically, units of input are measured on the horizontal axis, but the vertical axis measures dollars per unit of input rather than physical output. In a perfect market the purchase (price) curve for each productive service is perfectly elastic. The marginal revenue productivity curve becomes the demand curve of the firm for the variable input. It will pay the firm to use units of the variable input up to the point where the value of the marginal product (addition to total revenue) is just equal to the purchase price of the service (addition to total cost).

Since the two approaches give identical results, the choice between them is based on the terms in which the answer is sought. For the problem

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[6]See George J. Stigler, The Theory of Price, First Edition, The Macmillan Company, New York, 1946, figure 40, p. 128.

[7]This form is treated by Boulding, op. cit., pp. 516-519, and by Stigler, Ibid., pp. 175-177. Table XII in this treatise, page 107, is patterned exactly after Boulding's table 43, page 517, and Stigler's table 14, page 177.

being studied in this treatise, the answer is sought in terms of input. Hence the second approach is used.[8]

Figure 1 portrays graphically the model that has just been described as the "second approach". This graph is based on the assumption that the

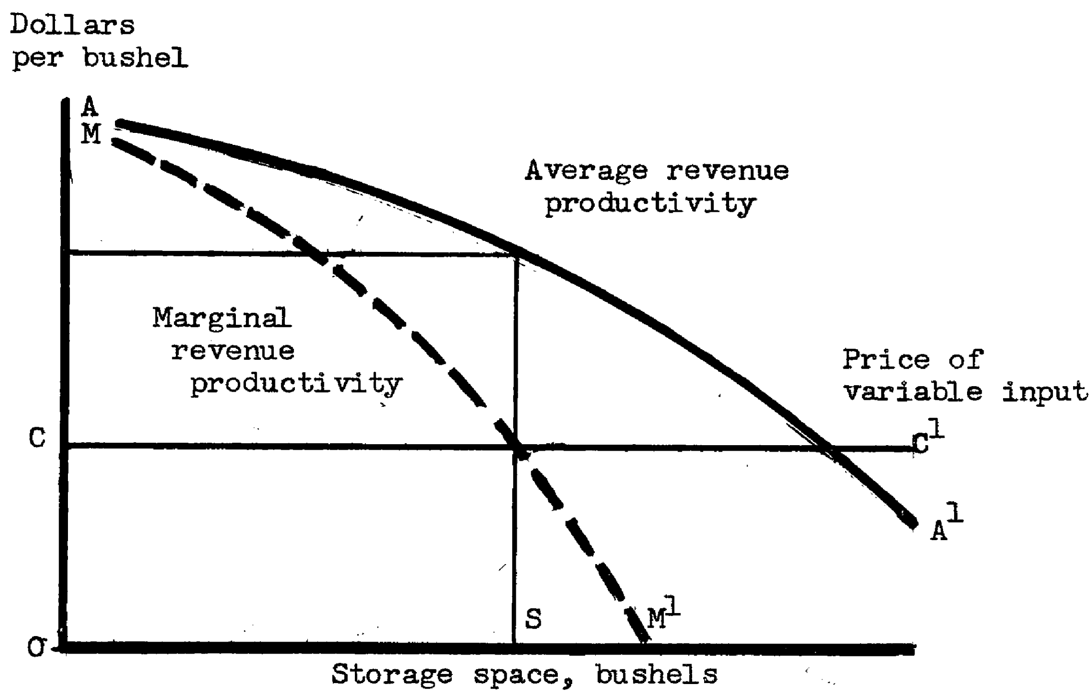


Figure 1. Most profitable use of a variable input (storage space) for a firm of a given size

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[8]Another reason for the use of the second approach is that for problems of resource use in the field of marketing, or "distribution", where the emphasis is on creation of time utility, place utility, and ownership utility, a basic difficulty is encountered in that "output" cannot be measured in terms of physical units of a product. The product of storage operations is not more bushels of wheat, but rather, wheat next January or in some other year as opposed to wheat at harvest time. The only practical measure of "output" is in terms of value added by the storage process. The principle of resource utilization, however, is no different than that for production of form utility. See Walter Wilcox and Willard Cochrane, Economics of American Agriculture, Prentice-Hall, Inc., New York, 1951, p. 266. Also Fritz Machlup, op. cit., p. 168.

variable service (storage capacity) can be added by one bushel increments and on the assumption that there is no relevant range of storage where average productivity is increasing. The marginal revenue productivity curve $MM^1$ is the farm firm's demand curve for storage space.[9] The perfectly elastic curve $CC^1$ represents the price of the variable input, storage space.[10] It will pay the firm to use storage service (invest in storage space) equal to OS, where the marginal revenue productivity of the service is equal to the price of the storage service.

It is this model which is used in the empirical phase of this study (See Chapter VII). The question posed in Chapter I was how much, if any, of the variable input (storage space) will it profit a farmer to apply on

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[9]This demand curve for inputs is the same as Boulding's curve in the range of application between the point where average revenue productivity is at a maximum and the point where marginal revenue productivity becomes zero. Op. cit., p. 519, Figure 65.

[10]This curve is what Boulding names the "purchase curve" for inputs (op. cit., p. 455). The counterpart of the "purchase curve" is the "sales curve" on the "form-cost-curve" graph. The "purchase curve" for the variable service is shown to be perfectly elastic in Figure 1 to conform to the assumptions of a perfectly competitive market and the addition of units of a homogeneous service. In order to avoid confusion this effect is achieved in Table XII, page 107 by adding 3,000 bushel increments of storage in the form of 3,000 bushel steel bins.

If increments of storage were added by increasing the size of bins or granaries (See Tables IV, V, VI, and VII, pp. 64 and 65) economies would result which would cause the "purchase curve", $CC^1$ to turn down and also would result in different curves for average price of the variable service and marginal price of the variable service. This further step is easily taken once the use of the simple model has been demonstrated.

a given farm. The given farm (fixed plant) is the typical wheat farm layout in the spring wheat area of North East Montana.[11]

Measuring cost of and benefits from adding units of storage space on a given farm is somewhat more difficult than measuring the cost and benefits from applying units of fertilizer to an acre of corn, although the principle involved is the same. The measure of the cost of storage space used involves a modification of Stigler's "productive service" concept.[12] A productive service may be yielded by a non-durable resource (heat from burning coal) or by a durable resource (shelter from buildings). The value of the durable resource is equal to the discounted value of its

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[11]The model developed here involves a "short-run" adjustment of the firm. A given size of farm is assumed, and therefore no change in scale of plant. Among the recommendations concerning further inquiry to be found in Chapter IX, (p. 133) is the suggestion that the relationship of storage benefits and size of farm should be explored.

Certain data on cost of storage facilities (pp. 64, 65,66) and on benefits from use of storage, (p. 90 and 91) presented in different sections of this treatise seem to support a hypothesis that, as far as the storage factor is concerned, there is a range within which increasing returns to scale might be expected although it might be found that economies resulting from the use of larger units of storage facilities would be offset by diseconomies elsewhere (e.g., higher income tax brackets). At any rate, data are not now available for an analysis of returns to scale.

The theory of returns to scale involves what is commonly termed "long-run" adjustment of the firm which gives the firm "time" to make complete adjustment of plant to output. It applies to the effect on the product of variations in quantities of all the productive services. Actually, the use of terms indicating an actual lapse of time is confusing. What is really involved is a choice between different sizes of plant. This is a static theory involving the assumption that there is to be no change in the "state of the arts". Treating the variation in scale as a range of choices rather than a series of changes through time avoids the problem that once an entrepreneur sinks funds into a fixed asset, then the cost of that asset has little or no bearing on future decisions.

[12]Op. cit., pp. 114-115.

future net incomes, but the value of a service need not be discounted since, by definition, it does not continue over a sufficiently long period of time to make the discount factor appreciable.

But, as Professor Stigler states, the services of durable goods can be hired and in this case could be treated the same as coal consumed in production. For arriving at the cost of the variable input, the method used in this treatise is to treat the annual cost of having storage space on the farm as equivalent to the cost of hiring such service. This cost is termed annual use cost of the storage structures by professional farm management firms. It consists of interest,[13] depreciation and repairs, insurance and property tax. The firm's "purchase curve" for this service is illustrated by the line $CC^1$ in Figure 1.

The annual benefit from having the storage facilities on the farm is simply the difference in annual net income from the farm, with different amounts of storage space available, and annual net income with no storage space available. This is income net of all costs excepting the "use cost" of the bins.

Actually, the planning period is the 30-year expected life of the storage bins. As a matter of fact, benefits from the use of the storage

[13] The average annual interest charge is taken as a percent of one-half of the original cost of the structure with the assumption of a straight line depreciation throughout the life of the structure. Although this method suffers from lack of refinement as compared with discounting future income, it does have the material advantage that farmers seem to have no difficulty of grasping the idea of annual use cost, whereas the idea of discounted present value is completely foreign to most farmers. Furthermore, data presently available are not of such refined nature as to justify emphasis on refinement of statistical procedure.

space, using different amounts of storage space, are calculated for the 30-year period in Chapter VII and then divided by the number of years to obtain the average annual benefit for comparison with annual use cost of the bins.

Equal increments of storage space in terms of 3,000-bushel steel bins are added in the budgets in Chapter VII, and marginal cost and marginal benefits with respect to input are presented in Table XII for the 3,000-bushel increments. However, the marginal cost per bushel and marginal benefit per bushel with respect to input are also shown to conform to common usage in literature related to grain storage.

## Dynamic Elements of the Problem

The major portion of research in production economics has assumed static theory and the absence of risk and uncertainty. And yet the very essence of farm management is the process of adaptation to change. It is when time is introduced into the analysis that the problem of risk and uncertainty and their relation to farmers' expectations, and in turn their effect on his decisions with regard to resource use, enter in.

There are three degrees of knowledge concerning the future. (1) Certainty is one hundred percent probability, sometimes termed "Single valued expectation". (2) Risk, refers to those situations where expectations are not single valued but have probability distributions which can be known with certainty. From the standpoint of the individual firm, certain risks can be converted to single valued expectations through insurance. (3) Uncertainty refers to those situations where expectations are not only not single valued, but either the probability is unknown or the probability distribution has a probability distribution.

What is the importance of risk and uncertainty from the standpoint of the decision of the Northern Great Plains farm firm regarding construction of on-the-farm storage? In the first place, the decision to build a granary is a long term decision involving expectations covering a considerable span of time. The greater the span of time the greater the uncertainty with regard to expectations. Involved here is the concept of capital rationing; i.e., the conflict between maximization of income and maximization of security.[14]

In the second place, the Northern Great Plains is characterized by extreme variability in precipitation, the result of which is uncertainty. Although the variation in inches is not greater than in some other more humid areas, the fact that the average precipitation over the area is so near the critical margin for successful crop production makes the variation extremely significant. Added to variability of precipitation but related to it, are other such natural hazards as grasshopper invasions, hail, and occasional blizzards. Storage of durable commodities on the farm is one device used by some farmers as a means of adjusting to the

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[14]For discussions on the balancing of maximization of "lucrativity" and "safety", see K. E. Boulding, "The Theory of the Firm", The American Economic Review, Vol. XXXII, No. 4, (December 1942), pp. 791-802. Also, M. Kalecki, "The Principle of Increasing Risk", Economica, 1937, pp. 440-447. Also, H. Makower and J. Marshak, "Assets, Prices, and Monetary Theory", Economica, 1938, pp. 261-288.

problems of risk and uncertainty. Flexibility in inventory management is suggested by both Schickele[15] and Heady[16] as a means of adaptation to uncertainty.[17]

The importance of expectations to decisions concerning investments in storage structures, and the role of flexibility in inventory management as a means of adjustment to risk and uncertainty, must not be left out of this analysis. It is true that not much is known yet about the determinants of expectations. In developing a method of analysis some crude probability distributions concerning such items as normal seasonal price variations and yields variations are used. For other variables certain assumptions are made. (Others may insert assumptions according to their own expectations.) And finally, areas are indicated which are simply not receiving treatment in this treatise and which would be profitable areas for further investigation.

In an area such as North East Montana, the opportunities for flexibility in farm operations are limited because there are few alternatives to the growing of wheat. The development of livestock feeding as an alternative might be a possibility. This might call for storage facilities in order to assure a dependable supply of feed and might also make

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[15]Rainer Schickele, "Farmers Adaptation to Income Uncertainty", Journal of Farm Economics, Vol. XXXII, No. 3, (August 1950), p. 358.

[16]Earl O. Heady, "Flexible Farming", Iowa Farm Science, July, 1948.

[17]When questioned by the author, several Montana Farmers gave holding reserves of grain on the farm as a means of preventing bankruptcy when "times are bad" as a reason for having storage facilities on the farm. (See Chapter IV, p. 56)

construction of the multiple purpose type of building which could serve as a granary, as livestock shelter, or as a machine shed, desirable. Although this particular analysis is limited to a cash grain operation, some of the above mentioned considerations suggest areas for further study.

Relation of Public Policy to Decisions of the Farm Firm

As was indicated in Chapter I, this analysis is concerned with the decisions made by the farm firm concerning construction of on-the-farm grain storage facilities. It is not implied that the social aspects of farm storage should be ignored. There is at least the implication that farmers operate under conditions of near-perfect competition, and therefore decisions will be made which will allocate productive resources in a socially desirable manner, subject to reservations expressed in footnote Number 2 of this chapter.

Public policy must certainly enter into the analysis, however, in the sense that expectations concerning public policy constitute part of the data with which the farmer must work in making his decisions. For example, whether or not the farm enterprise expects the Commodity Credit Corporation loan to be sometimes higher than the market price of wheat at harvest time may be a most important consideration. Tax assessment policies as related both to the building and to grain stored in it make a difference in costs of storage. One reason some farmers store grain is to equalize annual cash receipts and therefore stay in lower income brackets. Many farmers were encouraged to build granaries by a recent program of the Commodity Credit Corporation which made loans at a low rate of interest to finance construction of storage facilities.

Finally, inferences based on particular analysis may prove erroneous if macro-relationships are disregarded. For example, an inference from our analysis may be that more farm storage is desirable. But what if all farmers decide to store? Then the best advice to a particular firm might be to plan to sell immediately at harvest time.

## Empirical Counterpart of the Theoretical Model

As was stated on Page 16, the law of variable proportions forms the basis for the theoretical model which is used for this analysis. It is not practical to use the experimental method as a means of determining the production function of storage services. Therefore, the synthetic method is used. The synthetic method, variously called "budgetary" method, or the "method of substitution", involves the use of budgets designed to reflect the results of operating various types of combinations of the agents of production.

The use of the synthetic method is demonstrated in Chapter VII. The intervening chapters will be devoted to developing the assumptions and the data which will be reflected in the budgets.

## CHAPTER III

# REVIEW OF RESEARCH ON THE ECONOMICS OF GRAIN STORAGE IN THE PLAINS AREA

### Materials on Storage in General

In this chapter, discussion will be limited chiefly to research which has a direct bearing on farmer decisions concerning whether or not to build grain storage structures in the Northern Great Plains Area.

An immense amount of writing has been done on storage of farm commodities. At the present time a bibliography is being compiled by the Department of Agricultural Economics at Kansas State College of books, bulletins and magazine and journal articles related to grain storage. It is estimated that this bibliography will require more than 200 typewritten pages. Reference on storage of specific farm commodities other than grains are being omitted unless they have some bearing on grain storage.[1]

When the study of the economics of grain and forage storage was begun at Montana State College in 1951, a 10-page bibliography was compiled of references to the problems of storage of grain and forage and of references to theory related to these problems. This bibliography includes a section of references on production variability in the Northern Great Plains region, and on theory related to risk and uncertainty.

A large portion of the work which has been done on storage has emphasized a public policy approach to the problems of storage. For

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[1]This information was obtained during an interview with Professors Leonard Schruben and John H. McCoy at Manhattan, Kansas, April 10, 1953.

example, Graham (1937) gives a descriptive survey of state conservation of surplus. He lists three especially important examples of state conservation. "These are, first, the famous biblical narrative of Joseph and the famine in Egypt; secondly, the comprehensive policy of storage practiced by the Peruvian Incas prior to the Spanish conquest; and lastly, the ever-normal granary system maintained in China for twenty centuries".[2] Graham proceeds to outline a proposal for impounding reserves of storable commodities by the state as a part of a plan to stabilize the value of money.

During the past twenty years, much of the discussion by economists of storage has been from the point of view of national agricultural policy. The major emphasis has been on theoretical analysis of national storage policies and programs from the standpoint of objectives, effects, means of implementation, and relationship to other policies and programs. Prominent among economists who have made contributions in this area are Geoffrey Shepherd[3] and D. Gale Johnson.[4] An empirical approach to the question of National policy regarding reserve stock is exemplified by

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[2]Benjamin Graham, Storage and Stability, McGraw Hill, New York, 1937, p. 28.

[3]Geoffrey Shepherd, Agricultural Price and Income Policy, The Iowa State College Press, Ames, Iowa, 1952 (3rd Ed. Revised from Agricultural Price Policy). See also, Geoffrey Shepherd, "The Objectives, Effects and Costs of Feed Grain Storage", Journal of Farm Economics, Vol. XXXI, No. 4, Part 2, (November 1940), pp. 998-1007.

[4]D. Gale Johnson, Foreward Prices for Agriculture, The University of Chicago Press, Chicago 37, 1947, Chap. X.

a study recently made at the request of the U. S. Senate Committee on Agriculture and Forestry.[5]

Early Studies in the Great Plains Area

The only work done on the economics of storage prior to 1951 by the Montana Agricultural Experiment Station was a study made by Bell, 1924-26.[6] In this study, storage is considered only as related to the problem of marketing high protein wheat. After pointing out the difficulty elevator operators have in paying protein premiums to farmers during the harvest rush when wheat of different grades could not be binned separately, Bell states, "For the foregoing reasons, farmers with wheat of high protein content are finding it profitable to provide at least temporary storage space on the farm in years when such wheat is scarce."[7] Among other conclusions, Bell saw no point in elevator storage as far as protein is concerned. Storage tickets required elevators to deliver wheat of a given grade, with no mention of protein content. "There is little reason to believe that a farmer can make more money by holding wheat on storage tickets at the elevator than he could by purchases on the future market."[8]

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[5]Senate Document No. 130, Reserve Levels for Storable Farm Products, 82nd Congress, 2nd Session, U. S. Govt. Printing Office, Washington, D.C., 1952.

[6]E. J. Bell, Marketing High Protein Wheat, Montana Agricultural Experiment Station, Bozeman, Bulletin No. 213, May, 1928.

[7]Ibid., p. 24.

[8]Ibid., p. 32.

A study was made in Kansas by Green (1925) of seasonal fluctuations of wheat prices. This study indicated periods of price weakness in June, July and August, in November, and in February and March. Periods of strength were found to be in September, in January, and in April.[9] In another study, Green (1927) investigated the effect of shortage of storage and shortage of credit in "forcing" the Kansas wheat crop on the market. He concluded that for a period of over 30 years prior to 1927, "rushing" wheat to market right after harvest affected the price to the extent of 4 cents to 5 cents per bushel. (This was before the extensive use of combines in Kansas). Not more than 3 to 4 percent of Kansas wheat crops on the average was forced to market because of shortages of farm storage space, and not more than 10 to 12 percent because of shortages of local credit.[10]

In South Dakota, Peterson (1940) found that at a price of $1.50 per bushel, the spread between the November low and the May high for seasonal wheat prices would normally be about 18 cents. He concluded that most farmers would probably find the cost of storage and handling for the six

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[9] R. M. Green, Seasonal Fluctuations of Wheat Prices, Kansas Agricultural Experiment Station, Manhattan, Circular No. 121, December, 1925, p. 10.

[10] R. M. Green, The Effects of Shortage of Farm Storage Space and Inability to Get Local Credit on the Movement of Kansas Wheat to the Market, Kansas Agricultural Experiment Station, Manhattan, Bulletin 241, November, 1927.

months as large as the differential in seasonal price if storage involved building of additional storage capacity.[11]

Storage Related to Risk and Uncertainty

Several agricultural economists have been devoting much of their time to the problems of risk and uncertainty as they apply to Northern Great Plains Agriculture. In the course of their research and analysis they have considered the device of holding physical reserves of grain on the farm as one means of farmer adaptation to income uncertainty.

As one means by which the Northern Great Plains farmer can fortify himself against the probability of a risk loss large enough to render him insolvent, Schickele (1950) suggested flexibility in production, inventory, and reserve management.[12] According to Schickele, flexibility in production organization is severely limited in the Great Plains, but flexibility in inventory management is relatively high since grain can be stored easily and the dry cool air keeps quality losses rather low as compared with warm, humid areas. However, there is a tendency for good years and poor years to come in bunches.

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[11]Weber Peterson, Wheat and Flax Prices Received by Farmers in North Central and North Eastern South Dakota, South Dakota Agricultural Experiment Station, Brookings, Circular No. 37, 1942.

[12]Rainer Schickele, "Farmers Adaptation to Income Uncertainty," Journal of Farm Economics, Vol. XXXII, No. 3 (August 1950), pp. 356-374. See also, Rainer S. Schickele, "Farm Business Survival Under Extreme Weather Risks", Journal of Farm Economics, Vol. XXXI, No. 4, Part 2, (November 1949), pp. 931-943.

> Because of the great uncertainty regarding the length of the good and poor periods, the width of the gap between poor crop output and critical survival limit, the movement of future prices, and the technical limitations of farm storage, I suggest that emergency grain and forage reserves on individual farms can hardly be expected to do more than compensate for a partial crop failure of one year. To carry larger reserves would in most cases prove economically unjustified. Within this limit, however, the returns from such individually accumulated reserves, especially of feed grains and forage, might be very substantive.[13]

Alternative devices considered by Schickele are (1) a centralized grain storage program, (2) crop insurance, (3) cash reserves, (4) drought credit, (5) flexible debt and tax payments, (6) diversification of enterprises, (7) price supports, and (8) increasing the farm size. This last device appears to be related to the problem of storage in an important way, since other workers have found a relation between size of farm and amount of farm storage.

