ANALYSIS OF CORN HARVESTING AND GRAIN HANDLING SYSTEMS IN NORTHEASTERN VIRGINIA

by

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CHAPTER I

INTRODUCTION

The production of corn occupies a prominent place in Virginia's agriculture. The average acreage of corn harvested for grain for the period 1951-60 was 727,000 acres, with an average yield of 39.8 bushels per acre. In 1961, although only 545,000 acres were harvested, the yield jumped to fifty-three bushels per acre and a total production of 28,885,000 bushels.[1]

Northeastern Virginia is known as a cash-grain area. The nine-county area in this study had a significant proportion (63%) of its commercial farms classified as cash-grain farms. This was forty-one percent of the farms so designated in Virginia.[2]

In 1959, marketing problems in the area started to received increased attention from professional workers because of complaints about "sour corn" from foreign buyers. Two export facilities in Norfolk adopted a policy of not accepting corn containing more than 25 percent moisture. One facility would not accept corn that was heating, musty, or sour; the other stated that such corn was subject to rejection.

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[1]Virginia Crops and Livestock, Crop Reporting Service, U. S. Department of Agriculture Cooperating with Virginia Department of Agriculture, Division of Agricultural Statistics, December 1962, Vol. 34, No. 12, p. 4.

[2]Based on figures taken from the 1959 Census of Agriculture.

A grain marketing survey in the Northern Neck area, conducted by the Division of Markets, Virginia Department of Agriculture, suggested four distinct marketing problems:

1. A large volume (about 15,000,000 bushels) of wet corn reaching the market in a short period, about 45 days, of time;
2. A shortage of commercial grain driers (only three in the five-county area);
3. Shortcut methods of sampling and grading the farmer's grain;
4. A variation in the interpretation of discounts to the farmers and a lack of discount information on the farmer's receipt.[1]

Changes in export policy and the results of the Division of Markets' survey had an immediate effect on the local grain buyers and farmers. Repercussions were swift in coming because local grain buyers trade on a discount schedule authorized by their associates in Norfolk, Richmond, and Baltimore. Farmers were informed of the sour corn problem and encouraged to leave their corn in the field until the moisture content was below 25 percent.[2]

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[1]Follow-up Area Grain Marketing Study, Virginia Department of Agriculture, Division of Markets, James R. Kee, April 1961, pp. 1, 3, and 4.

[2]*Ibid*.

The magnitude of the marketing problems in the five-county area of that study was indicated by the volume of grain handled by eleven of the facilities in the area from September 1, 1959 through August 31, 1960:

Corn	1,636,027 bushels
Wheat	537,122 bushels
Soybeans	1,079,350 bushels
Oats	54,646 bushels
Barley	143,649 bushels
Total	3,486,794 bushels

Twelve grain handling facilities were in operation by the fall of 1960 and handled the following volume of corn and soybeans in the 3½ months from September 1, 1960 through December 15, 1960:

Corn	1,458,121 bushels
Soybeans	1,412,325 bushels
Total	2,870,446 bushels

The total storage capacity of the twelve grain marketing firms in 1960 was 559,800 bushels, an increase from ten firms and a total storage capacity of 516,900 bushels in 1959.[1]

Four new commercial grain driers were added in the area in 1960, making a total of seven grain drying facilities. At least one other grain dealer installed a drier before the 1961 harvest season.

Farmers responded to the problem by installing an increasing number of farm driers and storage bins, and delaying harvest. According to the Federal-State Grain Inspection Service, the first corn harvested

[1] *Ibid.*

in 1960 varied from 22 to 24 percent moisture as opposed to 25 to 27 percent in 1959. In 1961 the first lot of corn moved for Tappahannock, Nomini Grove, and Wicamico Church on September 8 had a moisture content of 26.5 percent. For the week ending September 15 the weighted average moisture was 19.4 percent with a low of 18.5 and a high of 20.0 percent. The lower moisture corn delivered to grain buyers and the increased number of commercial driers in operation were the main differences in the corn marketing situation between 1959 and 1961. Because of these factors, the marketing problems associated with new-crop corn have been reduced materially since 1960. The other problems uncovered in the 1959 survey concerning sampling and grading, and receipts and discounts were still in evidence.[1]