Barber (1950) made a study of methods of meeting risks in Kansas wheat farming.[14] By use of budgets he demonstrated the effectiveness of various devices for leveling out yearly fluctuations in farm income in order that the farmer might avoid financial difficulties or even disaster. The devices studied were accumulation of financial reserves, holding of commodity reserves on the farm, crop insurance, and modification of the federal income tax.

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[13] Ibid., Second Article, pp. 940-41.

[14] L. E. Barber, Meeting Weather Risks in Kansas Wheat Farming, Kansas Agricultural Experiment Station, Manhattan, Agricultural Economics Report No. 4, Contribution No. 160, 1950.

Barber concludes that storage operations of the type he postulates are effective in smoothing out short periods of low income, but would fail to maintain income over a long period of low yields such as that from 1933 to 1944, and that storage of grain on the farm is a relatively expensive method of attaining stability. Because of storage costs, average annual net income for his model was reduced by $70. after allowing for savings in Income Tax.[15] He concludes, also, that as a financial asset, grain is less liquid than cash in the bank, or bonds, as its value may be depreciated both by falling prices and physical deterioration.[16]

In addition to the Kansas study, Barber also studied the variability of wheat yields in the U.S. and portrayed this variation for each wheat-growing county in the United States by use of the coefficient of variation. If a county has a coefficient of variation of 60, this means that two-thirds of the yields would be expected to fall within a range of 40 percent and 160 percent of the average yield, and the other third would fall outside these limits. The average wheat yield in the

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[15] Ibid., pp. 16-17.

[16] Average net income after tax for Barber's model was just over $2,000. The savings on income tax would have been larger had he been working with a large wheat farmer whose net income reaches up into higher income brackets. It should also be stated that one of the reasons farmers sometimes give for holding reserves in the form of grain is that it is less liquid and not so apt to be spent. Further, the value of wheat appreciates with a rising price level and cash depreciates. If the farmer wishes to hedge against changes in the general price level he might be advised to hold some reserves in the form of cash and some in the form of wheat.

spring wheat area of North East Montana is approximately 10 bushels per acre and the coefficient of variation is 62. Therefore, in one-third of the years, the yield of wheat can be expected to be less than 3.8 bushels or more than 16.2 bushels per acre. Contrast this with an average yield of 23 bushels per acre for Saginaw County, Michigan, and a coefficient of variations of 22.[17] The significance of yield variability as related to grain storage will be discussed in a later chapter of this treatise.

Thair (1950) used empirical models for a typical central North Dakota wheat farm to compare the effects of various income stabilization measures. The measures studied were crop insurance, emergency credit, and maintenance of reserves. Partly because the average net income for Thair's model is greater than that of Barber's, and partly because the variability of yields, and hence of net income, is greater, income tax savings almost exactly offset the cost of storage, and the average net income after taxes remains approximately the same with a storage program as it would be without a program.[18] Thair also mentions the possibility of deterioration of quality of grain and of loss due to a fall in price

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[17] L. E. Barber, Variability of Wheat Yields By Counties in the United States, U.S. Dept. of Agriculture, Washington, D.C., Bureau of Agricultural Economics Mimeo, pp. 32-33 and 40-41.

[18] P. J. Thair, Stabilizing Farm Income Against Crop Yield Fluctuations, North Dakota Agricultural Experiment Station, Fargo, Bulletin No. 362, 1950, p. 5.

in addition to the cost of storage as offsets to the benefits of stabilization and savings on income tax.[19]

## The Kansas Studies

Pryor (1951) made a study in Kansas of the factors influencing the location of wheat stored by farmers.[20] He interviewed 114 farmers in Thomas County and Ford County during the summer of 1950. Of those interviewed, 74 percent preferred to store on the farm, and 26 percent preferred elevator storage. Most of Pryor's report consists of an evaluation of the reasons given by the farmers for their preference.

Of the farmers interviewed, forty-nine, or 43 percent, preferred farm storage because of full elevators, crowded elevator conditions, or convenience of farm storage. One-third of the farmers specifically mentioned crowded unloading conditions or full elevators as a reason for preferring farm storage. Pryor attributes crowded conditions at local elevators to use of combines for harvesting, freight car shortages, and elevator storage of grain owned by the Commodity Credit Corporation. He concludes that if relief does not come from these causes, increased use of farm storage would be desirable, although not free from criticism.

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[19] Ibid., pp. 24-26. For a further discussion on methods of meeting weather uncertainty, see L. E. Barber, and P. J. Thair, "Institutional Methods of Meeting Weather Uncertainty in the Great Plains", Journal of Farm Economics, Vol. XXXII, No. 3 (August 1950), pp. 391-410.

[20] H. A. Pryor, A Study of the Factors Influencing the Location of Wheat Stored By Farmers, Unpublished M.S. thesis, Kansas State College, Manhattan, 1951.

Almost 24 percent of the farmers interviewed felt that farm storage is cheaper. Pryor seems to have been impressed by the high costs for on-the-farm storage as reported in the Oklahoma and North Dakota studies,[21] but he admits that some farmers with low fixed storage costs and efficient methods can store for a cost less than the average. As factors influencing this difference he mentions structures built when materials were very cheap, and multiple-use structures.

Slightly over 18 percent of the farmers interviewed felt that seasonal price variations make farm storage profitable. Pryor gives evidence that there is little to gain above cost of storage from a consistent policy of holding wheat to gain through price increases, and concludes that if there are profits to be had from this practice, they could be obtained as well from storing at the elevator. Therefore, unless other factors make farm storage desirable, elevator storage would serve as well.

A few farmers said they store on the farm to "level the income tax." Pryor concludes that with a "good" farm budget there may be individual cases where there are definite tax savings to be had from storage to level incomes, but unless there are other factors which make farm storage desirable, these savings could be made through commercial storage.

Some farmers said they store on the farm as a reserve bank account. They argue that if they sell the wheat and place the money in the bank, they will not save as much money. Pryor feels that a "good" budget and system of farm accounting might be more practical. He mentions the cost

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[21] *Infra.*, pp. 44-49.

of storage, the offsetting effects on income tax, and the effects of changing general price levels on the value of the wheat.

All the farmers interviewed stored seed until planting time unless they had plans to change varieties. However, the farmer may also keep a seed reserve in order that he will be assured of a supply of good seed in case of crop failure and will not face a situation involving extremely high prices. Seed storage is important. About 8.3 percent of the average annual wheat production in Kansas from 1926-1950 was utilized for seed on the farm where it was grown.

Some farmers said they store on the farm to take advantage of a loan price above market price. Pryor states that the same advantages could be obtained from elevator storage.

Some farmers said wet wheat was not taken at the elevator, or they wished to avoid high dockage for low quality wheat. This can be a bad problem during wet harvest seasons. Usually, wheat which is too wet to be accepted by the local elevator is not in condition to be stored on the farm unless the farmer provides extra care and treatment. Farm dryers may be a possible answer to the wet wheat problem. Elevators may also dock heavily on wheat containing rye or various other matter during the rush season. The farmer may hold this wheat back and clean it or haul it to the elevator when they have time and space to give it proper treatment.

Of the other reasons given, only two were significant from the standpoint of this treatise. One was that storage of wheat on the farm helps pay for buildings for other purposes, and the other was that certified seed requires separate storage. Of the dual-purpose buildings, Pryor warns that the return from such a building is apt to be smaller than the farmer considers it to be.

Only a few of the reasons given by farmers for preferring elevator storage will be reviewed here. The first was that the farmer gets the benefit of shrinkage. Pryor concludes from tests made from bins of farmers interviewed that farmers tend to overestimate the amount of shrinkage. Furthermore, elevators shift shrinkage to the farmer in the form of lower grades and price discounts or in increased storage costs.

Elevator storage reduces loss from fire, winds, theft, weevil and rodents. This is an important consideration because farmers are usually not as well equipped to move, clean, and mix wheat, nor do farmers give such specialized attention to care of grain as do elevators. However, this problem can be exaggerated. Many farmers are doing a good job of storing wheat on the farm.

Some farmers said elevator storage is more convenient. When the elevator is not too busy and can handle the wheat on arrival, and when the distance is not so great as to tie up harvest help in long hauls, this is a telling argument for some farmers. Elevator tickets provide an easy way to divide a share crop.

Nineteen farm bins were tested three times by Pryor--once in August, once in October, and once in December. There were eight changes in grade observed. There were seven changes to a higher grade (42% of the 19 bins) and one change to a lower grade by grading weevily.

Pryor concludes that farm storage will probably continue to be an important part of the wheat storage system, to store wheat used on the farm for seed, feed, and other home uses, and to provide temporary storage for large quantities of wheat during years when production is above average.

The weakness of Pryor's analysis is that he does not consider the farmer's problem as a whole. He takes one reason at a time and concludes for several of them individually that unless other factors make farm storage desirable, elevator storage will serve as well. He admits that unless relief comes for crowded conditions at local elevators, increased use of farm storage would be desirable, especially for large quantities of wheat during years when production is above average. The farmer, when he considers his whole situation, will use money which he might pay to the elevator in storage fees when elevator space is available, to pay for on-the-farm facilities which he needs when elevator storage is not available.

A second recent study of grain storage was made in Kansas by Ostland (1951).[22] The report of this study consists of two main parts. (1) The development of a theoretical model which presents in a series of implicit equations the variable factors which act to determine the supply of wheat to be stored at three storage locations--terminal, country elevator, and farm--and to establish storage relationship to the total supply of wheat,

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[22]Karl H. Ostland, The Economics of Grain Storage, Unpublished M.S. thesis, Kansas State College, Manhattan, 1951.

and (2) a consideration of what he terms "the general services performed by storage facilities."

According to Ostland's model, the amount of storage capacity needed for wheat is equal to the normal crop plus the normal annual carry-over. The storage capacity needed for wheat at the terminals is equal to the normal off-the-farm carry-over of wheat plus the normal harvest movement of wheat to the terminals (taken in his example to be the July and August movement). The needed country elevator storage capacity is the normal crop less wheat needed on farms, times "R" (the ratio of the elevator capacity to annual volume of wheat handled). Farm storage capacity needed is equal to the normal crop plus normal farm carry-over less elevator capacity and less normal harvest movement of wheat to terminals.

Since terminal space needs are limited to the off-the-farm carry-over plus whatever the transportation systems can move to the terminals during the harvest rush, the rest of the crop will have to be stored either in country elevators or on farms. Elevator space will be determined by the most effective ratio of total capacity to total annual volume of wheat handled. If R is one to five, this means that elevators will handle a volume of grain equal to five times their capacity.

The storage space on the farm must be sufficient to meet the average farm needs and the farm carry-over. The farmer will also need to provide for that portion of the average wheat crop which cannot be moved from the farm during the harvest season.

At none of the locations should permanent storage be provided for more than the normal crop plus the normal carry-over because of the high overhead of excess storage capacity. The farmer will take care of that part of the normal crop which he himself does not need and which the elevators and terminals cannot handle in dual-purpose farm structures which are temporarily used for wheat.

At a later point, Ostland makes the following statement:

> Farm storage for wheat must be adequate to provide space for the farm needs, and all wheat which cannot move into commercial channels at harvest time. The farmer should have permanent space for this portion of the normal crop, and should also be in a position to provide storage for wheat in excess of the normal amount.[23]

The eight general services performed by storage facilities as listed by Ostland are as follows:[24]

1. The quality should be maintained.
2. Storage facilities should be convenient to transportation.
3. Storage should be convenient for inspection and supervision.
4. Storage facilities should be available to a market center.
5. Storage facilities should serve the individual interests of producer, processor, middleman and consumer.
6. Storage must be located at points of capital accumulation.
7. Storage of wheat stabilizes supply and demand.
8. Storage is necessary to implement government programs.

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[23]*Ibid.*, pp. 106-107. It is doubtful if the distinction made by Ostland and also by Hall and his associates (See p. 45) is as useful as they appear to believe it is. Although no quarrel is found with the dual-purpose concept, as a general rule, if storage space is needed, it should be well built.

[24]*Ibid.*, pp. 30-41.

Farm storage has its greatest advantage in serving the best interests of producers, processors, consumers, and middlemen. The principal service to producers is providing the farmer with space to store a reserve for seed, feed, home use, and emergency carry-over. This amount of space is the minimum necessary for farm storage.

The second service to producers is an outgrowth of the modern, mechanized harvest. The speed of wheat harvest releases a flood of grain in a few days' time and it is impractical to expect the wheat marketing systems to absorb the flow immediately. Therefore, some wheat needs to be held in farm storage until the rush has subsided. The dollar advantage of storage on the farm is often difficult to show, but when the choice is between storing on the farm or doing without storage, then the advantages of farm storage become evident.

The gain to merchants and processors is also evident. Due to transportation limitations and the limited capacity of handling equipment at terminals, the wheat cannot move immediately from the farm to the terminal. Therefore, farm storage is very useful in providing stability in the marketing system. This is useful to the merchants and processors because it enables them to stabilize their business operations on a year-round basis.[25]

## The Oklahoma and North Dakota Studies

Workers in the Cooperative Research and Service Division of the Farm Credit Administration in cooperation with state experiment stations have made two studies in the Great Plains Area in recent years, one in Oklahoma and one in North Dakota.[26]

No emphasis is made in these studies on the reasons why farmers store grain. The chief emphasis is on a comparison of costs of storing

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[25] Ibid., pp. 70-71.

[26] Thomas E. Hall, A. L. Larson, H. S. Whitney, and C. H. Meyer, Where and How Much Cash Grain Storage For Oklahoma Farmers, U.S. Dept. of Agriculture, Washington, D.C., Farm Credit Administration Bulletin No. 58, 1950, and Thomas E. Hall, P. V. Hemphill, C. H. Meyer, and W. K. Davis, Where and How Much Cash Grain Storage For North Dakota Farmers, U.S. Dept. of Agriculture, Washington, D.C., Farm Credit Administration Bulletin No. 61, 1951.

in farm storage facilities with costs of storing in elevators. The procedure in the two studies is almost exactly the same.

Because of the dryer and cooler climate, conditions were found to be more favorable for farm storage in North Dakota than in Oklahoma, but for both states the interesting conclusion was reached that farmers could not afford to store in their own bins, even if someone gave them the bins!

A distinction is made throughout both reports between "regular" storage facilities and "temporary" or "emergency" storage facilities. For "temporary" or "emergency" uses the authors of these reports recommend "dual-purpose" farm buildings which have other farm uses when not in use for storage.

In both studies it was found that the farmers who used farm storage most were the larger farm operators and those who used farm storage least were, as a rule, smaller operators, several of them living in town and operating farms as a part-time enterprise.

In North Dakota, 66 percent of the 1948 crop was stored in farm facilities, 12 percent was stored in elevators, and 22 percent was sold at harvest time. Principal reasons given by the farmers for storing on the farm were (a) elevators could not take grain for storage, (b) to save out-of-pocket storage expenses, (c) could not afford to wait in line at the elevator.

In Oklahoma, presumably due in part to less favorable storage conditions, only 27 percent of the 1947 crop was stored on the farm, 35 percent was stored in elevators, and 38 percent was sold at harvest time.

Those who stored on the farm gave essentially the same reasons as the North Dakota farmers gave.

In each report the recommendation is made that neither farmers nor commercial firms should build more "regular" storage capacity than is needed for average crops. Elevators may build some "emergency" capacity, but presumably it is chiefly the farmer's responsibility to care for the grain during the rush harvest season and also to store that part of any crop which is in excess of the average crop.

> In emergency situations when elevator storage is not available it may pay the farmer to buy a new steel bin even though he only expected to use it one year. In fact, such instances have often occurred in recent years.[27]

Although the selection of the samples and the collection of the data for this study seem to have been well done, one gets the impression that the analysis of the costs of farm storage was not carefully done. The reader of the reports is invited to put in his own estimate in a blank column left for this purpose in Table VI in each publication. Table I gives the costs of farm storage as estimated by the writer of this treatise as compared with the costs as found by Hall and his associates. Because the same method of estimating cost of farm storage is used for both studies, the writer's estimate is supplied only for the North Dakota costs, with reasons for differences. The same three 1,000 bushel steel bins plus mechanical loader used by Hall, Hemphill, Meyer and Davis are used.

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[27]Ibid., (North Dakota report), p. 26.

The fixed expenses of depreciation, insurance and taxes are accepted without change. (They would be less per bushel for larger structures). The interest charge reported is double what it should be. It is figured on 100 percent of the original cost, whereas the buildings are being steadily depreciated at 4 percent. This error is recognized in a footnote of the bulletin but not corrected in the table.[28] This correction makes the total fixed expense 2.9 cents per bushel instead of 3.8 cents.

Although the 2.7 cents per bushel loss from shrinkage is taken from farmers' estimates, it is too high. Attributing such a loss to farm storage assumes that the elevator operator accepts the 2.7 cents shrinkage on wheat which he stores for the farmer. Actually, the elevator will shift most of the shrinkage back to the farmer in lower grades and dockage, in increased storage charges, or some other method. If the margins in the grain trade are as low as the trade insists they are, the elevator cannot absorb the loss from shrinkage of grain held in storage for farmers. The writer would put 1 percent as a maximum nominal figure for shrinkage loss, or 1.8 cents per bushel at 1948 prices. No cost should be included for fire, hail and windstorm insurance for grain stored in steel bins. Most Northern Great Plains farmers simply do not carry such insurance and the probability of loss is very low. Nor should a nominal charge for "risk and inconvenience" for farm storage be included, especially if costs of insurance, treating, conditioning and loss of quality, and extra transportation and labor expenses were already allowed!

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[28] Ibid., (North Dakota report), p. 13.

TABLE I

SUMMARY OF FARM STORAGE COSTS FOR HYPOTHETICAL EXAMPLE, 1948-49 STORAGE YEAR, TWO DIFFERENT ESTIMATES*

| | Costs per Bushel According to Hall and his Associates | Costs per Bushel As Revised by the Writer of This Treatise |
|---|---|---|
| | (Cents) | (Cents) |
| Fixed expense on facilities and equipment ($1,302.) | | |
| a. Interest at 4% | 1.7 | .8 |
| b. Depreciation at 4% | 1.7 | 1.7 |
| c. Insurance - building | .3 | .3 |
| d. Taxes | .1 | .1 |
| | 3.8 | 2.9 |
| Variable expenses resulting from use of above facilities | | |
| a. Shrink | 2.7 | 1.8 |
| b. Insurance on grain | 1.0 | --- |
| c. Treating-insect control<br>d. Turning or conditioning<br>e. Loss of quality<br>f. Bin repair & maintenance | .5 | .5 |
| g. Risk and inconvenience | .5 | --- |
| | 4.7 | 2.3 |
| Extra transportation and labor expense on grain | 2.9 | 1.5 |
| TOTAL | 11.4 | 6.7 |

*Three 1,000 bushel steel bins plus mechanical loader, with the assumption that 3,000 bushels were stored.

Finally, the expense of extra transportation and labor is a doubtful item. The writer inserts, with reluctance, 1.5 cents per bushel. In the first place, part of the extra expense is already accounted for by including the cost of a mechanical loader in fixed cost. Secondly, with crowded elevator conditions as common as they are in Montana, and as reported in the North Dakota study, much of the wheat would have to be unloaded into temporary storage or onto the ground until the elevators could make room for it, and therefore this cost would not be avoided by elevator storage. Lastly, many farmers are as much or more concerned about time lost waiting in line at the elevator and the possibility of having to stop the combine as about the extra labor of unloading wheat with a mechanical loader.

The writer's estimate for cost of storing wheat on the farm in these structures would, therefore, be 2.9 cents for fixed cost and 3.8 cents for variable cost, or a total of 6.7 cents per bushel if the bins are used to capacity, as contrasted with a total cost of 11.4 cents given by Hall and his associates.[29]

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[29] Ibid., (North Dakota Report), p. 21, Table VI.

## CHAPTER IV

## GRAIN STORAGE IN MONTANA

### Peculiar Characteristics of Montana Which Are Related to Grain Storage

Prominent among the factors which favor storage of grain in Montana is its dry, cool climate. The mean annual precipitation for the state is approximately 15 inches. In much of the area where wheat is grown in Montana, the mean annual precipitation is as low as 12 inches. This compares with a mean annual precipitation of a little over 30 inches in Michigan, 31 inches in Iowa, 32 inches in Oklahoma, or 50 inches in Tennessee. The mean annual temperature in Montana is approximately 42 degrees fahrenheit as compared with 60 degrees in Oklahoma.[1] The significance of the dry, cool climate from the standpoint of storage is that not only do the common insects which infest stored grain (commonly referred to as "weevil") thrive under warm, moist conditions, but also the molds which cause wheat and other grains to go "out of condition".[2]

With a reasonable amount of care, wheat can be stored in Montana without deterioration of quality due to insects and molds. However, because of relative freedom from these hazards, farmers may not be vigilant in inspecting stored grain and may suffer some losses in exceptionally wet years or exceptionally warm winters.

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[1]U.S. Dept. of Agriculture, "Climate and Man", Yearbook of Agriculture, 1941, U.S. Govt. Printing Office, Washington, D.C., pp. 861, 917, 959, 1068, 1122.

[2]See R. A. Bottomley, C. M. Christensen and W. F. Geddes, "The Influences of Various Temperatures, Humidities, and Oxygen Concentrations on Mold Growth and Biochemical Changes in Stored Yellow Corn", Cereal Chemistry, Vol. 27, No. 24, (July 1950), pp. 271-272.

Closely related to the factor discussed above is the fluctuation in yields of grain crops grown on non-irrigated land in Montana. This fluctuation is due primarily to variations in rainfall about a mean which is near the effective margin for crop production. In all but two Montana counties where wheat is an important crop, the coefficient of variation of annual wheat yields is greater than 40, and in the important spring wheat area of North East Montana, the coefficient of variation is greater than 60 percent.[3]

Variations in wheat yields are significant from the standpoint of farm storage for two important reasons. First, elevators and other commercial storage firms are advised to construct facilities adequate for "average" or "normal" crops, with the supposition that on-the-farm storage facilities will be available for that part of crops in excess of the average.[4] The wider the variations in grain crop yields from the average, the greater the amount of farm storage which will be required for "bumper" crops. Secondly, variations in yield affect the desires of some farmers to carry reserves for seed and feed and for leveling income from sales from year to year.

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[3]L. E. Barber, Variability of Wheat Yields By Counties in the United States, U.S. Dept. of Agriculture, Washington, D.C., Bureau of Agricultural Economics Mimeo, 1951, pp. 40-41.

[4]Karl H. Ostland, The Economics of Grain Storage, Unpublished M.S. thesis, Kansas State College, Manhattan, 1951, pp. 20-25. See also, Thomas E. Hall, A. L. Larson, H. S. Whitney, and C. H. Meyers, Where and How Much Cash Grain Storage for Oklahoma Farmers, U.S. Dept. of Agriculture, Washington, D.C., Farm Credit Administration Bull. 58, 1950, pp. 42-45. And Thomas E. Hall, P. V. Hemphill, C. H. Meyer, and W. K. Davis, Where and How Much Cash Grain Storage for North Dakota Farmers, U.S. Dept. of Agriculture, Washington, D.C., Farm Credit Administration Bull. 61, 1951, pp. 43-47.

A third peculiar characteristic of Montana and other Northern Great Plains states related to the problems of grain storage is that in extensive areas diversification of crops is severely limited. One of the few opportunities available to the farmer in adjusting to income uncertainty is flexibility in management of inventories which may involve storage of physical reserves. To the extent that, under certain conditions, livestock feeding may be a possibility for diversification and flexibility, reserves of feed grains may also be involved. Further, storage operations can be integrated into the "one-crop" type of farming in such a way that supplementary relationships exist. Especially where the distance from the farm to the elevator is great, the farmer may store the grain in facilities on the farm at harvest time and utilize time between crop operations, at low opportunity cost, to haul the grain to the elevator. Also, the farm labor used to construct storage facilities may have very low opportunity cost because of slack seasons in the one-crop farmers' operations.

Montana is also different from other states in that farmers there are the last to harvest the crop in the United States. Not only is Montana in the Northern tier of states, but some of the wheat is grown at an elevation of 5,000 ft. or more. In some years, by the time wheat is harvested, terminal facilities are too full to take wheat even if railroad cars were available to move it. Near the Rocky Mountains, farmers often race the first snow with harvest operations, which is causing some farmers in this area to begin to investigate the feasibility of grain drying equipment.

Distances to the nearest elevator are greater in parts of this State than in states in the East and Midwest, making it, in some cases, uneconomical to tie up manpower at harvest time in hauling grain to the elevator. According to the 1950 agricultural census, the average distance to town from Montana farms and ranches is 14 miles. Over half of the farmers and ranchers reported distance to town of over 10 miles. Also the long railroad haul to terminals costs Montana farmers about 40 cents per bushel, depending, of course, upon the location of the farm in the State.

Finally, chiefly because of climate, Montana farmers grow wheat that is high in protein. High protein wheat usually sells at a premium on the market. Although at the present time the farmer has insufficient knowledge of the supply and demand for protein to carry on a systematic program of storage in order to obtain higher protein premiums, there are possibilities in binning wheat from certain fields separately in order to obtain the best price for his protein. For example, spring wheat is usually higher in protein than winter wheat, certain varieties have higher protein content than others, and wheat grown on high ridges is usually higher in protein content than wheat from low places on the field because of soil moisture.

## Recent Trends and Developments

There are some recent developments or trends which have affected the need for storage space and storage programs. One of the most important is the use of the combine for harvesting grains. A generation ago, the wheat harvest lasted two or three months. After the wheat was threshed it came to the elevator in small wagons drawn by teams, about one load per day from each farmer. Now the whole crop is combined in two or three weeks and comes to market in trucks. There are less than 25,000 farms in Montana which reported wheat acreage in the 1950 census, and 15,549 reported that they owned combines. Other combines from out of state operate on a "custom" basis. Apparently it is not feasible for elevators, railroads and terminals to furnish facilities to handle grain this fast. Moisture content of wheat harvested by combine often poses special storage problems.

A second important development is the recently stepped-up program of the Pure Food and Drug Administration to prevent contamination of wheat by birds, animals, rodents, insects and humans. Because of the increased danger of loss from seizure, elevators will be under pressure to refuse to take grain which is contaminated or which is so moist as to be in danger of insect contamination or spoilage. In the past, farmers have sometimes piled wheat on the ground when the elevator couldn't take it. If weather conditions were favorable, this could sometimes (but not always) be done without much loss from spoilage. With the increased emphasis on prevention of contamination, storing wheat on the ground or in "makeshift" structures not capable of excluding animals, birds, insects, and moisture, will probably be out of the question excepting for very short periods of time.

An important consideration during the past decade has been the increased burden of the income tax. With no provision in the tax law to compensate for fluctuating yearly incomes for tax purposes, the advantages of saving some of large crops to sell in years of crop shortage, thus staying within lower income brackets, will pay for some of the cost of storage. This item is particularly important for large operators whose incomes are in the higher brackets.

Loans made by the Commodity Credit Corporation as a part of the national price support program have encouraged many farmers to construct storage facilities. Commercial storage space available for farmers' use has been very limited at harvest time, and many farmers have had to construct their own storage space to take advantage of the loan program. In 1951 and 1952, the difference between the market price of wheat at Montana elevators and the loan available from the Commodity Credit Corporation was between 15 and 20 cents per bushel in the month of August, when most of the Montana wheat crop is harvested. This difference for the two years would pay the cost of good new storage structures on the farm. Additional incentive to build storage facilities has been provided since 1949 by a government program of lending money at a low rate of interest to farmers for the purpose of constructing storage facilities. Approximately thirty million bushels of farm storage capacity was built in Montana from 1949 to early in 1952. This comprised 22 percent of on-the-farm storage facilities which existed in early 1952. (See Table III, page 62).

Finally, the upward trend in population and the tendency for the Montana market to shift to the West Coast have implications from the standpoint of grain storage. If a feeding industry is to develop to better prepare certain Montana livestock for West Coast markets, a stable and dependable supply of feed must be provided in the feeding areas.

## What the Farmers Say About Grain Storage

In August and September of 1951, the author accompanied Mr. Bruce Brooks, Marketing Specialist for the Montana Extension Service, on a 15-day field trip to interview wheat farmers, elevator operators, and others, concerning the problems of grain storage.[5] Mr. Brooks had planned this trip preparatory to planning some grain marketing schools and the writer seized upon the opportunity to obtain ideas concerning storage in Montana. There was no opportunity to choose a representative sample or to use a schedule of prepared questions, although a pattern of questioning was followed. The purpose was to obtain ideas. After each interview the highlights of the conversation were recorded. Only information given in the form of numerical data was recorded during interviews.

The reason given most often by farmers interviewed (and stressed the most) for building on-the-farm storage facilities was that elevators simply are not able to take the grain as fast as it is harvested. A close second to this reason was the belief that heavy marketing at harvest time tends to depress wheat prices, and that as a general practice it pays to hold wheat to sell at a later date. Closely related to this was the need for storage space in order to take advantage of the loans available from the Commodity Credit Corporation. Some farmers said they like to keep some wheat as a reserve, in addition to seed reserves. One

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[5]On this trip, 22 farmers, 12 elevator operators, 6 county agents, 4 representatives of firms which sell storage materials and equipment, and 5 representatives of the Production and Marketing Administration and the Montana State Crop Reporting Office were interviewed.

advantage given for wheat reserves as compared with money in the bank is that wheat cannot be "spent" as readily as money.

Some farmers said they sometimes store grain to level their annual incomes and thereby reduce income taxes. Some farmers said they attempt to segregate wheat of different protein content in order to do a better marketing job. Some mentioned the multiple-purpose aspects of certain types of structures, especially the quonset type of building, which can serve as machine shed, work space, or livestock shelter if not being used for grain storage. And finally, because there were heavy and frequent rains during the 1951 harvest season, a large amount of grain had such high moisture content when harvested that elevators couldn't accept it even if they had room.

There was little interest on the part of those farmers interviewed in storing grain in the elevator. Some farmers said that they like to sell the wheat as soon as they can--as fast as it is harvested if the elevator can take it--rather than bother with holding it. Some said they could not "fool with" the "government loan". But most of the farmers interviewed who hold some of their wheat like to keep it on the farm. Typical responses were, "Elevator storage eats up the profits." "Why not invest what we pay the elevator in an asset on our own farm?"[6]

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[6]Elevator operators stressed moisture content of grain and purchasing on the basis of protein content as their two worst problems, and these problems are difficult to solve chiefly because of congestion at the elevator at harvest time.

Reports of the crops committees at six of the seven district rural progress conferences held in Montana in the spring of 1952[7] included recommendations on farm storage. In summary, these recommendations were as follows: that adequate farm storage facilities should be provided to alleviate congestion at local elevators at harvest time; that care should be taken to prevent deterioration and contamination of grain in storage; that more information should be made available relative to the building and use of grain dryers, and (in District VII); that every farmer should set aside a well-cared-for bin for storing one, and preferably two years supply of seed.[8]

Small Grain Storage Facilities in Montana

The section above reports some farmers' attitude toward farm storage. This section reports what action they have taken. In the spring of 1952 the Bureau of Agricultural Economics, Office of the Agricultural Statistician, at Helena, Montana, in accordance with a cooperative arrangement with the Department of Agricultural Economics, Montana State College, included a section on small grain storage facilities in their special wheat questionnaire.[9] Of 6,423 schedules sent to a representative sample of Montana wheat farmers, approximately 3,000 were returned by the farmer respondents, about 2,600 of which had usable information on farm

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[7]<u>Supra.</u>, p. 9.

[8]Montana Extension Service, <u>What the People Said</u>, Extension Bulletin 274, Bozeman, 1952, pp. 52, 63, 75, 84, 93, 107.

[9]A copy of the storage facilities section of the questionnaire is included as Appendix A.

storage facilities. This is a sample of over 10 percent of Montana farmers who grow grain. Information was obtained on each schedule on the number of acres of wheat seeded for the 1951 crop.

Storage capacity reported for the sample farms was multiplied by the reciprocal of the ratio of acres planted on the sample farms to total estimated seeded acres for the 1951 crop to obtain estimated total on-the-farm storage capacity. Data on commercial storage space in elevators and mills were obtained from annual reports made by commercial firms to the Montana Department of Agriculture, Labor and Industry. These data are summarized in Table II.

TABLE II

SMALL GRAIN STORAGE CAPACITY IN MONTANA
IN 1951 BY CROP-REPORTING DISTRICTS*

| District | Storage Capacity | | | Storage Capacity as a Percent of 1951 Grain Production (wheat, oats, barley) | | |
|---|---|---|---|---|---|---|
| | On Farms and Ranches (000 Bu.) | Commercial Mills and Elevators (000 Bu.) | Total (000 Bu.) | On Farm | Commercial | Total |
| West of Divide | 5,258 | 1,058 | 6,316 | 94.8 | 19.1 | 113.9 |
| North Central | 50,450 | 7,962 | 58,412 | 104.2 | 16.5 | 120.7 |
| North East | 41,282 | 5,308 | 46,590 | 136.6 | 17.6 | 154.2 |
| Central | 15,103 | 8,479 | 23,582 | 96.2 | 54.0 | 150.2 |
| South West | 6,075 | 1,850 | 7,925 | 113.5 | 34.6 | 148.1 |
| South Central | 9,907 | 2,231 | 12,138 | 97.2 | 21.9 | 119.1 |
| South East | 7,583 | 1,010 | 8,593 | 133.7 | 17.8 | 151.5 |
| STATE TOTAL | 135,658 | 27,898 | 163,556 | 112.1 | 23.0 | 135.1 |

*Source - 1952 Co-operative Survey, Bureau of Agricultural Economics, U.S. Dept. of Agriculture and the Dept. of Agricultural Economics, Montana Agricultural Experiment Station.

Total storage capacity available in the State was 135 percent of the 1951 crop. Total farm storage space was 112 percent of the 1951 crop. But the 1951 small grain crop was above the average in size--121 million bushels as compared with 112 million bushels for the five-year average, 1947 to 1951. Total storage capacity available in 1951 was 147 percent of the five-year average grain crop.[10]

At first glance it would appear that there was excess storage capacity in Montana, and that there should, therefore, be no problem concerning whether or not more storage space is needed. On examination, however, this impression is found to be deceiving. In the first place, allowance must be made for the holdover. Stocks of wheat, oats, and barley in Montana on July 1, 1951 totaled 31 million bushels, of which 10 million bushels were stored off the farm and 21 million bushels were stored on the farm. The July 1 carry-over on farms plus the 1951 crop exceeded the 1951 total farm storage capacity by about 7 million bushels. A few elevator operators reported to the writer that farmers added to the congestion at the elevators in the summer of 1951 by bringing in sizeable amounts of the 1950 crop just before harvest time in order to make room for the new crop of wheat.

In the second place, it cannot be assumed that this storage capacity is distributed among farmers or even among communities in proportion to the amount of grain normally grown, or that the wheat crop in any one

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[10]Data on small grain production were obtained from Montana Agricultural Statistics, Vol. IV, Montana Dept. of Agriculture, Labor and Industry and the U.S. Dept. of Agriculture, Bureau of Agricultural Economics, Helena, Montana, (December 1952), pp. 16-17.

year is distributed among the various communities according to the normal pattern. Table II indicates that a range exists between crop reporting districts of from 95 percent to 137 percent of the 1951 crop for on-the-farm storage capacity, and from 114 percent to 154 percent for all storage capacity. The range is much greater for individual farms. Of the farms reporting, 4.3 percent said that they had no storage facilities at all, whereas some farmers reported as much as four times as much storage capacity as the 1951 crop. Usually, farmers reporting such large capacity include multiple-purpose buildings which can serve as storage space, machine sheds, garages, shops, or livestock shelter.

In the third place, only 70 percent of on-the-farm storage facilities in 1951 were reported as good. (See Table III). Farmers were asked to rate their storage facilities as good, fair or poor. Although these are terms which are subject to differences in interpretation, the writer assumes that facilities rated only fair or poor would be useful only for very short-time use in view of the vigorous program of the Pure Food and Drug Administration to prevent contamination of food grains.

Most of the steel bins and quonset-type structures were reported to be in good condition. Practically all of the quonsets and more than half of the steel bins have been built since 1946. Seventy-eight percent of the wooden bins were built prior to 1946, as were 76 percent of the structures grouped as "other" in Table III. In the "other" class are a few farm elevators, most of which were rated as good, and a miscellaneous assortment (mostly rated as fair or poor) of box cars, rock structures, log structures, and old houses and barns.

TABLE III

CONDITION OF ON-THE-FARM SMALL GRAIN STORAGE FACILITIES IN MONTANA IN 1951, TYPE OF STRUCTURE AND TIME OF CONSTRUCTION*

| District | Condition of Storage Facilities | | | Type of Structure | | | | Time of Construction | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Good (%) | Fair (%) | Poor (%) | Steel Bins (%) | Quonset (%) | Wooden Bins (%) | Other (%) | 1949-1952 (%) | 1946-1948 (%) | Prior to 1946 (%) |
| West of Divide | 66.6 | 31.8 | 1.6 | 7.3 | 1.4 | 87.6 | 3.7 | 16.5 | 11.9 | 71.6 |
| North Central | 69.2 | 28.8 | 2.0 | 13.1 | 5.3 | 74.9 | 6.7 | 24.3 | 7.2 | 68.5 |
| North East | 72.4 | 24.4 | 3.2 | 9.5 | 4.6 | 82.8 | 3.1 | 20.3 | 8.2 | 71.5 |
| Central | 71.7 | 23.7 | 4.6 | 12.6 | 6.0 | 76.1 | 5.3 | 23.9 | 7.5 | 68.6 |
| South West | 59.4 | 31.4 | 9.2 | 14.1 | 0.0 | 82.2 | 3.7 | 13.6 | 5.3 | 81.1 |
| South Central | 69.4 | 27.1 | 3.5 | 11.6 | 2.1 | 80.5 | 5.8 | 19.3 | 12.2 | 68.5 |
| South East | 66.5 | 27.4 | 6.1 | 20.2 | .9 | 75.1 | 3.8 | 19.7 | 10.1 | 70.2 |
| STATE TOTAL | 70.0 | 26.8 | 3.2 | 12.1 | 4.5 | 78.4 | 5.0 | 21.9 | 8.1 | 70.0 |

*Source - 1952 Co-operative Survey, Bureau of Agricultural Economics, U.S. Dept. of Agriculture, and the Dept. of Agricultural Economics, Montana Agricultural Experiment Station.

# CHAPTER V

## COSTS OF FARM STORAGE

### Construction Costs of Farm Storage Structures

Data are presented in this section on the costs of materials only. This provides a base which is useful to a farmer in making his own calculations. Farmers' valuations of the labor cost of farm improvements vary greatly. If he uses only family labor for building during seasons when he would otherwise not be occupied, the farmer is apt to figure that labor cost is zero. At the other extreme would be the case where a contractor is hired to construct the building and no farm labor is used. Typical comments of farmers are: "The materials cost me $3,000. I did my own work"; "The cost was $3,000. That includes $2,500. for materials and $500. for hired labor."

An average of the valuations of construction labor cost of all the farmers in an area would be of little use to an individual farmer, and therefore, no attempt has been made to arrive at such an average. In the budgets in Chapter VII, a nominal cost for family labor will be used for illustrative purposes, but Tables IV, V, VI, and VII include costs of materials only.

The costs of the various types of structures presented in this chapter were budgeted, using data furnished by lumber, hardware, and equipment dealers, by insurance companies, and by the biennial report of the Montana State Board of Equalization. In order that data throughout this treatise would be consistent, cost data for the year of 1951 were used. These budgeted costs are comparable to data obtained in 1951 from farmers on costs of storage structures. Data used for prices of materials are summarized in Appendix B.

TABLE IV

COSTS OF MATERIALS FOR ROUND GALVANIZED STEEL BINS AT GLENDIVE, MONTANA, 1951*

| Capacity of bin (bushels) | Total Cost of Materials | Materials Cost per Bushel Capacity |
|---|---|---|
| 500 | $283. | $0.57 |
| 1,000 | 407. | .41 |
| 1,250 | 463. | .37 |
| 1,500 | 522. | .35 |
| 2,050 | 711. | .35 |
| 2,400 | 774. | .32 |
| 2,750 | 839. | .31 |
| 3,000 | 935. | .31 |

*List price at Billings, Montana, plus freight to Glendive, Montana, plus materials cost for concrete foundation wall at $1.00 per running foot.

TABLE V

COST OF MATERIALS FOR A WOODEN GRANARY OF CRIBBED TYPE CONSTRUCTION, USING 1951 PRICES OF MATERIALS*

| Number of Bins 14.5' x 14.5' x 14' | Capacity (bushels) | Total Cost | Cost per Bu. Capacity |
|---|---|---|---|
| 1 | 2,042 | $ 856. | $0.42 |
| 2 | 4,084 | 1,427. | .35 |
| 3 | 6,126 | 1,999. | .33 |
| 4 | 8,168 | 2,570. | .32 |
| 5 | 10,210 | 3,141. | .31 |

*See Appendix B for a list of prices of materials used. Six-inch cribbed outer walls and four-inch cribbed partitions, corrugated galvanized steel covering for roof and outer walls, and concrete floor and foundation walls.

TABLE VI

COST OF MATERIALS FOR A WOODEN FRAME GRANARY, USING 1951 PRICES OF MATERIALS*

| Number of Bins 14' x 14' x 12' | Capacity (bushels) | Total Cost | Cost per Bu. Capacity |
|---|---|---|---|
| 1 | 1,882 | $ 468. | $0.25 |
| 2 | 3,764 | 800. | .21 |
| 3 | 5,646 | 1,132. | .20 |
| 4 | 7,528 | 1,463. | .19 |
| 5 | 9,410 | 1,795. | .19 |

*See Appendix B for a list of prices of materials used. Outer walls of shiplap covered with drop siding. Roof covered with galvanized steel, and floor and foundation wall of concrete.

TABLE VII

COST OF MATERIALS FOR QUONSET TYPE STEEL BUILDINGS AT GLENDIVE, MONTANA, USING 1951 PRICES OF MATERIALS*

| Capacity of Bldg. (bushels) | Total Cost of Materials | Cost per Bushel Capacity |
|---|---|---|
| | A. Buildings 32 Feet Wide | |
| 7,588 | $2,794. | $0.37 |
| 10,930 | 3,362. | .31 |
| 14,302 | 3,930. | .27 |
| 17,604 | 4,498. | .26 |
| | B. Buildings 40 Feet Wide | |
| 21,578 | 5,741. | .27 |
| 30,278 | 7,036. | .23 |
| 38,978 | 8,331. | .21 |
| 47,678 | 9,626. | .20 |

*Quonset with steel lining and concrete floor and foundation wall. The first four buildings are 32 ft. wide, and the second four buildings are 40 ft. wide.

The first type of farm storage structure to be considered is the round galvanized steel bin. Bins of this type to be found on Montana farms range in size from 500 bushels capacity to about 3,000 bushels capacity per bin. Data on cost of these bins in 1951 are presented in Table IV. Freight to Glendive, Montana, was added to the list price at Billings, Montana, in order to cover an area of a radius of about 225 miles from Billings. Also, materials cost was added for a good concrete foundation to which the bin can be securely fastened to prevent damage from wind and ground moisture.