To meet the need on the part of the farmers in the area in making farm adjustment decisions, information was obtained from a survey of 178 farms visited in the summer of 1961. The data were used to determine enterprise combinations in the area under varying price and resource conditions.[2]

An analysis of the problems related to high moisture corn was still needed.[3] Specific information on corn harvesting and handling

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[1] Ibid.

[2] Chambliss, R. Lee, Jr. and Paul H. Hoepner, "Estimated Costs and Returns for Selected Crop and Livestock Enterprises in the Cash-Grain Area of Northeastern Virginia," Research Report No. 83, March, 1964, Agricultural Experiment Station, Virginia Polytechnic Institute, Blacksburg, Virginia.

[3] "High moisture" corn as used in this study means corn with too much moisture to store safely or to grade as No. 2 for sale.

was obtained in the fall of 1961 in a follow-up survey. The purpose of this study was to define feasible alternative systems, relationships, and criteria used for decision making, related to the problem of high moisture corn.

Purpose of Study

High moisture corn has been a marketing problem in the Northern Neck area of Virginia. This problem has been aggravated by the rapid replacement of the ear corn picker with field shelling equipment.

With the development of new technology, numerous alternative methods of harvesting, handling, storing, and using corn must now be considered by farm managers. Their decisions have been complicated by several long-term trends:

1. The use of higher-yielding hybrids requiring additional storage facilities and improved machinery and equipment;
2. Farmstead mechanization and the shift to mechanical harvesting have changed the pace of performing farming operations, placing new demands on men and equipment;
3. The improvement and increased availability of different types of equipment for the various farm operations has made the selection of machinery and equipment an ever more difficult process.

The specific objectives of this study were to:

1. Determine the available resources and their restrictions for harvesting, handling, drying and storing corn.

2. Consider admissible combinations of machinery and equipment for harvesting, handling, drying and storing corn.
3. Determine the proper combinations of resources to use in a system with a given quantity of corn under alternative typical resource and price conditions.
4. Identify the chief management problems involved in harvesting, drying, and storage of corn.

It was hypothesized that:

1. There are important differences among farms in Northeastern Virginia in the returns above harvesting and subsequent costs per bushel of corn due to:
   a. the time of sale and seasonal fluctuations in price;
   b. quantity and quality of corn for disposal;
   c. resources and methods used to harvest, dry, and store corn.
2. There is a minimum number of acres or bushels of corn required to make the ownership of harvesting, handling, and drying equipment economically feasible.
3. The most economical individual item of equipment required to perform an operation is not necessarily the item of equipment that will fit the most profitable system.
4. The combination of this equipment into an optimum system from the standpoint of profit maximization is a function of the size of operation and resources available with some consideration given to timeliness, risk and uncertainty.

It is hoped that this study will provide guides to assist Virginia farmers in organizing the available resources and alternatives in their corn enterprise into a system that will maximize returns. In addition, it is hoped that this information will assist professional agricultural workers in informing farmers about alternatives and combinations of resources to be considered in developing their corn enterprise.

Area of Study

Northeastern Virginia is generally known as the cash-grain area of the State. Nine contiguous counties in this area, Essex, Gloucester, King and Queen, King William, Lancaster, Middlesex, Northumberland, Richmond, and Westmoreland were selected as the sample area from which the data were collected (see Figure 1). In each of these counties cash grain farms composed 46 percent or more of all commercial farms. These farms were operated under all systems of tenure, including owner-operators, tenant operators, part owners, and manager-operators. The owner-operator system was the most common form of tenure among farms in the sample.[1]

The sample area lies on the Coastal Plain, bordered by the Potomac River on the north, the York River on the south, the Cheasapeake

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[1]Survey of 178 farms in Northeastern Virginia, 1961.