Materials cost varies from 31 cents per bushel capacity to 57 cents per bushel capacity, depending on the diameter and height of bin. An important consideration, then, from the standpoint of the farmer, is the size of bin to buy. A 1,000 bushel bin costs 41 cents per bushel of storage capacity, whereas a 1,250 bushel bin costs only 37 cents. Or, to put it another way, an additional 250 bushels of storage space could be bought for $56. A 2,050 bushel bin costs less than two 1,000 bushel bins. However, the higher cost of the smaller bins should be balanced against the benefit of having two bins instead of one, in case grains of different kinds or quality are to be stored. The farmer may wish, also, to equip one bin for purposes of drying grain.

Some advantages of the round steel bins are simplicity of construction, their fireproof nature, and the relative ease with which entry by rodents, birds, insects and humans can be prevented. Some disadvantages are that they are easily damaged by wind or by careless use of vehicles, and that their value for other purposes than grain storage is practically nil.

A second type of storage structure which can be found on Montana farms is the cribbed wooden structure. This type of construction is used for a few farm elevators which are similar to the small country elevator in design, but is also used occasionally for farm granaries. Table V presents data on costs of a granary of cribbed wooden type, showing differences in cost of granaries of different sizes, the added capacity being obtained by adding equal-size bins to the length of the structure. As was found for round steel bins, added capacity can be obtained at less than proportional cost, within limits, by adding to the floor area and the height of rectangular granaries.

Materials used in constructing Table V include cribbed outer walls of 2" x 6" lumber, corrugated galvanized steel covering for roof and outer walls, and concrete floor and foundation walls. This is a sturdy type of construction which gives long years of service with very little expense for upkeep. It is expected to last longer than the round steel bins, but the cost of materials is higher than for steel bins (of like capacity) and the labor cost of construction is also greater. The chief disadvantages are that the structure is not fireproof, is not as rodent-proof as steel structures, and has little use for purposes other than storage. The common practice is to build two rows of such bins with a driveway between, which furnishes workspace, shelter for machinery or truck loads of wheat, or even extra temporary storage space at little extra cost.

A less expensive type of wooden granary is a frame structure with outer walls of shiplap covered with drop siding. Cost of such a structure with galvanized steel roof and concrete floor and foundation wall is presented in Table VI. Its chief advantage as compared with other types of storage structure discussed is its low original materials cost. A driveway arrangement is common for this type, also. It has a shorter life than the cribbed type structure and the cost of upkeep is greater, including a coat of paint now and then. This structure is also not fireproof, and is not easily kept free of insects and rodents.

A fourth type of structure used for farm grain storage purposes is the quonset-type steel building. Materials costs for these buildings are presented in Table VII. These buildings are noted for their simplicity of design. Labor costs of construction are relatively low. They are fireproof, and upkeep expense is negligible. They may be classified as dual-purpose or multiple-purpose buildings in that they are adapted to use as a machine shed, general storage building, work space, or livestock shelter. These buildings are thought by some to be the answer to the "temporary" storage problem arising from unusually heavy crops. It may be more difficult to prevent contamination of wheat in this, or any other dual-purpose structure, than in specialized storage facilities, especially if dual-purpose structures are used for other purposes at the same time they are being used for grain storage.

Along with the study of cost of farm storage structures, some information was obtained on cost of auger grain loaders and on grain drying equipment. It was found that a loader capable of elevating grain to a height of $12\frac{1}{2}$ feet (adequate for filling round steel bins up to 2,200 bushels in capacity) and capable of loading a maximum of 25 bushels per minute under favorable operating conditions, could be purchased in Montana for approximately $350. in 1951.

Equipment for drying grain by pulling unheated air through it could be obtained for two 1,000 bushel bins for approximately $450.

Fixed Costs of Farm Storage Structures

These costs have been termed the "annual use cost" of farm storage structures.[1] They include four items--interest, depreciation, property taxes, and insurance. To illustrate how the average annual use cost of a storage structure can be computed, a 1,000 bushel round steel bin is used. The materials cost of the bin is $407. (See Table IV). If a nominal cost of $25. is added for the labor to set up the building on the farm, the total investment is $432.

If the bin is depreciated at a constant rate, the average investment in the building over the period of its probable use is $216. At a rate of 5 percent, the annual interest cost would be $10.80. The same method would be used for property tax excepting that in actual practice the tax assessment would probably strike a minimum when the value of the bin reached about 20 percent of its original value, making the average tax value $225. In Montana, buildings are given a taxable value equal to 30 percent of their assessed value, so the taxable value would be $67.50. The average property tax levy in Montana in 1951 was 80 mills. Therefore, the property tax on the 1,000 bushel bin in 1951 would be $5.40, assuming the assessor places the value always at 100 percent of

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[1] Supra., Chapter II, p. 23.

the depreciated value of the bins, with a minimum valuation of 20 percent.

Companies which sell round steel bins advertise that they will give good service for 25 years. Actually, this is a conservative estimate for a steel bin well anchored to a concrete foundation in Montana climate. In this example, the life of the bin is assumed to be 30 years, which gives an annual depreciation rate of 3-1/3 percent. For the 1,000 bushel bin, therefore, the depreciation is $14.39.

Insurance on the building can be had for up to 80 percent of its value, at a premium rate of 85 cents per $100. value insured. This is fire insurance with extended coverage which covers wind, lightning, hail, vandalism, and damage from vehicles. The average annual insurance cost on the 1,000 bushel bin, therefore, would be $2.94. The total annual use cost of the bin is $33.53, or 3.3 cents per bushel capacity.

Variable Costs of Farm Storage

These are costs which are related to the amount of use made of the storage facilities. Whereas fixed costs on farm storage facilities must be met (once the facilities are built) whether or not the facilities are used, variable costs are incurred only when the storage facilities are used and vary with the amount of use.

Among the variable costs which are relevant to farm storage operations are cleaning, spraying, and repairing bins, conditioning or treating of the grain to prevent loss of quality, insurance on the grain when bins used are not fireproof, labor involved in putting the grain into bins and taking it out, and possibly shrinkage. If wheat is held past the time when assessments are made, the property tax will apply to grain in storage in Montana.

Turning again to the round steel bin used above for illustrative purposes, the cost of bin repair and maintenance is negligible unless there is damage by wind or by vehicles, and 80 percent of these risks were covered by insurance as a part of fixed costs. Assuming that grain is stored in good condition, costs related to maintenance of quality, such as turning or fumigating the grain, are also low. Hall (1951) and his associates reported the cost of turning and treating in North Dakota in 1948 to be two one-hundredths cents per bushel and storage conditions are even more favorable in Montana than in North Dakota.[2] In the North Dakota report, total cost of bin repair and maintenance, and quality maintenance, were given as .5 cents per bushel.[3] This figure will be used here for illustrative purposes.

Under certain circumstances, grain is so moist or contaminated with foreign materials when harvested that some amount of cleaning or drying is necessary before it can be safely stored. If this grain is taken to the elevator it will be subject to heavy dockage or price discount, if the elevator operator will take it at all. Under such circumstances, considerable expense may be justified to improve the quality of the grain or prevent its complete loss. However, this expense is not

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[2] Thomas E. Hall, P. V. Hemphill, C. H. Meyer, and W. K. Davis, Where and How Much Cash Grain Storage for North Dakota Farmers, U.S. Dept. of Agriculture, Washington, D.C., Farm Credit Administration Bull. 61, May 1951, pp. 16-17.

[3] Ibid., p. 21.

properly charged to storage operations, even though bins used for normal storage operations may be used in the process of conditioning the grain.

Since a fireproof structure, securely anchored to a concrete foundation wall, is being used for illustrative purposes, no insurance for fire, hail and wind would be needed on the grain.

There will be some additional expense of labor, and in some cases, transportation, involved in placing grain in farm bins and removing it when it is later taken to the elevators. An average cost for all farmers has little meaning as far as transportation is concerned because farm layouts vary so much. In cases where the farmstead is on the highway and all the wheat comes through the farm yard, no extra transportation is involved. In some cases the wheat may be grown on a tract closer to the elevator than the farmstead where the farm storage facilities are located. In this case, transportation cost would be a factor. For illustrative purposes it is assumed that no extra transportation cost, or only insignificant extra transportation cost is involved.

Good grain loaders are said to have a capacity of 25 bushels per minute. Some farmers estimated for the writer that a 200 bushel load can be unloaded in 15 minutes. Allowing five minutes more for backing in the truck and starting the motor of the loader, the whole operation would not require more than 20 minutes. At $1.00 per hour, the labor cost would be 33 cents per 200 bushel load. Fuel for the loader motor would not cost more than 10 cents per 200 bushel load, making a total cost of 43 cents per 200 bushel load. The time required for loading the wheat from bin to truck with the mechanical loader would be somewhat longer, but this would likely be labor valued at a lower rate than the $1.00 per hour harvest wage assumed above. Repairs on a loader used only a few hours each year are not expensive. Depreciation, interest and taxes on the loader amount to .5 cents per bushel based on the assumption that the loader will handle 150,000 bushels over a period of 30 years. The total cost of putting wheat into a farm bin and taking it out would be approximately $2.00 per 200 bushel load, or <u>1 cent</u> per bushel.

If wheat or other grain is owned by a farmer on March 1, it is subject to assessment for property tax. The taxable value of grain in storage is 7 percent of the assessed value. A levy of 80 mills would result in a tax of <u>1.1 cents</u> per bushel on wheat valued at $2.00 per bushel.

Just how much shrinkage costs are involved in on-the-farm grain storage operations is a question on which good information is not available. Farmers probably tend to estimate the cost of shrinkage at too high a figure. It is known that under certain conditions moisture content of wheat increases during storage. It is known, also, that elevator operators tend to pass the cost of shrinkage back to the farmer by price discounts, dockage procedure, higher storage costs, or other means. It is said that grain buying is one of the most competitive fields, and that the margin taken by elevators is about as low as it can be because of competition. For these reasons, the writer concludes that financial losses suffered by farmers in Montana from loss of moisture from stored grains are very low. Some of what is lost in weight is gained in better grade and, therefore, better price. The North Dakota study reports that farmers estimated, on the average, 1.5 percent loss from shrinkage.[4] For the budgets used in this treatise, a figure of 1 percent will be used, which amounts to 2 cents per bushel on wheat valued at $2.00 per bushel.

The loss from rodents and insects may well be greater than shrinkage in areas and under circumstances where rodents and insects are difficult to control. By using steel bins in Montana, both these losses can be avoided.

Under the assumptions made in this section, the variable costs of storing wheat on the farm would be 3.5 cents per bushel if sold before March 1, and 4.6 cents per bushel if it is owned by the farmer on March 1.

## Intangible Costs of Farm Storage

Just as there are some intangible benefits from on-the-farm storage (See Chapter VI), so there are intangible costs which cannot be measured in monetary terms. For example, there are farmers who find the responsibility of periodic inspection of stored grains annoying, or who do not wish to be bothered with listening to market news on the radio or with analyzing outlook information in order to decide when to market grain. They like to prepare the seed bed and seed the grain, and they like to operate the combine, but they wish to get the wheat into the elevator as soon as possible and forget it. Even to those who do not mind the chores mentioned above, these chores constitute a cost.

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[4] Ibid., p. 21.

Quite a few wheat farmers in Montana wish to live in town and drive out to the wheat fields only when there are farming operations to attend to. To these farmers there is extra cost involved in on-the-farm storage operations. Along with the intangible costs of extra worry and bother, they should probably carry insurance against theft, whereas this insurance is not necessary when wheat is stored near the farmer's house. (Insurance, of course, is a cost measurable in terms of money). The writer knows of cases where such operators have built storage facilities on their town property. This paragraph applies also to part-time wheat farmers who grow some wheat as a side-line to their regular occupation.

Also, there are those farmers who wish to be free to spend their winters in Florida, California, or Arizona after the fall work is done. To them, any responsibility such as caring for grain stored on the farm would be a real but intangible cost.

In another section of this treatise it was pointed out that the decision to build a granary was a long-term decision, involving expectations covering a considerable span of time. Therefore, because of uncertainty, the farmer may stop investing in storage facilities short of the point of maximization of income over a long period of time.[5]

Although these considerations do not necessarily destroy the usefulness of an analysis of the economics of on-the-farm storage of grains, the writer cannot escape the conclusion that the decision concerning

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[5] Supra., p. 25.

whether or not to build on-the-farm storage facilities will often turn on intangible costs and benefits. (See Chapter IX).

On-the-Farm Storage vs. Storage in Commercial Facilities

Once the costs of on-the-farm storage are determined to the satisfaction of a farm operator, it is a simple matter to compare these costs with what the elevator operator will charge him. However, the decision concerning whether or not to invest in on-the-farm storage facilities is not this simple.

Important questions concerning elevator storage are whether or not it will be available and when it will be available. If, for example, elevators cannot even buy wheat at harvest time, much less store it, then the cost of putting wheat into and taking it out of farm storage is not an extra cost of farm storage, for it must be done anyway. This cost would occur even if the wheat were piled on the ground, along with some amount of worry, waste, and spoilage.

Also, the benefits from storing wheat in the elevator and from storing it on the farm are not always the same. For example, the farmer may store wheat on the farm in order to avoid hiring extra help at harvest time for hauling wheat to town. Or, by having storage facilities in the farm yard, the small farmer may get by with a one-half ton pickup rather than investing in a large truck which he may not need the rest of the year. In the next chapter, benefits from on-the-farm storage are considered.

# CHAPTER VI

## BENEFITS FROM THE USE OF FARM STORAGE FACILITIES

### Specific Benefits to the Farm Operator from the Use of Farm Storage Facilities

There is not a list of benefits from on-the-farm storage facilities which will apply to every farm in Montana in the same way, or even to every farmer in some particular area in Montana. Each farmer must consider his own needs in making decisions concerning investments in storage facilities. Not every farmer will be interested in all the possible benefits which are discussed in this chapter, but each farmer should consider all of them. It is not enough to consider a single benefit, such as probable gain in price from holding wheat.

Various benefits to the farm operator from storage facilities will be discussed one at a time in the hope that such a discussion will furnish some data and some insights which will be useful to a farmer in making his analysis. For some of these benefits, data can be presented. Other benefits are tangible and are probably measurable in monetary terms, but little or no data are available which can be furnished the farmer at this stage. It is likely that the farmer will have some rough notion concerning their monetary value. A third group of benefits are intangible. The farmer comes to some conclusions concerning their value to him, but it is doubtful if items in this group can be measured in dollars and cents terms. A discussion of these three groups follows.

### Measurement of Some Specific Benefits

(1) Some Montana farmers are convinced that it pays them to store their wheat and sell it after the period of heavy harvest-time marketing.

The argument is that many farmers have to dump their crop on the market at harvest time (or do it as a matter of policy). Freight cars are scarce and both local and terminal elevators are often "plugged".[1] Therefore, prices are depressed. Therefore, it pays to store.

It is important to distinguish between opportunity for profits available to individual farmers from holding wheat beyond the harvest rush and any plan for concerted action among farmers to hold wheat in order to raise the price at harvest time. If a preponderance of sales were shifted from harvest months to months now affording the best prices, the opportunity for profits to individual farmers from storing would disappear.

The question arises, "But why store wheat on the farm? Cannot these benefits be obtained from storing in elevators and warehouses?" One answer is that in Montana commercial storage space is very scarce at harvest time, especially when the crop is better than average. Another answer is that elevator storage costs money which might be invested in facilities on the farm which are useful for other purposes than storing for higher prices. Further, there is some question as to whether storing in elevators to gain profits from seasonal price increases is to be preferred to purchases in the future market.

The seasonal index of prices received for wheat by Montana farmers, computed for a 16-year period from 1936 to 1951, varies from 95 in August, when most Montana wheat is harvested, to 104 in January. (See

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[1]See, for example, the discussion by Earl F. Crouse, (of Doane Agricultural Service), "Store It Yourself--It Pays", Farm Journal, July, 1951, pp. 32, 33, 105, 106.

Figure 3 and Table VIII). Although the 16-year period might be considered short for index construction, it is as long as it can be and be representative of modern conditions. There has been a revolutionary change in grain harvesting patterns since the early 1930's. The seasonal price pattern associated with the binder or header and threshing machine is of little or no use for predicting the future.[2]

The modern seasonal price pattern for wheat in Montana as portrayed in Figure 2 is not very different from similar indexes for wheat for other areas and for other times. For example, Thomsen's seasonal index of wheat prices at Chicago, published in 1936, shows the price of wheat to climb gradually from a low of about 96 in July and August, to a peak of 102 in February, then drop slightly in March, and climb to a second peak of 107 in May.[3] Variations in the peaks and lows can be expected between areas and between periods of time due to variations in harvest seasons and methods of harvesting.

Green (1925) discussed three potential weak spots in the United States seasonal wheat price pattern. The first was in June, July and August when prices are affected by actual or potential movement of new-crop wheat to market in the winter wheat belt of the United States. The second, in November, was caused by new Canadian wheat and spring

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[2]The use of the seasonal price index for purposes of prediction should be tempered by the knowledge that the market pattern was influenced to some degree during the 16-year period by various governmental programs which influenced prices, including the price support program for farm commodities. So, among other considerations, a farmer is also obliged to make some predictions concerning future governmental programs.

[3]F. L. Thomsen, Agricultural Prices, McGraw-Hill, New York, 1936, p. 438.

TABLE VIII

SEASONAL PRICE PATTERN FOR PRICES RECEIVED
BY MONTANA FARMERS FOR WHEAT, 1936 to 1951*

| Month | Index of Prices Received (1936 to 1951=100) | Index Converted to Average Wheat Price of: | | |
|---|---|---|---|---|
| | | $2.00 per bu. | $1.50 per bu. | $1.00 per bu. |
| Jan. | 104 | $ 2.08 | $ 1.56 | $ 1.04 |
| Feb. | 101 | 2.02 | 1.52 | 1.01 |
| Mar. | 102 | 2.04 | 1.53 | 1.02 |
| Apr. | 103 | 2.06 | 1.54 | 1.03 |
| May | 102 | 2.04 | 1.53 | 1.02 |
| June | 98 | 1.96 | 1.47 | .98 |
| July | 100 | 2.00 | 1.50 | 1.00 |
| Aug. | 95 | 1.90 | 1.42 | .95 |
| Sept. | 97 | 1.94 | 1.46 | .97 |
| Oct. | 98 | 1.96 | 1.47 | .98 |
| Nov. | 99 | 1.98 | 1.48 | .99 |
| Dec. | 101 | 2.02 | 1.52 | 1.01 |

*Index computed by M. C. Taylor, Department of Agricultural Economics, Montana State College. Actual market prices corrected for changes in the general price level.

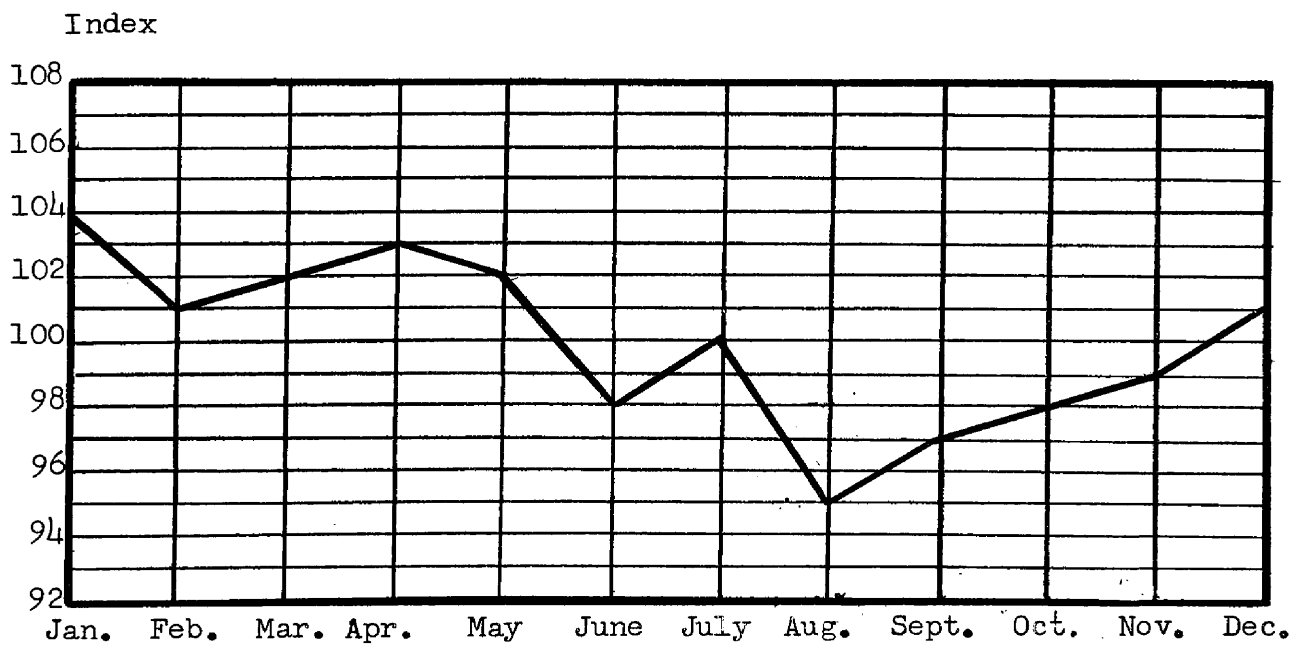


Figure 2. Seasonal index of prices received by farmers in Montana for wheat, 1936 to 1951. Average annual price = 100. (Corrected for changes in general price level)

wheat from the United States. The third potential weak period, in February and March, was caused by movement of wheat from Argentina and Australia. Green also discussed three potential strong spots. The first came in September and October between the peak movement of winter and spring wheat (pre-combine period), the second in January following cessation of Great Lakes movement of Canadian grain and prior to heavy movements of grain from the Southern Hemisphere, and the third in April when the peak of Southern Hemisphere shipments is past, and the Great Lakes have not yet been opened to navigation for Canadian wheat.[4] Although the time incidence of these various influences have been changed some by harvesting methods, it appears that Green isolated sufficient factors to explain the Montana seasonal low in August, when most of the wheat is harvested in this state, and seasonal highs in January and April.

An index covers up the failure of wheat prices in individual years to follow the average seasonal movements. If he is to attempt to take advantage of the seasonal price rise which can be expected on the average, the conservative policy for the wheat farmer to follow is to store regularly, in which case gains above the average compensation for storage will cancel out losses below the average compensation for storage over a period of years. Such a conservative policy is assumed here for illustrative purposes and is used in the demonstration of the method

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[4]Roy M. Green, Seasonal Variations of Wheat Prices, Kansas Agricultural Experiment Station, Manhattan, Circular 121, 1925, p. 10.

of analysis in Chapter VII.[5] The possibility that the farmer might make use of available outlook information and analysis in order to select the years in which storing is most likely to prove profitable, and therefore, do somewhat better than follow a regular policy of holding his wheat, is treated in Chapter VIII.[6]

If it is assumed for illustrative purposes that the farmer expects the price of wheat to average $2.00 per bushel[7] over the period on which he is basing his predictions, (say, the life of a bin), a consistent policy of holding wheat from harvest time to January would yield a gross return of 18 cents per bushel according to the experience of the period covered by the index. (See Table VIII). If he expects the price of wheat to average only $1.00 for the period on which he is basing his expectations, then he could expect the gross yield of storage to be only 9 cents per bushel.

(2) A second benefit from on-the-farm storage which can be measured is the ability to take advantage of price support loans available from the Commodity Credit Corporation. This benefit is closely related to the purpose of storing for higher prices, for the loan protects the farmer from the consequences of a fall in the market price while he "bets on a rise". The loan also provides the farmer with operating

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[5]*Infra.*, p. 102.

[6]*Infra.*, pp. 119-122.

[7]Average price received by farmers for wheat in Montana in 1951 was $1.96 per bushel. The Commodity Credit Corporation loan rate was $2.00 per bushel in Great Falls, Montana.

funds and funds to cover family living expenses while he waits for higher prices. The benefits of storing for higher prices and of taking advantage of the loans available from the Commodity Credit Corporation cannot be added in computing benefits from on-the-farm storage facilities. Only that part of the loan (support) which is in excess of the market price when the farmer would have sold his wheat, can be considered a gain, in addition to the gain from holding for a higher price.

Data are presented in Table IX which illustrate the gain which might result from providing storage facilities which will qualify for storage of wheat on which a loan is taken. The data are for No. 1 heavy (60 lb.) dark northern wheat with a protein test of 12 percent or less. Wheat price and loan rate vary by areas in Montana, but both are directly related to freight rates, and therefore, the difference between market price and loan rate does not vary greatly throughout the State.

Predicting what will happen to a price support program presents problems of a different nature than predicting seasonal price variations or variations in wheat yields. Data for a 6-year period from 1948 to 1953 are presented here to illustrate what has happened in the past. No implication is intended that the same experience can be predicted for the future.

For the 6-year period, the total gross gain from using the "government" loan as opposed to selling at harvest time was $1.05 per bushel, an average of 17.5 cents per bushel per year. Of this gain, 54 cents could have been obtained by storing in commercial storage facilities if commercial storage space was available. An additional 51 cents could be used to pay for farm storage. Actually, commercial storage space is available for only a small part of the grain crop in Montana at harvest time. In case commercial storage facilities are not available, the whole amount of $1.05 could be attributed to the use of farm storage facilities.[8]

TABLE IX

AVERAGE PRICE OF NO. 1 DARK NORTHERN WHEAT WITH 12 PERCENT PROTEIN IN AUGUST AT GREAT FALLS, MONTANA, COMPARED WITH LOAN AVAILABLE FROM THE COMMODITY CREDIT CORPORATION FOR THE SAME AREA, 1948 - 1953*

| Year | C.C.C. Loan Rate, Stored on the Farm | C.C.C. Loan Rate, Stored at Elevator | Av. Price of Wheat at Elevator, August | Difference Between Loan and Market Price of Wheat | |
|---|---|---|---|---|---|
| | | | | At Farm | At Elevator |
| 1948 | $ 1.90 | $ 1.83 | $ 1.74 | $0.16 | $0.09 |
| 1949 | 1.85 | 1.78 | 1.68 | 0.17 | 0.10 |
| 1950 | 1.88 | 1.81 | 1.80 | 0.08 | 0.01 |
| 1951 | 2.00 | 1.90 | 1.81 | 0.19 | 0.09 |
| 1952 | 2.00 | 1.90 | 1.85 | 0.15 | 0.05 |
| 1953 | 2.01 | 1.91 | 1.71 | 0.30 | 0.20 |

*Data on average price of wheat tabulated from the market section of the Great Falls Tribune. Data on loan rate obtained from the State Office of the Production and Marketing Administration, Bozeman, Montana.

[8]In recent years it has often happened that the whole cost of storage bins could be paid in one year by the difference between market price and loan rate. Crouse relates an example of two tenants in Minnesota who stored 90 cent corn at harvest time in 1949, and received the loan price of $1.32. The gain of 42 cents per bushel would pay for metal bins with concrete platforms. Ibid., p. 105.

When wheat has a high protein content the analysis is more complex because of the premium usually paid in Montana for protein. Only a small amount is added to the amount of the support loan for protein (about 6 cents for 16 percent). Price gains made by holding wheat of high protein content may be either increased or partially offset by increases or decreases in protein premiums after harvest time. With the limited amount of information now available concerning the marketing of protein, prediction is impossible.

A special inducement to farmers to build storage facilities on the farm has been provided since 1949 by a storage facilities loan program. Under this program a loan could be obtained from the Production and Marketing Administration for as much as 85 percent of the cost of the structure (80 percent since 1952). The interest rate is 4 percent and the term of the loan is five years.

(3) A third possible benefit from having storage facilities on the farm is the reduction in cost of harvest operations. Supplementary relationships exist between farm storage operations and other farm enterprises. Operations on a Montana wheat farm are highly seasonal. In the spring wheat area of North East Montana, the bulk of the work commences with spring seeding and ends with the harvest in late summer. In the off-season, comprising fall and winter months, the larger part of the farmer's labor and equipment stand idle. He can build storage facilities during this period. He can haul his wheat to town during this period if he has farm storage facilities. The opportunity cost of the labor and other resources used in the slack season are extremely low.

Consider the plight of the farmer who is trying to harvest his wheat as rapidly as possible at a time when the facilities at the local elevator are overloaded.[9] He has several alternatives if he does not have storage space on the farm. He can take his turn waiting at the elevator with other farmers, letting equipment and labor stand idle and chancing losses from shattering and storms. He can continue his harvest operations at a normal rate and pile his wheat on the ground. He is taking chances on loss from spoilage and from contamination, and the cost of piling and reloading into trucks is as great as putting wheat into and removing it from farm bins. Or, he can stop harvesting operations and wait until the congestion at the elevator is relieved. This choice also involves taking a chance on heavy losses from shattering of the grain or from storms.

If he has storage space on the farm, the farmer can operate during harvest time with less help and less equipment by storing it on the farm during the harvest period unless he is very close to the elevator, even if he has but short waits at the elevator. More labor and more equipment are tied up if the waits are long. Several farmers estimated for the writer that at least one more man would be required during harvest time if the wheat were to be moved to the elevator during harvest. During the past five years labor has been hired during harvest time in

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[9]See discussion of harvest congestion, p. 52.

Montana at a rate of $10. to $15. for a 10-hour day.[10] A 500-acre wheat crop would be harvested in approximately 17 days, using a 12-foot combine. Wages for one man at $10. per day for 17 days would amount to $170. for the season. If the yield on the 500 acres were 12 bushels, the extra help would cost about 2.8 cents per bushel. This the farmer sees as additional income for his family if it can be earned during the slack season.

But the extra labor is not all the cost involved. An additional truck may be needed. Here, supplementary relationships make calculations of benefits very involved. Many operators of "family farms" operate their farms with only one truck or perhaps a pickup for hauling purposes. A pickup or truck is a necessary item of equipment on a farm and it can help "pay for itself" if it is used to move the crop to market. This can be done if there is storage space on the farm, but if the grain must be moved to market during harvest, then an extra truck may be required.[11] Cost of the second truck to the grain farming operation would depend on extra work which might be found for the truck during the rest of the year.

(4) In order to demonstrate possible savings on federal net income tax through storage operations, a budgetary procedure has been used.

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[10]See Roy E. Huffman, Production Costs on Selected Dryland Grain Farms, Montana Agricultural Experiment Station, Bozeman, Mimeo Circular No. 52, 1949, p. 5. This rate is for help other than combine operator. Combine operators are paid $25. per day.

[11]Or someone else must be hired to haul the grain. Custom hauling is done at a rate of 5 cents per bushel minimum plus an additional one-half cent per mile for distances greater than five miles.

The budget is adapted from a study made by Huffman in 1948.[12] Huffman studied single enterprise grain farms in the spring wheat area of North East Montana having on the average 527 crop acres, and operating with a single line of machinery based on three-four and four-five plow tractors. He found that the average cost per acre of growing wheat, exclusive of operator and family labor, was $14.64 per acre in 1948. When this figure is adjusted to 1951 by use of various indexes of prices paid by farmers, it is found to be $16.15. This cost figure was used in the budgets summarized in Table X with adjustments for harvesting and grain handling costs when crops yields are above or below average.

For a study of the possible effects of storage on income tax payments, a 500 acre wheat farm was first used. Yields vary in the budgets as did actual wheat yields in Roosevelt County for a 30-year period from 1922 to 1951, although it is recognized that average yields for a county do not vary as much as would yields on an individual farm. For the budgets, costs and prices received were held constant at the 1951 level of $16.15 per acre for costs, and $2.00 per bushel for sales price of wheat. Income tax rates for 1951 were used, also, and the farm family was assumed to consist of four persons throughout the period.

In the first budget it was assumed that no storage space was available on the farm and that each year's crop was sold at harvest time. Net income after federal income tax was computed as presented in Table X, Column 3. Next, it was assumed that storage space was available for one

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[12] _Op. cit._, p. 17.

average crop of 6,000 bushels, and that any amount of wheat produced in excess of the average crop would be stored, up to the capacity of the bins, and if the yield dropped below average, wheat would be taken from storage to make sales equal to an average crop as long as stored grain was available. Because regular annual net incomes are subject to less income tax than irregular incomes which average the same amount as the regular incomes, the rule is used to approach the average crop each year as near as possible with the storage space available. The results are presented in Column 4, Table X.[13]

In order to isolate the effect of leveling out annual sales to the extent that was possible with the storage space available, storage costs were not included in computing net income after taxes. This is consistent with the general purpose in Chapters V and VI of setting forth costs and benefits separately in order to demonstrate the use of marginal analysis in Chapter VII. Gains from equalizing annual incomes

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[13]To obtain net income after tax, the value of sales for each year was first computed at $2.00 per bushel and the cost of production subtracted from the value of sales, giving net income before tax. From each year's net income was subtracted 10 percent (up to $1,000) for allowable deductions and $2,400 exemptions for a family of four, giving taxable income. The income tax was then computed according to the 1951 schedule of tax rates. In budgets in which storage facilities were used, sales were distributed more evenly between years to the extent available space would permit. No allowance was made in these budgets for seasonal price variations.

The present federal tax law allows the operator to carry net losses forward five years or backward one year as an offset to net gains for tax purposes. Hence, in the budgets no storage was used for the period from the eighteenth year to the twenty-first year because losses from previous years could be used to hold down the income tax. Therefore, in the twenty-second year, according to the rule of operation, the storage space was filled and could have no effect on incomes until the short crop in the twenty-eighth year.

TABLE X

NET FARM INCOME AFTER FEDERAL NET INCOME TAX ON TWO SIZES OF NORTH EAST MONTANA SPRING WHEAT FARMS WITH NO STORAGE FACILITIES AND WITH STORAGE FACILITIES EQUAL TO ONE NORMAL CROP

| Year | Yield per Acre, Bushels | Net Income After Tax, 500 Acre Wheat Farm: No Storage Facilities On the Farm | Net Income After Tax, 500 Acre Wheat Farm: Storage Facilities For One Normal Crop of 6,000 Bu. | Net Income After Tax, 1,000 Acre Wheat Farm: No Storage Facilities On the Farm | Net Income After Tax, 1,000 Acre Wheat Farm: Storage Facilities For One Normal Crop of 12,000 Bu. |
|---|---|---|---|---|---|
| 1 | 17 | $7,596 | $3,543 | $14,064 | $6,590 |
| 2 | 11 | 2,910 | 3,727 | 5,331 | 6,949 |
| 3 | 20 | 9,852 | 3,449 | 17,910 | 6,406 |
| 4 | 9 | 1,040 | 3,788 | 2,080 | 7,069 |
| 5 | 10 | 2,000 | 3,755 | 3,755 | 7,005 |
| 6 | 17 | 7,596 | 3,543 | 14,064 | 6,590 |
| 7 | 17 | 7,774 | 7,596 | 14,625 | 14,064 |
| 8 | 7 | -885 | 3,849 | -1,770 | 7,189 |
| 9 | 10 | 2,000 | 3,884 | 4,000 | 7,278 |
| 10 | 2 | -5,700 | -700 | -11,400 | -1,400 |
| 11 | 10 | 2,000 | 2,000 | 4,000 | 4,000 |
| 12 | 6 | -1,850 | -1,850 | -3,700 | -3,700 |
| 13 | 2 | -5,700 | -5,700 | -11,400 | -11,400 |
| 14 | 5 | -2,810 | -2,810 | -5,620 | -5,620 |
| 15 | 2 | -5,700 | -5,700 | -11,400 | -11,400 |
| 16 | 0 | -5,735 | -5,735 | -11,470 | -11,470 |
| 17 | 4 | -3,775 | -3,775 | -7,550 | -7,550 |
| 18 | 11 | 2,965 | 2,965 | 5,930 | 5,930 |
| 19 | 12 | 3,925 | 3,925 | 7,850 | 7,850 |
| 20 | 16 | 7,775 | 7,775 | 15,550 | 15,550 |
| 21 | 19 | 10,357 | 10,357 | 20,196 | 20,196 |
| 22 | 24 | 12,589 | 3,245 | 22,358 | 6,000 |
| 23 | 19 | 9,118 | 9,118 | 16,662 | 16,662 |
| 24 | 13 | 4,482 | 4,482 | 8,426 | 8,426 |
| 25 | 12 | 3,694 | 3,694 | 6,885 | 6,885 |
| 26 | 17 | 7,596 | 7,596 | 14,064 | 14,064 |
| 27 | 16 | 6,825 | 6,825 | 12,713 | 12,713 |
| 28 | 8 | 75 | 3,816 | 150 | 7,124 |
| 29 | 21 | 11,552 | 7,456 | 19,063 | 13,819 |
| 30 | 14 | 5,266 | 5,266 | 9,907 | 9,907 |
| Carry-over* | | | 11,538 | | 22,071 |
| TOTAL | | 96,832 | 100,922 | 175,273 | 187,797 |
| Average | | $ 3,228 | $ 3,364 | $ 5,842 | $ 6,260 |

*Bins full at end of period. Value assigned these stocks assumes they will be used to bring two short crops just up to normal. Tax for two normal crops deducted.

as presented in Table X are to be compared with the cost of obtaining these gains through storage.

For the 30-year period, total gain from equalizing annual income to the extent that it could be done with 6,000 bushel storage space would be $4,090. This amounts to $136. per year, or $2\frac{1}{4}$ cents per bushel of storage capacity, which would assist materially in paying the cost of farm storage. The effect of the "bunching" of good years and poor years is obvious. During the first ten years of the period, storage would be quite effective in equalizing income from year to year. Only in the seventh year would the amount of storage space prove to be inadequate. During the long drought period from the eighth to the seventeenth year, storage would have no effect after the first three years. After the drought, the 6,000 bushel capacity would be filled in the twenty-second year, allowing for carrying forward losses for tax purposes, and no wheat could be released until the twenty-eighth year.[14]

Two other runs were made using a 1,000 acre wheat farm. The same assumptions and the same production costs were used as were used for the 500 acre farm. It was assumed that the increased use of hired labor for the larger farm would be offset by greater efficiency, particularly in the use of larger units of equipment. Because the net income from the larger farm gets into higher income brackets, the savings are relatively

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[14]For a discussion of the tendency of good years and poor years to come in "bunches" in the Great Plains, see Marion Clawson, "Sequences in Variation of Annual Precipitation in the Western United States", Journal of Land and Public Utility Economics, Vol. XXIII, No. 3 (August 1947), pp. 272-287.

greater than were obtained for the smaller farm. (See Table X, Columns 5 and 6). Total gain from equalizing annual income to the extent that it could be done with storage space for one average-sized crop was $12,524 for the 30-year period. This amounts to an average annual gain of $418., or a gain of 3½ cents per bushel of storage space.[15]

## Other Benefits Which Might Be Measured

(1) Reserves for contingencies. Related to the variations in yield demonstrated in Table X is the need for reserves for seed in the case the crop is a complete failure or in case the quality is not satisfactory for seed. Data might be obtained to measure the value of these reserves.[16] Certain aspects of the use of grain as reserves to prevent yearly fluctuations in income for family use and for operating funds might be measured, such as alternative costs of interest on borrowed funds or cost of insurance. However, this should be combined with a study of other alternatives such as the maintenance of cash reserves.

(2) It is probable that under certain circumstances gains can be obtained by using farm storage facilities to segregate lots of wheat with differences in protein content. A few farmers report that they often cut wheat which they have reason to believe is high in protein content and

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[15] It should be noted that not only is the gain to be expected from leveling out irregular incomes greater for larger farms, but it is also greater when wheat prices are high than when wheat prices are low. See Chapter VIII, p. 114.

[16] Although the use of grains for feed for livestock has been excluded from this analysis for the sake of simplifying the discussion, it is a phase which should be treated in further study.

put it in a separate bin. For example, wheat grown on high ridges is apt to have greater protein content than wheat grown in low, wet sections of the field. As a rule, the differences in premium for each percent change in protein content increase as the protein content increases. If, for example, the premiums for 13 percent, 14 percent, and 15 percent protein were 3 cents, 6 cents, and 12 cents per bushel, respectively, then the premiums for 500 bushels of wheat with 13 percent protein, and 500 bushels of wheat with 15 percent protein would amount to $75. as compared with a premium of $60. if the two lots were mixed to make wheat of 14 percent protein.

Little is known at present concerning the possibility of using outlook information in order that the best time for marketing wheat of high protein content can be chosen.[17]

(3) More data can be obtained on allocating the benefits of multiple purpose structures to their various uses. These benefits would vary with the way the structures were used. For example, a building which is regularly used for holding wheat for only one or two months during and immediately following harvest time could be given almost full credit as a shelter for machinery which would very likely be in use much of this time anyway. On the other hand, a building which is used for long periods to

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[17]At the present time, two studies are in progress at Montana State College on marketing protein in wheat. One is being made by Mr. Jack Parfett as a part of the requirements for a Masters Degree, and one is being made by Professor Clive Harston under the auspices of the Montana State College Research Foundation. The latter study is being made under contract with the Bureau of Agricultural Economics, Washington, D.C. It remains to be seen what information may be brought to light by these studies which might be related to grain storage.

carry good crops over to poor crop years might be given little credit for shelter for machines when it is not filled with grain.

(4) It is possible to obtain benefits from storage by holding grains in anticipation of price rises not associated with the normal seasonal pattern discussed in the first section of this chapter. This process may be termed long-term speculation in the sense that it may involve holding a crop over into the next crop year although it is not easy to draw a line between using available information to determine which year is favorable for holding grain for seasonal gains and determining possibilities of obtaining gains by holding grains for more than a year. This type of benefit is tangible and measurable but prediction in terms of dollars and cents in this area presents some difficult problems.[18]

(5) Finally, some measure could be obtained of the benefits under certain conditions of storage facilities as a requirement for various conditioning processes which may increase the market value of grain, or, in some cases, prevent a complete loss of grain. Included here would be artificial drying, cleaning, and mixing or blending. In 1951 a farmer near Cutbank, Montana, invested $4,000. in a grain drier that dries 100 bushels per hour at an operating cost of 12 cents per bushel. Without this equipment, his whole crop would have been lost. At high altitudes where harvest operations are often made difficult by fall precipitation, investments in some amount of drying equipment in conjunction with storage facilities might prove to be economically feasible. Grain with

[18]See Chapter VIII for further discussion of price fluctuations.

sufficient moisture content to grade "tough" is often subject to heavy discounts.

A successful farmer in Eastern Montana who operates a large acreage states that he believes it would pay him to clean his wheat before he markets it. He ships his wheat in carload lots direct to a commission firm in Minneapolis. Not only does he lose the "dockage" which would feed out some hogs, but he pays freight on the dockage to Minneapolis. The same day, an elevator operator in the same county informed the writer that he was feeding 1,100 hogs on "cleanings" from grain cleaned in his elevator.

A farmer in Glacier County held frosted wheat from the 1950 crop to mix with the 1951 crop in such amounts that he would not have to take a $1.00 per bushel discount on the frosted wheat.