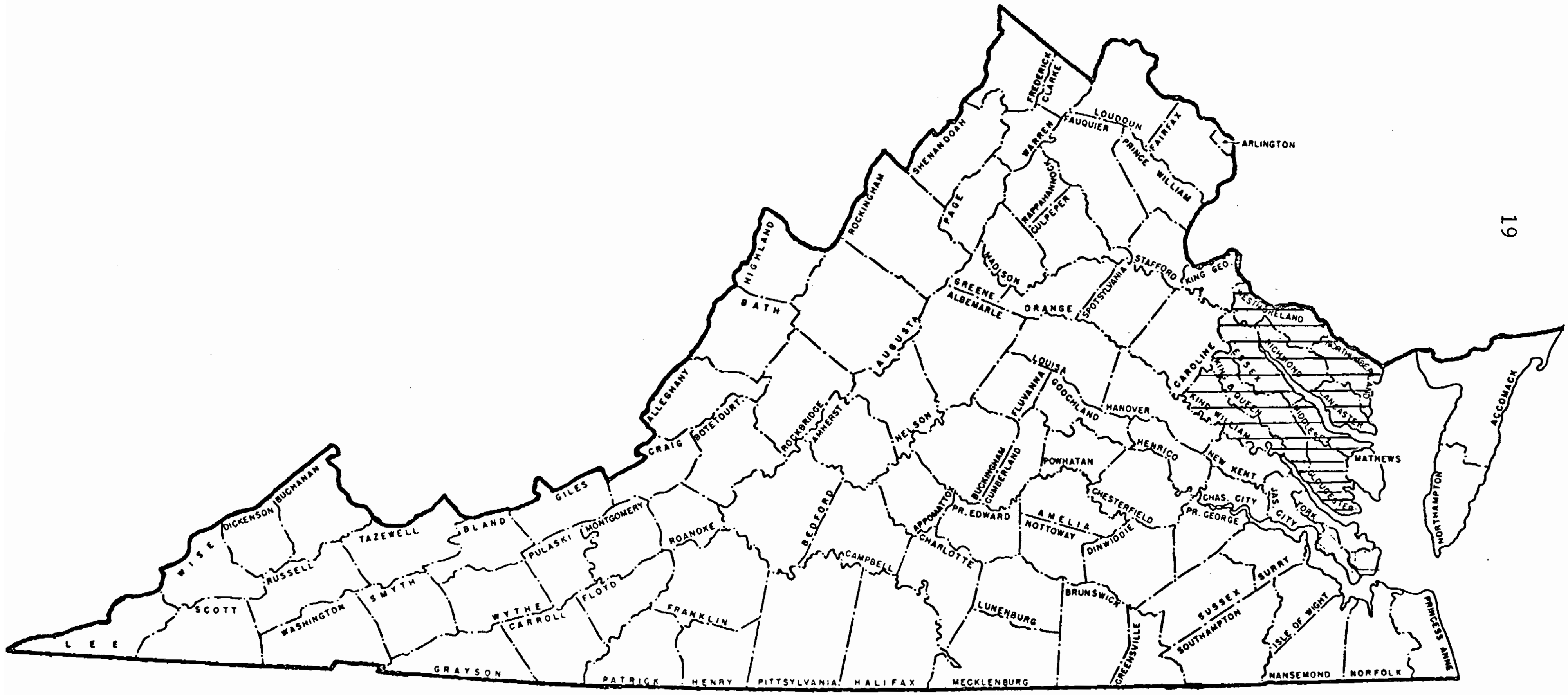

Figure 1. Nine County Area of Study in Northeastern Virginia.

Bay on the east, and the fall line on the west. The topography of the area is slightly to gently rolling with nearly level areas along the streams. The elevation ranges from sea level to approximately 200 feet.