In the examples cited above, the storing function is what Working (1949) called a "necessary adjunct to the merchandising or processing business".[19] In this generalized sense, storage may be what Crouse calls it, "a necessary part of modern farming".[20]

### Intangible Benefits from Farm Storage Facilities

Into this category should go the purpose of keeping some reserves on the farm in the form of grain "because if I get the money I spend it". (Or other members of the family spend it.) This is related to

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[19] Holbrook Working, "The Theory of Price of Storage", American Economic Review, Vol. XXXIX (December 1949), p. 1260.

[20] Op. cit., p. 33.

the general purpose of keeping reserves in the form of grain in order to parry knockout blows in an area where large fluctuations in production are the rule and not the exception. What is it worth to the farmer to have a smaller but a steadier income?

In Table X data are presented which indicate that with certain patterns of fluctuations, storage can do much to equalize annual incomes and at the same time save some on income tax to offset the cost. The benefits, however, under the assumptions used for Table X, carried over only three years into the long period of drought and depression following 1928. There are alternative methods, or companion methods, of offsetting fluctuations in production, some of which may have more appeal to the economist than carrying physical supplies of grain. Nevertheless, the relative satisfaction which some farm people obtain from having grain in the bin as compared with insurance or money in the bank is real, even though it is intangible.

### Social Benefits from On-the-Farm Grain Storage

Although consideration of social aspects of the problem of whether or not farmers should build storage facilities was excluded in the delineation of the problem in Chapter I, the writer wishes to express a belief that if it pays the farmer to store grain on the farm, in general this process will not be in conflict with social goals. Certainly, if any crop is harvested in a particular season and consumed throughout the year, someone must store it until it is used.

Ostlund (1950) finds that farm storage has its greatest advantage in regulating the flow of wheat into the marketing system so that elevators, railroads, terminals, merchants, and processors can stabilize their business on a year-round basis. Certainly these groups can make more efficient use of resources if they are not required to service the whole crop in a few weeks' time.[21] The chief disadvantage of farm storage, according to Ostlund, is in quality maintenance. Because of peculiarly favorable climatic conditions, it may well be that on Montana farms may be one of the best places to store wheat from the social point of view.

There is a relation between the stabilizing of the flow of grain from year to year from an individual farm and social goals. Individual yields or yields for sizeable areas may fluctuate in a different direction than the yield for all producers. This could result in some storage in years of relatively short total crops. It may be argued, however, that the stabilizing of incomes of Montana wheat farmers is a social goal in itself, and that costs to society may result if this goal is not achieved, as witnessed by relief payments in the Great Plains Area during the drought and depression period of the 1930's.

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[21] Karl H. Ostlund, <u>The Economics of Grain Storage</u>, Unpublished M.S. thesis, Kansas State College, Manhattan, 1951, p. 70.

CHAPTER VII

# ECONOMIC FEASIBILITY OF INVESTMENTS IN GRAIN STORAGE FACILITIES ON A NORTH EAST MONTANA SPRING WHEAT FARM

## A Trial Application of The Method of Analysis

As was stated in Chapter I, the purpose of this treatise is to develop a method of analysis which will be useful to the farm enterpriser in the process of deciding how much, if any, storage space it will profit him to construct on his own farm.[1] The theoretical model is developed from the law of variable proportions. The most profitable use of the variable service is said to be made when its use is expanded to the point where marginal revenue productivity just equals the price of the service.[2]

The purpose of this chapter is to demonstrate the use of this marginal analysis in the decision-making process as applied to construction of farm storage facilities, using data from a county in the Spring Wheat farming area in North East Montana. The decision-making process requires that predictions be made. Historical wheat yields for a 30-year period are used here as an indication of level of yields and variations in yields to be expected in the future. The seasonal index of prices received for wheat by Montana farmers for the past 16 years is also used as an indication of the probable future seasonal price pattern. It is the writer's judgment that the past level of prices for wheat is of

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[1] Supra., p. 10.

[2] Supra., pp. 19-21.

little use as a guide for future action. The method used in this chapter is to assume a level of prices consistent with the 1951 costs data used.

The use of a consistent pattern of holding wheat each year in order to obtain gains from storage indicated by the seasonal price index is a conservative practice. It does not imply that prices in individual years will follow the average seasonal movement. It implies only that gains over the average compensation for storing and losses below the average compensation will cancel out over a period of years. The possibilities of selecting the best years to hold wheat and the best month in which to sell, and hence improve over the conservative practice of holding wheat regularly as a consistent practice, is treated in Chapter VIII.[3]

Also, when a given level of future prices for wheat is assumed, such as the $2.00 level assumed for the budgets in this chapter, it is not implied that prices will never average more or less than $2.00 in any individual year. It is implied that the years when wheat prices average less than $2.00 must be balanced by years when wheat prices are more than $2.00. In making a decision concerning investment in building, machinery, livestock or land, a farm operator must make some assumption about the future level of prices of the commodities he expects to produce, even though he may not make the assumption explicit.

In Chapter VIII the effect of the use of different assumptions concerning future price levels for wheat on decisions concerning

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[3]*Infra.*, pp. 119-122.

investment in storage facilities is explored. The reader is free to take his choice of the assumptions or even supply his own. Also, the possibility of using available information to predict and profit from changes in the year to year level of wheat prices is discussed in Chapter VIII.[4]

## The Model Farm

The model farm used in this section is the same as that used in Chapter VI to illustrate the possibility of savings on income tax by reducing fluctuations in annual cash income.[5] This is a single enterprise spring wheat farm in North East Montana on which is planted 500 acres of wheat each year. A single line of farm machinery based on the three-four and four-five plow tractor is used to produce the crop. Much of the data used for the model are adapted from a study made by Huffman in 1948 of farms of this type.[6]

The 30-year actual county wheat yield record from 1922 to 1951 in Roosevelt County is used for the construction of the budgets. The range in yields is from zero in 1937 to 24 bushels per acre in 1943. The average yield for the 30-year period is 12 bushels per acre. Therefore, an average crop is 6,000 bushels. The distance from the farm to the elevator where wheat is marketed is assumed to be 10 miles.

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[4]*Infra.*, pp. 122-125.

[5]*Supra.*, p. 88.

[6]*Op. cit.*, p. 17.

## The Budget Procedure

The method used is to develop budgets in which every production factor is held constant excepting the amount of farm storage facilities used in order to isolate the possible effects of the use of storage facilities on the farm. A total of six budgets have been constructed to determine the results of the use of six levels of storage facilities.

The first budget is the "control" budget in which no storage facilities are used. The wheat must be marketed from the combine, although this might possibly involve piling some of it on the ground temporarily. The other five budgets assume the use of on-the-farm storage facilities of 3,000, 6,000, 9,000, 12,000 and 15,000 bushels capacity. In terms of the average wheat production on the model farm, these figures amount to one-half crop, one whole crop, one and one-half crops, two crops, and two and one-half crops, respectively. A second variable is the yield of wheat, which is allowed to vary according to actual past yields in Roosevelt County over the 30-year period. (See Table XI, Column 2).

Costs of production used in budgets are held constant at the 1951 level. The costs of producing wheat per acre as found by Huffman in 1948 were converted to a 1951 level by use of various indexes of prices paid by farmers. The resulting average cost figure is $16.15 per acre. This cost figure excludes family labor since family income is the dependent variable which we wish to measure. For every bushel in yield over 20, a 5 cent increment is added for combining costs. For each bushel more than the average yield of 12 bushels, $7\frac{1}{2}$ cents are added for grain handling costs and for each bushel less than the average yield, $7\frac{1}{2}$ cents of handling costs are subtracted.

The average price received by farmers for wheat in Roosevelt County in 1951 was $2.02 per bushel.[7] Therefore, $2.00 per bushel is used for the level of sales price for the budgets consistent with the use of 1951 costs. In accordance with the seasonal index of prices received by Montana farmers for wheat,[8] if the wheat were sold at harvest time (in August), it would be sold for $1.90 per bushel, whereas if it were consistently sold in January, it would be sold for $2.08 per bushel. For the control budget, using no storage, value of the crop was computed by multiplying the number of bushels produced by $1.90. Income tax was computed for each year, using 1951 income tax rate schedules and assuming a farm family of four members. The resulting net income after taxes is presented in Column 3, Table XI.

The same assumptions concerning production costs and prices received are used in the five budgets where various amounts of storage facilities are used. See Columns 4, 5, 6, 7 and 8, Table XI. In the postulated use of storage facilities, two rules were followed consistently: (1) To the extent that storage space was available, wheat from each crop was held to be sold the following January, at a price of $2.08 per bushel, up to an amount equal to an average crop of 6,000 bushels. (2) For budgets using 9,000 bushels or more storage facilities, amounts more than an average crop (6,000 bushels) were held over to be sold some other January to the extent that storage space was available, or if the

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[7] Montana Agricultural Statistics, Vol. IV, (December 1952), pp. 47-49.

[8] See Figure 2, p. 80.

crop were less than average, wheat was taken from storage, if any reserves had accumulated, and sold in January to make sales equal 6,000 bushels.

Three of the possible benefits from storage which are discussed in Chapter VI are reflected in these budgets. (1) Wheat sold in January was valued at $2.08 per bushel, whereas wheat sold in August was valued at $1.90 per bushel. (2) The costs of production were reduced 2 cents per bushel for wheat not marketed at harvest time, on the assumption that cash outlay is reduced if family labor is used to haul the wheat to the elevator later in the season.[9] (3) Savings were achieved in income tax payments in budgets where storage facilities were adequate to make possible some carry-over from good crop years to poor crop years. No provision is made in the budgets for benefits from Commodity Credit Corporation loans in excess of market prices. It was assumed that these loans were available to finance the holding of wheat, if necessary, but at levels equal to, or less than, market price.

For any wheat that was put in storage, a variable storage cost of 3.5 cents per bushel was added.[10] For each bushel held over (on hand the first Monday of March), a property tax of 1 cent was added to costs.[11]

To sum up, the data on net income after federal net income tax presented in Table XI reflect the benefits of storage. This is income net

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[9] See discussion, pp. 85-87.

[10] Supra., p. 74.

[11] A sample section of the worksheet used for constructing the budgets is attached as Appendix C.

TABLE XI

NET INCOME AFTER FEDERAL NET INCOME TAX, MODEL FIVE HUNDRED ACRE SPRING WHEAT FARM IN ROOSEVELT COUNTY, MONTANA, SIX DIFFERENT LEVELS OF STORAGE CAPACITY[1]

| Year | Yield | Net Income After Federal Net Income Tax | | | | | |
|---|---|---|---|---|---|---|---|
| | | No Storage | 3,000 Bu. Storage | 6,000 Bu. Storage | 9,000 Bu. Storage | 12,000 Bu. Storage | 15,000 Bu. Storage |
| 1 | 17 | 6,781 | 7,177[2] | 7,572[2] | 3,763[2] | 3,763[2] | 3,763[2] |
| 2 | 11 | 2,305 | 2,776 | 3,947 | 3,927 | 3,927 | 3,927 |
| 3 | 20 | 8,932 | 9,316 | 8,907 | 8,215 | 3,653 | 3,653 |
| 4 | 9 | 500 | 995 | 4,008 | 3,983 | 3,959 | 3,959 |
| 5 | 10 | 1,400 | 1,895 | 1,202 | 3,963 | 3,939 | 3,939 |
| 6 | 17 | 6,781 | 7,177 | 5,931 | 3,759 | 3,735 | 3,735 |
| 7 | 17 | 7,032 | 7,339 | 7,572 | 7,548 | 7,524 | 3,714 |
| 8 | 7 | 1,305 | -810 | 4,224 | 4,045 | 4,020 | 4,000 |
| 9 | 10 | 1,400 | 1,895 | -842 | 3,971 | 3,947 | 3,927 |
| 10 | 2 | -5,820 | -1,565 | 2,525 | 3,548 | 4,355 | 4,180 |
| 11 | 10 | 1,400 | -2,195 | -5,955 | -5,955 | -842 | 3,976 |
| 12 | 6 | -2,210 | -1,715 | 2,375 | 2,375 | 2,375 | 2,375 |
| 13 | 2 | -5,820 | -1,565 | -1,565 | -1,565 | -1,565 | -1,565 |
| 14 | 5 | -3,110 | -5,765 | -5,765 | -5,765 | -5,765 | -5,765 |
| 15 | 2 | -5,820 | -2,588 | -2,588 | -2,588 | -2,588 | -2,588 |
| 16 | 0 | -5,735 | -3,690 | -3,690 | -3,690 | -3,690 | -3,690 |
| 17 | 4 | -4,015 | -7,775 | -7,775 | -7,775 | -7,775 | -7,775 |
| 18 | 11 | 2,305 | 755 | -3,945 | -3,945 | -3,945 | -3,945 |
| 19 | 12 | 3,205 | 3,700 | 3,173 | 3,173 | 3,173 | 3,173 |
| 20 | 16 | 6,815 | 7,310 | 7,805 | 4,045 | 4,045 | 4,045 |
| 21 | 19 | 9,525 | 9,908 | 10,515 | 8,965 | 8,025 | 8,025 |
| 22 | 24 | 11,539 | 11,900 | 12,261 | 13,924 | 10,398 | 10,398 |
| 23 | 19 | 8,222 | 8,618 | 9,001 | 8,979 | 8,955 | 4,421 |
| 24 | 13 | 3,845 | 4,249 | 4,653 | 4,629 | 4,604 | 4,580 |
| 25 | 12 | 3,106 | 3,510 | 3,915 | 3,890 | 3,866 | 3,841 |
| 26 | 17 | 6,781 | 7,177 | 7,572 | 7,548 | 7,524 | 7,500 |
| 27 | 16 | 6,128 | 6,454 | 6,849 | 6,825 | 6,801 | 6,777 |
| 28 | 8 | -405 | 90 | 4,037 | 4,012 | 3,988 | 3,963 |
| 29 | 21 | 9,615 | 9,980 | 7,169 | 7,425 | 7,401 | 7,375 |
| 30 | 14 | 4,580 | 4,984 | 5,388 | 5,364 | 5,339 | 5,315 |
| Carryover[3] | | | | | 5,830 | 11,672 | 17,523 |
| Total | | 77,957 | 89,537 | 98,476 | 102,423 | 104,818 | 106,756 |

[1]Income net of all costs excepting "use cost" of bins. 1951 prices paid and prices received used in budgets.

[2]Wheat carried over to sell in January of the thirty-first year entered here to offset wheat carried over from the first crop to sell in January of the second year.

[3]Carryover of 3,000 bu., 6,000 bu. and 9,000 bu. for last three budgets assumed to be used to bring up to average size, one crop, two crops, and three crops, respectively. Average-size-crop taxes for one year, two years, and three years, respectively subtracted.

of all costs excepting "use cost" of bins (price of the variable service). Differences in net income as 3,000 bushel increments of storage space are added constitute increments in revenue productivity of the storage service.

### Comparison of Benefits from Storage with Use Cost of Storage Facilities

The use cost of storage facilities was computed according to the procedure illustrated in Chapter V, pp. 69 and 70. The storage facilities used are assumed to consist of 3,000 bushel steel bins. Average annual interest cost was calculated at 4 percent to conform to the interest rate on loans made by the Production and Marketing Administration for construction of on-the-farm storage structures. For depreciation purposes, the life of the bins was taken to be 30 years. The 1951 Roosevelt County 94 mill levy was used for computing property tax on the bins. Insurance on 80 percent of the average value of structures was figured at 85 cents per $100. value insured.

Data comparing benefits from the use of farm storage facilities with use cost of the facilities are presented in Table XII. According to these data, it pays to expand the use of storage space up to (and including) that increment which brings the capacity up to 12,000 bushels. For this increment, marginal annual benefit is 2.6 cents per bushel and marginal annual use cost per bushel is 2.3 cents.[12]

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[12]For the sake of simplicity, increments of storage space are added in Table XII in the form of 3,000 bushel round steel bins. This is a reasonable procedure if this type of bin is used although the farmer may feel that the advantages of having more separate bins may offset the

Graphic Study of the Use of Storage on the Model Farm

The use of on-the-farm storage facilities on the model farm can perhaps be best understood by reference to Figure 3. Wheat production as portrayed by the vertical bars varies according to the actual yield history in Roosevelt County from 1922 to 1951. Horizontal lines on the chart indicate various levels of storage facility use, the choices ranging from an amount equal to one-half an average crop to an amount equal to two and one-half average crops.

If storage facilities are available with a capacity of only 3,000 bushels, full use could be made of the facilities in 24 of the 30 years for convenience at harvest time and for taking advantage of seasonal price rise: In only one year would the facilities be completely idle.

When storage capacity for 6,000 bushels (one average crop) is available, full use of these facilities would be made only in half the years. In 7 of the 30 years, the 3,000 bushel increment would not be used at all for harvest time convenience or for holding wheat for seasonal price gains. According to the rules adopted for the use of storage, no wheat would be held over into the next crop year when storage space is available for 6,000 bushels or less. If production exceeds the average of 6,000 bushels any year, all but 6,000 bushels must be

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additional cost per bushel capacity of using smaller sized bins. A popular sized steel bin is the 2,000 bushel bin which holds just enough to fill a modern railroad box car.

A small amount of economy which would result from adding increments of storage by increasing the size of bins might make it profitable to increase the amount of storage space to 15,000 bushels in Table XII. See, for example, the quonset-type building holding 14,302 bushels in Table VII, p. 65. (See also footnote 10, Chapter II, p. 21.)

TABLE XII

BENEFITS FROM THE USE OF ON-THE-FARM STORAGE FACILITIES AS COMPARED WITH THE USE COST OF THE FACILITIES, MODEL SPRING WHEAT FARM IN ROOSEVELT COUNTY, MONTANA

| Number of 3,000 Bushel Bins | Average Annual Benefit[1] | | Marginal Annual Benefit | | Average Annual Use Cost[2] | | Marginal Annual Use Cost | |
|---|---|---|---|---|---|---|---|---|
| | Per Bin | Per Bushel Capacity (Cents) | Per Bin | Per Bushel Capacity (Cents) | Per Bin | Per Bushel Capacity (Cents) | Per Bin | Per Bushel Capacity (Cents) |
| 1 | $386.00 | 12.9 | $386.00 | 12.9 | $70.19 | 2.3 | $70.19 | 2.3 |
| 2 | 341.98 | 11.4 | 297.96 | 9.9 | 70.19 | 2.3 | 70.19 | 2.3 |
| 3 | 271.84 | 9.1 | 131.57 | 4.4 | 70.19 | 2.3 | 70.19 | 2.3 |
| 4 | 223.84 | 7.5 | 79.83 | 2.6 | 70.19 | 2.3 | 70.19 | 2.3 |
| 5 | 192.00 | 6.4 | 64.60 | 2.1 | 70.19 | 2.3 | 70.19 | 2.3 |

[1]Benefits defined as net income from the farm with different levels of storage as compared with (in excess of) net income from the farm with no storage. (See totals at bottom of Table XI) Annual benefit is simply the benefit for the 30-year period divided by the number of years.

[2]Use cost is the cost of having the bins on the farm, consisting of interest, depreciation, insurance and property taxes on the bins.

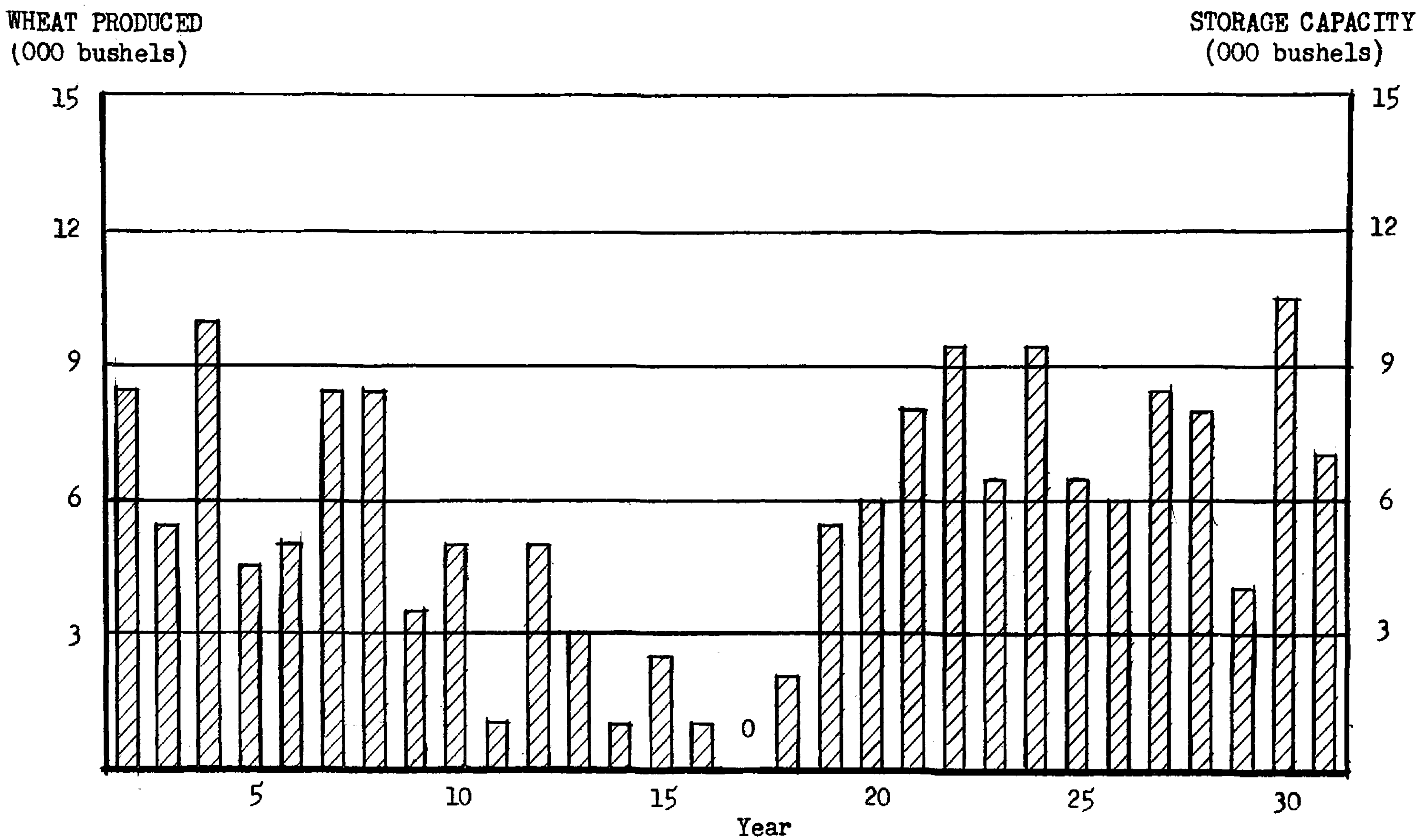


Fig. 3. Bushels of Wheat Produced on Model 500 Acre Spring Wheat Farm, Roosevelt County, Montana, For a Thirty-Year Period, Related to Various Levels of On-the-Farm Storage Capacity

sold at harvest time. In January, the 6,000 bushels will be sold to make way for the next crop.