The soils of the area are alluvial and predominantly sandy, but there are small areas of heavy-textured soils derived from Coastal Plain sediments. Soil drainage varies from very poor to excessive. Because of the level land and many of the poorly drained soils can be artificially drained, a high percentage of the open land is suitable for continuous row-crop production.[1]

The growing season of the area is about 200 days, and the annual rainfall averages about 43 inches.[2]

Source of Data

The data for this study were obtained by means of farm inspections and interviews in nine counties of Northeastern Virginia during the summer of 1961. In order to assist farmers with their management problems, information was obtained on the basic resources available (land, labor, buildings, equipment, etc.), the crops and livestock currently produced, and other basic information of this type (see

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[1]"Northeast Virginia's Changing Industry of Agriculture, Area V," Virginia's Opportunity in Agriculture, Virginia Agricultural Extension Service, Blacksburg, Virginia, March 1964.

[2]Ibid.

Appendix B). Additional data to assist in an analysis of problems on corn storage and marketing, along with daily records of harvesting and drying operations, were obtained by farm visits on a follow-up schedule (see Appendix B) in the fall of 1961. The basic data, therefore, reflect conditions prevailing during the 1960 farming year, but the grain handling and marketing information represent the 1961 harvesting operations.

A stratified random sample was used to select the 178 farms with typical combinations of resources from which the data relative to resources available, inputs used, enterprises, production, disposition of products, practices, etc., were obtained. The farms selected for the sample were those which responded to a post card survey in the spring of 1961 with information that indicated an operation of the size and type that would have an influence on the surplus grain situation in the area. The types of farms selected were cash-grain farms, livestock farms (hogs, beef cattle, and very few sheep), and combination cash-grain and livestock farms.

The fifty co-operators visited on the follow-up schedule were selected from the cash-grain farms, and larger combination cash-grain and livestock farms. This group was composed of farmers with a corn enterprise large enough to already have experience with, or warrant consideration of, newer grain handling methods.

The follow-up schedule was completed in December of 1961. Useable information was obtained on 39 questionnaires. The information on the other eleven farms was not useable because of the inability or unwillingness of the farm operator to furnish the requested information. Experience gained in making this study suggests a need for the maintenance of more complete records on farming operations. Although arrangements were made in advance with the co-operators and forms for keeping a record of the harvesting and drying operation (see Appendix B) were left with the operators immediately preceding the harvest, the data obtained were very inadequate.

It was necessary to procure additional data from secondary sources to supplement the survey data. Machinery costs and performance data were obtained from the Department of Agricultural Engineering; storage and drying costs from the Departments of Agricultural Economics and Agricultural Engineering; price and moisture information from the Departments of Agricultural Economics and Agronomy, all of Virginia Polytechnic Institute and from the Division of Markets, Virginia Department of Agriculture. Other sources of information on weather risk, uncertainty, crop losses, and grain discounts are included in the bibliography.

General Characteristics of Sample Farms

The crops produced on the sample farms were typical for the area (Table 1). Three acres of soybeans and small grains for each acre of corn produced was a common ratio on farms in the sample. The larger farms in the area were selected for the study in view of the trend to

Table 1. Crop Production on Follow-up Survey in Northeastern Virginia, 1961

Item	No. of farms	Mean	s.d.[1]	c.v.[2]
Tillable acres	39	413.5	250.97	60.69
Corn acres	39	105.2	76.91	73.11
Corn produced (bu.)	39	7100	5296	74.59
Soybean acres	38	196.9	123.95	62.95
Soybeans produced (bu.)	38	3660	2167	59.21
Oats acres	15	36.6	37.87	103.47
Oats produced (bu.)	15	1650	2017	122.24
Wheat acres	37	59.7	39.22	65.70
Wheat produced (bu.)	34[3]	1985	1471	74.29
Barley acres	21	44.2	54.56	123.44
Barley produced (bu.)	21	2400	3520	146.67

[1] Standard deviation.

[2] Coefficient of variation.