If storage capacity is available for 9,000 bushels, then some of this capacity is available for carrying surpluses from above-average crop years to below-average crop years. For example, in the first year the whole crop of 8,500 bushels could be put into storage. In the next January, 6,000 bushels would be sold and 2,500 bushels carried over. At harvest time in the second year all the crop can be placed in the bins, and in the month of January, next, 6,000 bushels would be sold, 500 bushels of which are carried over from the first crop, and 2,000 bushels carried over into the third crop season. At harvest time in the third year, there are 12,000 bushels of wheat but only 9,000 bushels storage space, so 3,000 bushels must be sold at harvest time, 6,000 bushels sold next January and 3,000 bushels carried over to make up deficits in the fourth and fifth crops. Note that the 9,000 bushel capacity could not serve to carry over the surpluses of both the first and third crops, nor could it carry the surpluses of both sixth and seventh crops.

Only when 15,000 bushels of storage capacity is used is it possible to sell just 6,000 bushels in January for the first 11 years. Then net income varies only because of differences in costs (See Column 8, Table XI). After the twentieth year some wheat still had to be marketed at harvest time in six different years because surpluses accumulated in storage.

At storage levels greater than 6,000 bushels some benefits can still be had from harvest time convenience and from taking advantage of seasonal price rise, but at these levels benefits can also be had by savings on income tax. Total net income tax paid in the six budgets, ranging from no storage to 15,000 bushels storage capacity, was as follows: $11,868, $13,459, $14,334, $12,582, $10,834, and $9,492.

As more and more increments of storage facilities are added to the farm plant in an area of variable production, the time when each additional increment remains empty and unused increases. Although some benefits were obtained from the 3,000 bushel increment which brought the storage capacity to 15,000 bushels, the added benefits did not pay for the use cost of the added facilities.

## Significance of the Findings

The results of the analysis in this chapter, summarized in Table XII, indicate that under the assumptions used for the construction of the budgets, it would profit the farmer to expand on-the-farm storage facilities up to an amount equal to two average crops of wheat.

The conclusion is valid only for the model farm and for a setting as prescribed by the assumptions. Because the primary data which were obtained as a part of this study, particularly data on cost of construction of storage structures and the amount of storage facilities available on farms, were obtained for the year 1951, it was considered reasonable to convert all data on costs and benefits to a 1951 base. If, according to the expectations of a farm enterpriser, probable future prices for wheat and future costs are assumed to be higher or lower than the level reflected in Tables XI and XII, then different conclusions would possibly result, but this does not affect the usefulness of the method.

As a means of testing the reasonableness of the conclusion which follows from information presented in Table XII, schedules obtained from Roosevelt County farmers in 1951 reporting amounts of on-the-farm storage facilities[13] were sorted out and inspected.

Of 136 farmers who gave information on storage facilities, 79 had less than 300 acres in wheat in 1951, and 57 had more than 300 acres in wheat. Acres planted in 1951 were assumed to be normal, or typical, for the farms reporting. Therefore, the acreage in wheat was multiplied by the 30-year average wheat yield for Roosevelt County to obtain an average crop figure, with a small upward adjustment to allow for the small production of other grains in the county in 1951. This average grain production was then compared with the amount of storage capacity reported.

In total, the smaller farms, with an average of 186 acres in wheat, had storage capacity equal to 162.2 percent of the average crop. The larger farms, with an average of 695 acres in wheat, had storage capacity equal to 162.0 percent of the average crop. This amounts to more than one and one-half average crops but less than two average crops.

When the reports were arranged into a frequency distribution according to the ratio of storage capacity to average production, the

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[13] <u>Supra.</u>, p. 58-59.

modal group was found to be that with storage capacity equal to one and one-half times the average crop. (See Table XIII).

The larger farms, which resemble the model farm used in Chapter VII more closely than do the smaller farms, had a somewhat heavier distribution in the higher storage-production ratio groups than did the smaller farms, but the preponderant number of both groups have storage capacity for from one to two average crops. These data indicate that the conclusion to be drawn from data presented in Table XII is not unreasonable as measured in terms of the judgment of farm operators. Since the farmers have built less storage than would be justified in terms of the budgetary analysis, it seems plausible that one explanation might be that farmers based their plans on expectations of a future level of wheat prices somewhat lower than the level assumed in the budgets. In the next chapter the effect of using a lower price level assumption is examined.[14]

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[14]Although a $2.00 level of future wheat prices is assumed in the budgets in this chapter to correspond with the use of 1951 cost data, the writer feels that an assumption of $1.50 would be more realistic. See Chapter VIII.

TABLE XIII

AMOUNT OF ON-THE-FARM GRAIN STORAGE CAPACITY AS REPORTED IN 1951 BY RESPONDENTS FROM ROOSEVELT COUNTY, MONTANA

| Amount of Storage Capacity in Terms of Average Crop | Farms with Less Than 300 Acres in Wheat, 1951 | | Farms with More Than 300 Acres in Wheat, 1951 | | All Farms | |
|---|---|---|---|---|---|---|
| | No. | Percent | No. | Percent | No. | Percent |
| Less than 25% | 3 | 3.8 | 1 | 1.7 | 4 | 3.0 |
| 25 to 74.9 | 12 | 15.3 | 5 | 8.8 | 17 | 12.5 |
| 75 to 124.9 | 19 | 24.0 | 13 | 22.8 | 32 | 23.5 |
| 125 to 174.9 | 19 | 24.0 | 19 | 33.3 | 38 | 27.9 |
| 175 to 224.9 | 8 | 10.1 | 9 | 15.8 | 17 | 12.5 |
| 225 to 274.9 | 7 | 8.9 | 5 | 8.8 | 12 | 8.8 |
| 275 or more | 11 | 13.9 | 5 | 8.8 | 16 | 11.8 |
| Total | 79 | 100.0 | 57 | 100.0 | 136 | 100.0 |

CHAPTER VIII

# THE PRICE VARIABLE AS RELATED TO DECISIONS CONCERNING CONSTRUCTION OF FARM STORAGE FACILITIES

## Assumptions Concerning the Expected Future Level of Wheat Prices

In making a decision concerning an investment in any kind of durable productive resource an enterpriser makes some assumption concerning the future level of prices for the product he expects to produce. This is common procedure used also by lending agencies, particularly agencies lending money to farmers for the purchase of land and buildings.

In demonstrating the use of marginal analysis in Chapter VII as applied to decisions concerning investments in storage structures, a future price level of $2.00 per bushel for wheat was assumed. It was concluded that, based on this assumption, the marginal increment of storage facilities which would just pay for itself would be that 3,000 bushel increment which brought storage facilities up to two average crops. (See Table XII).

What the future average price for wheat will be cannot be foretold. Reference to the past gives us very little comfort in this area. A device which is useful is to make different assumptions and let the reader take his choice.[1] Table XIV presents the results of calculating the benefits from the use of storage facilities using three assumptions concerning the future price level of wheat.

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[1]The reader can also furnish his own assumptions and arrive at some reasonable conclusions from the data by the processes of interpolation or extrapolation.

TABLE XIV

NET INCOME AFTER TAX ASSUMING THREE DIFFERENT PRICE LEVEL EXPECTATIONS FOR WHEAT, MODEL 500 ACRE SPRING WHEAT FARM IN ROOSEVELT COUNTY, MONTANA

| Year | Yield | Production, Bushels | Net Income After Tax | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Level of Wheat Prices at $2.00 per Bushel | | Level of Wheat Prices at $1.50 per Bushel | | Level of Wheat Prices at $1.00 per Bushel | |
| | | | No Storage Capacity | 6,000 Bu. Storage Capacity | No Storage Capacity | 6,000 Bu. Storage Capacity | No Storage Capacity | 6,000 Bu. Storage Capacity |
| 1 | 17 | 8,500 | $6,781 | $7,572 | $4,880 | $5,490 | $2,955 | $3,363 |
| 2 | 11 | 5,500 | 2,305 | 3,947 | 1,325 | 2,754 | 354 | 1,321 |
| 3 | 20 | 10,000 | 8,932 | 8,907 | 6,534 | 6,513 | 4,143 | 4,037 |
| 4 | 9 | 4,500 | 500 | 4,008 | - 20 | 2,807 | - 534 | 1,371 |
| 5 | 10 | 5,000 | 1,400 | 1,202 | 655 | 508 | - 90 | - 186 |
| 6 | 17 | 8,500 | 6,781 | 5,931 | 4,880 | 4,233 | 2,971 | 2,495 |
| 7 | 17 | 8,500 | 7,032 | 7,572 | 5,126 | 5,490 | 3,018 | 3,397 |
| 8 | 7 | 3,500 | -1,305 | 4,224 | -1,368 | 2,898 | -1,422 | 1,421 |
| 9 | 10 | 5,000 | 1,400 | - 842 | 655 | -1,024 | - 90 | -1,206 |
| 10 | 2 | 1,000 | -5,820 | 2,525 | -4,731 | 1,525 | -3,642 | 525 |
| 11 | 10 | 5,000 | 1,400 | -5,955 | 655 | -4,857 | - 90 | -3,759 |
| 12 | 6 | 3,000 | -2,210 | 2,375 | -2,043 | 1,395 | -1,866 | 425 |
| 13 | 2 | 1,000 | -5,820 | -1,565 | -4,731 | -1,541 | -3,642 | -1,517 |
| 14 | 5 | 2,500 | -3,110 | -5,765 | -2,713 | -4,702 | -2,310 | -3,634 |
| 15 | 2 | 1,000 | -5,820 | -2,588 | -4,731 | -2,308 | -3,642 | -2,028 |
| 16 | 0 | 0 | -5,735 | -3,690 | -4,430 | -2,897 | -3,180 | -2,159 |
| 17 | 4 | 2,000 | -4,015 | -7,775 | -3,387 | -6,205 | -2,754 | -4,630 |
| 18 | 11 | 5,500 | 2,305 | -3,945 | 1,325 | -3,359 | 354 | -2,763 |
| 19 | 12 | 6,000 | 3,205 | 3,173 | 1,999 | 1,977 | 798 | 786 |
| 20 | 16 | 8,000 | 6,815 | 7,805 | 4,692 | 5,436 | 2,574 | 3,072 |
| 21 | 19 | 9,500 | 9,525 | 10,515 | 6,711 | 7,455 | 3,906 | 4,404 |
| 22 | 24 | 12,000 | 11,539 | 12,261 | 8,841 | 9,591 | 5,811 | 6,554 |
| 23 | 19 | 9,500 | 8,222 | 9,001 | 5,983 | 6,587 | 3,683 | 4,091 |
| 24 | 13 | 6,500 | 3,845 | 4,653 | 2,672 | 3,282 | 1,242 | 1,740 |
| 25 | 12 | 6,000 | 3,106 | 3,915 | 1,999 | 2,729 | 798 | 1,296 |
| 26 | 17 | 8,500 | 6,781 | 7,572 | 4,880 | 5,490 | 2,955 | 3,363 |
| 27 | 16 | 8,000 | 6,128 | 6,849 | 4,327 | 4,938 | 2,574 | 2,999 |
| 28 | 8 | 4,000 | - 405 | 4,037 | - 694 | 2,832 | - 978 | 1,396 |
| 29 | 21 | 10,500 | 9,615 | 7,169 | 7,051 | 5,164 | 4,399 | 3,133 |
| 30 | 14 | 7,000 | 4,580 | 5,388 | 3,221 | 3,831 | 1,686 | 2,184 |
| Totals | | | 77,957 | 98,476 | 49,563 | 66,032 | 19,981 | 31,491 |

The same budgetary method was used as was reported in Chapter VII (See also Appendix C). Data in Table XIV showing benefits on the 500 acre model farm when a $2.00 future price of wheat is assumed are brought over from Table XI.

According to the seasonal index of prices received by Montana farmers for wheat, when a future price of $1.00 per bushel for wheat was assumed, wheat sold in August was valued at $0.95, and wheat sold in January was valued at $1.04. (See Table VIII). The corresponding figures for the budgets assuming $1.50 wheat were $1.42 for August and $1.56 for January.

In the budgets in which $1.00 was used as the expected price of wheat, an average cost per acre of $9.66 for producing wheat was used, with adjustments for handling costs for yields above and below the average yield. This cost figure was obtained by adjusting Huffman's cost per acre of $14.64 in 1948 to a 1942 base by use of various indexes of prices paid by farmers. The average price received by Montana wheat farmers for the 1942 wheat crop was approximately $1.00 per bushel.

Variable costs for storage were also reduced to correspond to the $1.00 per bushel price of wheat. For example, a 1 percent shrink amounts to only 1 cent per bushel for $1.00 wheat, as compared with 2 cents per bushel for $2.00 wheat. Extra cost of putting wheat into and taking it out of storage was reduced by the index of prices paid by farmers for labor as was also the charge for additional cash outlay when the farmer hires his grain hauled. The 1949 federal income tax schedule was used as an approximation of the level of taxes which might be expected with wheat prices lower than $2.00.

TABLE XV

BENEFITS FROM THE USE OF ON-THE-FARM STORAGE FACILITIES, THREE DIFFERENT PRICE LEVEL ASSUMPTIONS, MODEL SPRING WHEAT FARM IN ROOSEVELT COUNTY, MONTANA

| Item | Level of Wheat Prices at $2.00 per Bushel | Level of Wheat Prices at $1.50 per Bushel | Level of Wheat Prices at $1.00 per Bushel |
|---|---|---|---|
| Average annual net income after taxes | | | |
| 6,000 bu. storage capacity | $3,283 | $2,201 | $1,050 |
| No storage capacity | 2,599 | 1,652 | 666 |
| Difference due to storage | 684 | 549 | 384 |
| Average earnings per bu. from storage space | 11.4¢ | 9.2¢ | 6.4¢ |

Costs of producing wheat and variable costs of storage for the budgets in which $1.50 was used as the expected price of wheat were assumed to be midway between costs used for the $1.00 budgets and the $2.00 budgets.

Benefits from the use of storage facilities using the three price level assumptions are summarized in Table XV. Average annual earnings per bushel from the use of storage space equal to one average crop is found to be 11.4 cents, 9.2 cents and 6.4 cents, respectively, on the model farm when future wheat prices of $2.00, $1.50, and $1.00 per bushel are assumed. These benefits can then be compared with the annual use cost of the storage as was demonstrated in Table XII.

The earnings per bushel for 6,000 bushels storage capacity at each of the three price level assumptions are greater than the annual use cost of bins at 1951 construction costs for bins as recorded in Table XII. Presumably, however, if the study is extended to storage capacity increments in excess of 6,000 bushels (one average crop), the most profitable amount of storage space, using $1.50 and $1.00 price assumptions, will be less than that observed when a price of $2.00 for wheat was assumed in Chapter VII.[2]

It should be noted that no change in the use cost figures for storage structures is suggested. The decision to construct storage space is based on what bins cost now. This cost can be known with certainty. At some future date the cost of bins may be different, but prediction of the future cost of bins is not a part of the problem.

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[2]As a check against the use of budgets up to this point which assumed various future price levels for wheat, two budgets were constructed using actual sales prices for each year of the 30-year period from 1922 to 1951. One budget assumes no storage space and the other assumes 6,000 bushel storage space. Cost figures were adjusted to correspond to the price of wheat each year by use of indexes of prices paid.

As with the other budgets, it was assumed the farmer would hold wheat each year to take advantage of average gains rather than try to predict the most favorable years to hold. For the period from 1922 to 1936, when much of the wheat was cut with header or binder, threshed, and hauled to town with horses, the month of lowest prices (harvest month) was October and the month of peak prices was July. From 1937 to 1952 the low and high months were August and January, respectively.

The possible net gain from the use of 6,000 bushels of storage space for the 30-year period was $10,868 or just over 6 cents per year per bushel of storage capacity. Average harvest-time price of wheat was $1.08 and average peak-month price was $1.15. This result compares reasonably well with the budgets assuming a $1.00 level of wheat prices. (See Tables XIV and XV).

## Divergence from the Average Seasonal Movements of Wheat Prices

For the budgets introduced in Chapter VII it was assumed that the farmer would follow the conservative practice of holding wheat regularly as a consistent practice in order to take advantage of average gains from storage as indicated by the seasonal index of prices received by farmers. Gains in individual years over the average compensation for storing and losses in individual years under the average compensation for storing would cancel out over a period of years. The seasonal index of prices received for wheat was computed for a 16-year period from 1936 to 1951 with corrections for trend in the general price level.[3]

In individual years prices vary from the average seasonal pattern. The question arises, "Could not the farmer, by use of outlook information and analysis, do better than follow the consistent pattern of operation mentioned above?" Certainly if he had perfect knowledge he could do better. Prices in individual years fail to follow the average seasonal movement because of such causes as changes in the general price level, variations in crop size relative to demand, changes in stocks, changes in production in different countries with different harvesting seasons, and mistakes (and their corrections) made by traders.[4] How would a farmer organize his storage program if he had perfect knowledge of these factors?

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[3]*Supra.*, p. 80, Table VIII.

[4]See F. L. Thompson, *Agricultural Prices*, McGraw-Hill, New York, 1936, p. 438.

Actual prices received for wheat by Montana farmers for the period used in computing the seasonal price index are presented in Table XVI. One item of interest concerning the actual price data is that in five of the 16 years the highest average monthly price is in June and July after harvest operations are underway in the southern wheat states. This is due to the rising general price level associated with World War II. When the data are corrected for general price level trend, the high period is found to be from January through May. (See Table VIII and Figure 2). An important cause of divergence from the average price pattern during this period, then, was an upward trend in the general price level. The highest price which could have been obtained for the 1949 crop was in July of 1950 after the beginning of the Korean War. This is an incident which the farmer could hardly have been expected to predict.

According to Table XVI, a consistent policy of selling wheat in January rather than at harvest time would have earned the Montana farmer an average of 14 cents per year for a period when the average price of wheat was $1.33 per bushel, which corresponds to the figures used in the budgets in this treatise. The average actual price paid for wheat during the 16-year period was as high in April and May as in January, (See Table XVII), but variable costs of storage are greater when wheat is held beyond the property tax assessment date in March.

Assuming that the wheat is to be sold before the next harvest each year, then the best the farmer could have done with perfect knowledge is indicated by Column 4 in Table XVI. By choosing the best month in which

TABLE XVI

ACTUAL PRICES RECEIVED BY MONTANA FARMERS FOR WHEAT FOR THE PERIOD USED TO COMPUTE THE SEASONAL PRICE INDEX, 1936 to 1951

| Crop Year | Price of Wheat in August | Price of Wheat in January | High Price During Crop Year |
|---|---|---|---|
| 1936 | $1.20 | $ 1.37 | $1.38 (Feb.) |
| 1937 | 1.07 | .92 | 1.07 (Aug., Jan. next high) |
| 1938 | .46 | .46 | .53 (May & June) |
| 1939 | .45 | .72 | .77 (Apr.) |
| 1940 | .49 | .62 | .73 (June & July) |
| 1941 | .77 | .98 | .98 (Jan.) |
| 1942 | .88 | 1.07 | 1.13 (June & July) |
| 1943 | 1.13 | 1.34 | 1.37 (Apr. & May) |
| 1944 | 1.26 | 1.35 | 1.43 (June) |
| 1945 | 1.38 | 1.43 | 1.85 (July) |
| 1946 | 1.68 | 1.81 | 2.37 (March) |
| 1947 | 2.07 | 2.81 | 2.81 (Jan.) |
| 1948 | 1.85 | 1.87 | 1.93 (Nov.) |
| 1949 | 1.76 | 1.82 | 1.99 (July) |
| 1950 | 1.94 | 1.94 | 2.08 (Feb.) |
| 1951 | 1.92 | 1.99 | 2.02 (Nov.) |
| Average | 1.27 | 1.41 | 1.53 |

Source: Data being prepared for publication by the Montana Agricultural Experiment Station.

TABLE XVII

AVERAGE ACTUAL MONTHLY PRICES RECEIVED BY MONTANA FARMERS FOR WHEAT, 1936 to 1951

| Month | Average Price per Bu. Received for Wheat | Month | Average Price per Bu. Received for Wheat |
|---|---|---|---|
| January | $ 1.41 | July | $ 1.39 |
| February | 1.37 | August | 1.27 |
| March | 1.40 | September | 1.30 |
| April | 1.41 | October | 1.33 |
| May | 1.41 | November | 1.35 |
| June | 1.38 | December | 1.39 |

Source: Data being prepared for publication by the Montana Agricultural Experiment Station.

to sell, which would include selling at harvest time in 1937, the farmer could have averaged a gain of 26 cents per bushel by holding his wheat for the appropriate length of time. Supposedly, then, possible gains from storage for that period ranged somewhere between the 14 cents which would have been obtained by the conservative policy used in the budgets in this treatise and the 26 cents which, according to "hindsight", could have been gained with perfect knowledge.[5]

### Year to Year Changes in Wheat Prices

Closely related to the failure of prices in an individual year to follow average seasonal price movements is year to year variations in the price of wheat. The latter is often a cause of the former.[6] These year to year variations in wheat prices are related not only to supply and demand relationships for wheat but also to normal business cycles and to wartime inflation and post-war deflation.

For the budgets used in Chapter VII and in the first section of this chapter, a future average level of wheat prices was assumed. Such an assumption does not imply that prices will not fluctuate from year to year but only that movements above and below the average will cancel each other out over a period of years. However, actual changes in the

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[5]At least two qualifications should be made to the comments of this paragraph. (1) Actually, the farmer's judgment or the advice he receives may be of such quality that attempts to predict the right year to store and the right month to sell would leave him worse off than if he followed the "conservative" policy. (2) If perfect knowledge is assumed, then the farmer might even do better by choosing a certain day in the year in which to sell than is indicated when monthly averages are used.

[6]*Supra.*, p. 119.

level of wheat prices would modify the income-leveling effect of holding stocks of wheat from good crop years to sell in years when crops are poor. Moreover, there are opportunities of using outlook information and analysis for the purpose of obtaining speculative benefits from holding wheat from year to year.

Figure 4 portrays the year to year movements of wheat prices in Montana for a 42-year period from 1911 to 1952. The average price received by Montana farmers for wheat for the 42-year period was $1.20 but the range in yearly average prices was from $0.43 in 1932 to $2.32 in 1947. The four most spectacular movements were (a) the 77 cent rise from 1916 to 1917 associated with World War I, (b) the $1.15 fall from 1920 to 1921 associated with the post-war depression, (c) the 50 cent drop from 1937 to 1938 associated with the 1937 "recession", and (d) the 69 cent rise from 1946 to 1947 associated with the removal of price controls after World War II. From the standpoint of decisions concerning whether to hold wheat or not to hold wheat, these were the situations where prediction was vitally important and yet they constitute the kind of situation which is very difficult to predict.

Periods of consistently decreasing or consistently increasing prices are easily discernable in Figure 4. Prices decreased steadily, for example, from 1925 to 1932 and increased steadily from 1939 to 1947. In all but two of the years from 1925 to 1932 gains could have been made from holding grain for seasonal price rises, (though less than the average seasonal gains), but losses would have been made from holding wheat over into the next year. In the period from 1939 to 1947 seasonal gains

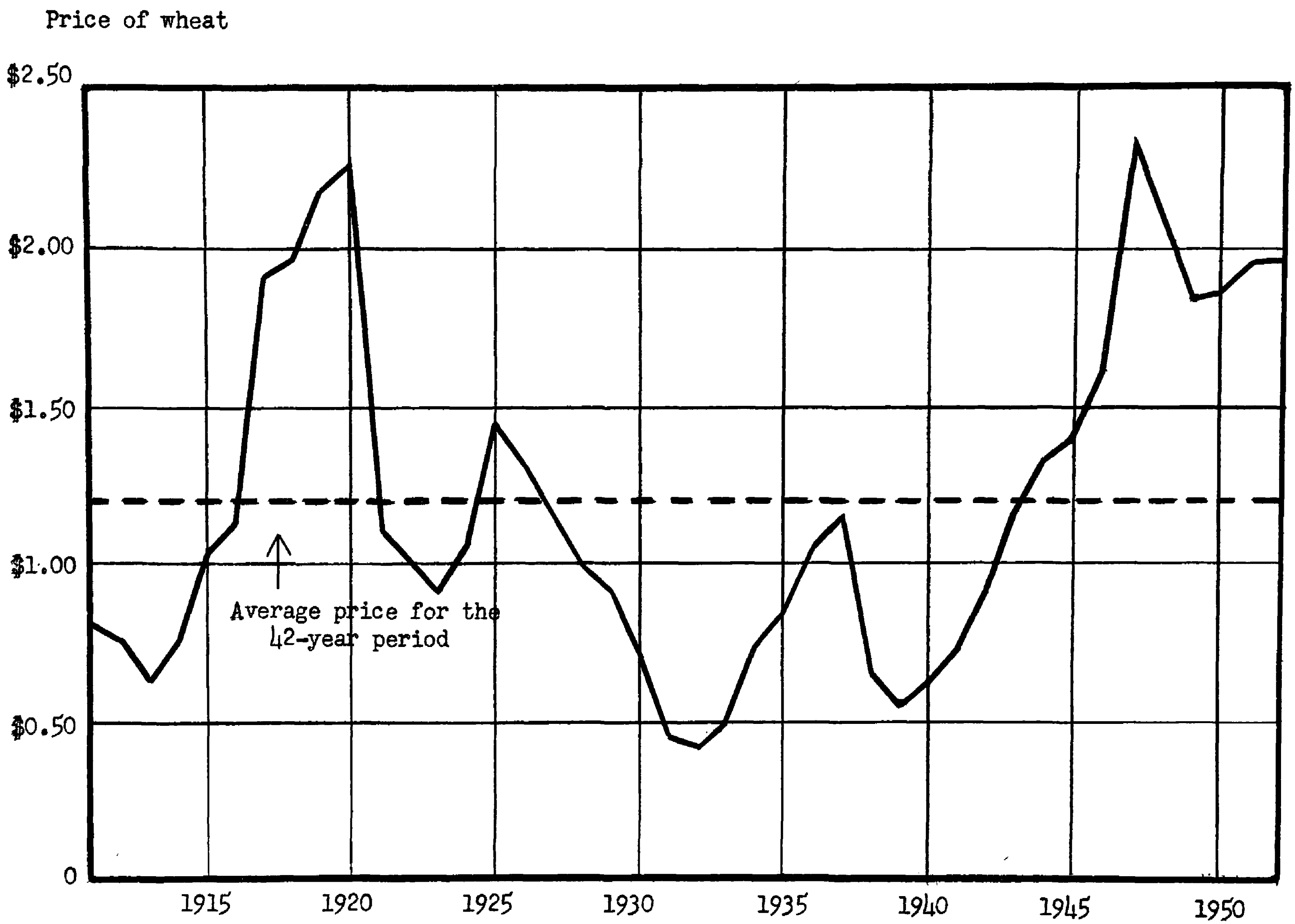


Figure 4. Average annual prices received for wheat by Montana farmers, 1911 to 1952.

were more than average, and additional gains would have been made by holding wheat over into the next year.

The farmer may wish to use whatever information and analysis is available, including business cycle analysis, to make speculative profits from storing wheat.[7] For the farmer who wishes to hedge against changes in the price level, holding some of his assets (reserves) in the form of wheat and some in the form of dollars or dollar claims serves the same purpose as keeping some of both common stocks and government bonds in the investment portfolio.

Although it is not a part of the problem outlined for this treatise, an important area for study is the relation between a feed reserve program designed to stabilize livestock operations and possible benefits from year to year price changes. Particularly for roughages, it appears to be a reasonable hypothesis that reserves could be built up in years of good crops when prices are usually relatively low and would be used in years when feed crops are poor and prices are usually relatively high.

## The U.S. Government Price Support Program

In Chapter VI it was stated that it would be double counting to add the advantage of obtaining a government loan higher than the market

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[7]As was pointed out for seasonal price movements, it is quite possible for the farmer to do worse by trying to predict year to year price movements than by a consistent practice of storing according to a regular plan or of not storing at all. See Footnote No. 4, this chapter.

price at harvest time to the benefits of storing for seasonal price rises. Only that part of a loan which is in excess of the market price when the farmer would have sold his wheat can properly be added to gains from holding for seasonal price increases.[8]

For the budgets in Chapters VII and VIII it was assumed that benefits to be expected from price support loans at harvest time would not exceed benefits from storing for seasonal price rises, but that loans would be available to help finance the holding of wheat. For the purpose of predicting the course of future events this appears to be a reasonable assumption since there is little basis for predicting the level of future commodity loans. However, according to the old adage that "a bird in the hand is worth two in the bush", the commodity loan program of the Commodity Credit Corporation has undoubtedly directly influenced many farmers to build storage structures and is likely to continue to do so.

There are even cases where the loan available from the Commodity Credit Corporation in any one year is higher than the harvest-time market price by an amount greater than the necessary investment in storage facilities. In such cases, especially if commercial storage space is not available, an involved discussion of such items as interest and depreciation on the investment is purely academic. For example, in August of 1953, the difference between the market price for wheat of less than 12 percent protein and the loan which could have been obtained

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[8] <u>Supra.</u>, p. 94.

at Great Falls, Montana, was 30 cents per bushel.[9] This amount would pay the full cost of construction of some kinds of storage facilities.[10]

In Montana wheat must be purchased by elevators on the basis of protein content. The protein premium complicates the analysis of storage benefits. The average market price of No. 1 hard wheat in August, 1953, at Great Falls, Montana, was $1.71 for wheat of less than 12 percent protein content. The basic loan rate at Great Falls was $2.01. However, the average market price for wheat with 14 percent protein content was $1.88, and for wheat with 16 percent protein content was $1.96. A very small amount is added to the basic loan rate (about 6 cents for 16 percent) for protein. The farmer is prone to argue that if the price of wheat with protein premium is as great, or nearly as great, as the loan rate, the loan is "not worth fooling with".

It is true that if the farmer expects not to pay off the loan, to be "worth fooling with" the loan must be enough greater than the market price, including protein premium, to pay at least the cost of storage. If the farmer takes the loan to protect himself against a fall in the market price while he holds wheat in hopes of a price rise, then he is still speculating on the protein premium. The premium may fall enough by the time the wheat is marketed to offset gains in the general market price of wheat. At the present time there is practically no information available on which to base predictions concerning protein premiums.

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9 See Table IX, p. 84.

10 See Tables IV, V, VI, and VII, pp. 64, 65.

# CHAPTER IX

## SUMMARY AND CONCLUSIONS

### Summary

The stated purpose of this treatise was to develop a method of analysis which will be useful to the farm enterpriser in the process of deciding how much, if any, storage space it will profit him to construct on his own farm. As a general hypothesis it was postulated that under certain conditions of costs, yield variability, prices of grain, farm organization, and availability of storage space off the farm, it will pay the farm operator to construct storage facilities on his farm up to a point which can be approximately determined by the method to be developed.[1]

The theoretical model which constitutes the design for the undertaking is derived from the law of variable proportions. It was postulated that within the relevant range of combination of the variable input (storage facilities) with a fixed quantity of other resources (typical farm layout), the marginal return from the variable input will be diminishing. The optimum use of the variable input will be achieved if its application is expanded to the point where marginal revenue productivity is just equal to the price of the service (input). Revenue productivity of the variable input (storage space) is defined as the annual net income from the farm (after taxes) with storage space as compared with (in excess of) net income from the farm with no storage

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[1] Supra., p. 10.

space. The price of the variable service, termed annual "use cost" of the bins, is made up of interest, depreciation, insurance and property taxes on the bins.

In Chapters III, IV, V and VI information was presented on the reasons why some farmers build storage facilities in Montana and other Northern Great Plains States. A study was made of the measurement of costs and benefits of the use of farm storage facilities of various types.

In Chapter VII, a test was made of the theoretical model using empirical data for a 500 acre spring wheat farm in Roosevelt County, Montana. Actual yield experience in that county for a 30-year period from 1922 to 1951 was used as an indication of future yield variations. A 16-year seasonal price index was used as a measure of future seasonal price movements. Prices paid and prices received as of 1951 were assumed to measure the future level of costs and returns.

The synthetic (or budgetary) method was used. This method involves the use of budgets designed to reflect the results of various combinations of the agents of production.[2] Six budgets were constructed for the model farm, to reflect the use of six levels of on-the-farm storage facilities in combination with a fixed amount of other resources. The results, summarized in Table XII, indicate that, under the assumptions used for the construction of the budgets, it would profit the farmer to

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[2] Supra., p. 101.

expand on-the-farm storage facilities up to an amount equal to two average crops of wheat.

## Some Conclusions

The conclusion to be drawn from the data presented in Table XII, that storage facilities can profitably be constructed up to an amount equal to two average crops, is valid only for the model farm and for a setting prescribed by the assumptions used for a test of the model.

In comparing any individual farm with the model farm used, it would seem reasonable to conclude that if yield variability for the individual farm is greater, distance to town is greater, or storage costs less than for the model farm, then benefits to be expected from on-the-farm storage operations would be greater. If, on the other hand, storage costs for the individual farm are greater, yields are more stable, distance to the elevator shorter and local commercial facilities more plentiful and less apt to be congested at harvest time than for the model farm, then benefits to be expected from on-the-farm storage operations would be smaller.

Moreover, if a lower level of expected future prices to be received for wheat is assumed, along with a corresponding lower level of expected future costs, then benefits to be expected from on-the-farm storage operations would be smaller, as was demonstrated in Chapter VIII. Presumably, also, the inverse is true. This observation does not reflect on the applicability of the method of analysis, but it indicates that results from the use of the method depend upon the data available for use.[3]

The device of assuming a consistent policy of holding wheat regularly to take advantage of seasonal price movements is held to be a conservative practice. It is possible that by the use of outlook information and analysis the farmer might make additional gains of a speculative nature by trying to select which years it would be most profitable to hold wheat, either for seasonal price gains or year to year price rises, as was demonstrated in Chapter VIII. It is also possible to lose by this process. At any rate, with information available at the present time, prediction is difficult.

There will be cases where the difference between the market price for wheat and the loan available from the Commodity Credit Corporation is greater than the total investment required to construct on-the-farm storage structures. If commercial storage space is not available, then a discussion of long term costs and earning capacity of bins is academic.

Finally, the writer cannot escape the conclusion that the decision concerning whether or not to build storage facilities or concerning how

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[3]To illustrate; it can be said that if different assumptions concerning future costs and returns are used in the capitalization formula for obtaining the value of land, different answers are received. But this does not reflect on the validity of the capitalization method for arriving at the value of land. It does, however, point up one of the limitations of the method.

much of such facilities to build will in many cases hinge on such intangible costs and intangible benefits as are discussed in Chapters V and VI.[4]

## Work Which Remains to be Done

It was not the purpose of this treatise to provide all the answers concerning the economic feasibility of construction of on-the-farm storage facilities in Montana. It was hoped that the method developed here would be useful for further study of the problem.

Only two independent variables were included in the analysis made in Chapter VII. According to the general hypothesis stated in Chapter I, page 10, there are several variables which should be investigated. The probability distribution of yields is itself a variable. One of the next steps of the Montana study will be the use of the technique developed in Chapter VII to study a model winter wheat farm in Cascade County, Montana, where the coefficient of variation of annual wheat yields is 43, as compared with 61 in Roosevelt County.

Other factors affecting the economic feasibility of on-the-farm storage are the level of prices received and prices paid by farmers, including cost of building storage structures, and variations in the relationship of prices paid and prices received. These were assumed to be constant in the budgets constructed for Roosevelt County. Different levels can be assumed, depending on judgment or guesses, but any information which could assist in making predictions in this area would be useful.

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[4] <u>Supra.</u>, pp. 74-76 and 95-96.

Still another variable is the size of farm unit. Certain data presented in Chapter V[5] and in Chapter VI[6] appear to support a hypothesis of increasing returns to scale. The relationship between size of farm and benefits from storage should be explored further. It has some bearing on possible savings on net income taxes (see Table X), and possibly on the ease of financing the investment and on the relationship of use of farm storage facilities to efficiency of harvest operations.

Variations in distance from the farm to the elevator, the kind of farm roads, the availability of commercial storage space, possible other uses of storage facilities and expectations concerning future price support programs, all may affect the decision of the farm enterpriser concerning whether or not to build storage structures on his farm.

Even if these were all investigated, measured, and integrated into a system of analysis, there would still be such intangible benefits and costs as discussed in Chapters V and VI[7] upon which the decision may turn.

More data on possible benefits from reducing cash outlay, from maintaining seed reserves, from segregating lots of wheat with different protein content, from multiple use of storage structures, and from use of storage as a necessary adjunct to cleaning, drying, and blending

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[5]*Supra.*, pp. 64-66.

[6]*Supra.*, pp. 90-92.

[7]*Supra.*, pp. 74-76 and 95-96.

grain will be useful if and when they are obtained.[8] So, also, would data on such variable costs of storage as shrinkage and additional costs involved in putting wheat into and taking it out of farm storage structures.

In view of trends in population number and distribution, it seems likely that feed reserves for livestock will take on increasing importance in Montana in the future. Involved is the adaptation of an uncertain feed production pattern to the need for stability in livestock feed operations. Information is needed on the economics of grain and forage storage for feed reserves.

## Economic Analysis and the Farmer

Traditionally, the farmer uses a much more simplified approach to the question of feasibility of investments than is suggested in this analysis. Ordinarily, for example, he does not think of interest as a cost unless it is paid out. A piece of equipment is a good investment if it "pays for itself" before it is worn out. Actually, his goal is not different from that toward which the economist strives, and although the farmer's method is more simple, it can also be misleading particularly when the concepts of marginal costs and marginal benefits are ignored.

Because of differences in the relevancy of the various costs and benefits to individual farm situations, it was not expected that the result of this analysis would be a simple answer to the question of

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[8] *Supra.*, pp. 92-95.

how much farm storage would be profitable for a particular farm. The individual farmer might obtain some help from a comparison of his farm with the model farm. The greater hope, however, was that a framework of analysis could be supplied which would be useful to the individual farmer in arriving at his own conclusion, or which might be useful to the researcher in arriving at some conclusions which would be applicable to farmers when classed into homogeneous groups as far as storage problems are concerned.

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# APPENDIX A

## SCHEDULE USED TO OBTAIN DATA ON GRAIN STORAGE FACILITIES IN MONTANA

| Small Grain Storage Facilities on This Farm or Ranch | | | | | | | |
|---|---|---|---|---|---|---|---|
| Kind of bin space built for small grain storage | Total capacity on this farm or ranch Jan. 1, 1952 (Bu.) | Amount and condition of each kind of storage placed on farm or ranch during periods shown below | | | | | |
| | | 1949 to 1952 | | 1946 to 1948 | | Prior to 1946 | |
| | | Bu. | Condition[1] | Bu. | Condition[1] | Bu. | Condition[1] |
| 9. Steel bins | | | | | | | |
| 10. Quonset type | | | | | | | |
| 11. Wooden bins | | | | | | | |
| 12. Other, specify kind | | | | | | | |
| | | | | | | | |

[1]Report condition of storage in terms of good, fair, and poor.

# APPENDIX B

## PRICES OF MATERIALS USED IN COMPUTING COST OF CONSTRUCTION OF VARIOUS TYPES OF ON-THE-FARM GRAIN STORAGE STRUCTURE

| Materials used | Unit of measurement | Price |
|---|---|---|
| Dimension lumber | 1,000 bd. ft. | $ 95.00 |
| Sheeting | 1,000 bd. ft. | 95.00 |
| Shiplap | 1,000 bd. ft. | 120.00 |
| Drop siding | 1,000 bd. ft. | 165.00 |
| Galvanized steel sheets | sq. ft. covered | .16 |
| Cement | 90 lb. sack | 1.45 |
| Nails | pound | .13 |
| Sand and Gravel | Cubic yard | 2.50 |

# APPENDIX C

## SAMPLE OF WORKSHEET USED IN CONSTRUCTING BUDGETS SHOWING NET STORAGE BENEFITS IN CHAPTERS VII AND VIII[1]

| Year | Yield | Production Bushels | Sold in August at $1.90 per Bu. | | Sold in January at $2.08 per Bu. | | Carry-over, Bushels | Total Value of Sales | Expense of Producing Crop | Variable cost on Grain Stored at 3.5 Cents per Bu. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bu. | Value | Bu. | Value | | | | |
| 1 | 17 | 8,500 | | | 6,000[2] | $12,480[2] | | $12,480 | $8,260 | $210. |
| 2 | 11 | 5,500 | | | 6,000 | 12,480 | 2,500 | 12,480 | 8,035 | 210. |
| 3 | 20 | 10,000 | 3,000 | $5,700 | 6,000 | 12,480 | 2,000 | 18,180 | 8,375 | 210. |
| 4 | 9 | 4,500 | | | 6,000 | 12,480 | 3,000 | 12,480 | 7,960 | 210. |
| 5 | 10 | 5,000 | | | 6,000 | 12,480 | 1,500 | 12,480 | 8,000 | 210. |

(continued)

| Additional Cash Outlay, Wheat Marketed From Combine, at 2 Cents per Bu. | Property Tax on Carry-over at 1 Cent per Bu. | Total Cost | Net Income Before Tax | Minus 10 Percent up to $1,000 (Deductions) | Minus $2,400 for Family of Four (Exemptions) | Federal Net Income Tax | Net Income After Tax |
|---|---|---|---|---|---|---|---|
| | | $8,470. | $4,010. | $3,609. | $1,209. | $ 247. | $3,763. |
| | $25. | 8,270. | 4,210. | 3,789. | 1,389. | 283. | 3,927. |
| $60. | 20. | 8,665. | 9,515. | 8,563. | 6,163. | 1,300. | 8,215. |
| | 30. | 8,200. | 4,280 | 3,852. | 1,458. | 297. | 3,983. |
| | 15. | 8,225. | 4,255 | 3,830. | 1,430. | 292. | 3,963. |

[1]Budget for 500 acre farm, 9,000 bu. storage capacity. Rules of procedure were (a) to store crop to sell next January except that (b) if space is available, sell only 6,000 bu. (one average crop) and hold remainder over until another January in order to move toward equalizing annual income.

[2]Assume 6,000 brought over from previous year.