[3] Two farms reported crop yields were too low to warrant harvesting. One farm reported winter wheat acreage for following year.

operate larger acreages. The relationship between the size of operation on the 178 farms included in the initial survey and those selected for the 39 farm follow-up survey is indicated in Table 2.

Average corn yields for the two samples were 65 and 67.6 bushels per acre respectively, compared with a State average of 53 bushels per acre in 1961. It should be noted that the above data for the initial survey represent the 1960 crop year and data for the follow-up survey were for the 1961 crop year.

Table 2. Relative Size of Farms in Two Surveys, Northeastern Virginia, 1961

Item	178 Farm survey		39 Farm survey	
	mean	s.d.[1]	mean	s.d.[1]
Tillable acres	286	216	413.5	251
Corn acres	50	40	105.2	77

[1] Standard deviation

Review of Literature

Research studies designed to aid farmers in the selection of equipment and methods have utilized many different forms of analysis, but farm budgeting and, more recently, linear programming have been the more common tools used.

Most research workers have stressed the need to consider the entire system and its interrelationships rather than to select equipment and methods on the basis of only one process. The following writings were selected from the great quantity of material on the selection of system components for grain handling.

Smith[1] stated, that in making the choice between buying one of several types and sizes of combines and hiring a custom machine, the conventional analysis attempts to determine the annual acreage required to justify the purchase of a combine on a cost basis. This approach often proves inadequate because it does not consider a number of other relevant variables. He suggests a simple way in which these difficulties may be overcome and includes important variables, such as opportunity cost of capital and labor, in his analysis. A fuller explanation of this procedure is presented in Chapter V.

Van Fossen and Stoneberg[2] presented ideas for estimating annual costs per bushel for development of a system for harvesting, drying, and storing corn. Included in their analysis were alternative methods of harvesting, size and type of machines used, acreage operated and a number of other factors.

Curtis and Nichols[3] discussed the economics of drying, marketing, and storing corn relative to the price of corn, the amount of moisture,

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[1] Smith, Edward J., "Buying Versus Renting a Combine," Agricultural Economic Research, U. S. Department of Agriculture, Vol. XIII, No. 4, October 1961.

[2] Van Fossen, Larry, and E. G. Stoneberg, "Harvesting, Drying and Storing Corn?" Iowa Farm Science, College of Agriculture, Iowa State University, Vol. 17, No. 2, pp.3, 4, and 5.

[3] Curtis, John, and Everett Nichols, "Economics of Drying Corn for Sale or Storage," North Carolina Agricultural Extension Service, University of North Carolina, Raleigh, North Carolina, August 1958.

and the volume of corn produced and dried. They assumed that drying is necessary. They recognized the loss of weight in natural drying and its importance if the farmer is making a decision between sale at a high level of moisture and allowing the corn to dry naturally in the field.

Davis, Van Arsdall and Wills[1] studied the complete harvesting process from the viewpoint of integrating it into the farm business in order to determine the economic and managerial implications of changes in harvesting methods. The principal reasons farmers gave for making the shift to shelled-corn methods were: (1) shortage of storage space; (2) cheaper storage for shelled corn; (3) less work; and (4) a reduction in field losses. Field losses, quality of corn, and the difference in rate of harvesting among types of field shellers were found to be insignificant. Reduction of field losses through earlier harvesting and relatively low travel speed, however, were the most significant economic effects of using field shellers. From the standpoint of both management and costs, drying was the critical part of the harvesting operation. Heated-air drying, a new operation for most farmers, involved technical relationships with which farmers were not familiar. They presented information to assist operators with these new technical relationships and management problems.

[1] Davis, V. W., Van Arsdall, R. N., and Wills, J. E., "Management and Costs of Field-shelling and Artificial Drying of Corn in Illinois," Agricultural Experiment Station, University of Illinois, Urbana, Illinois, Bulletin 638, February 1959.

Sammet[1] outlined the "systems engineering" concept and its applicability to agricultural problems. He stressed the division of systems into stages, with a number of alternatives at each stage. He noted the large number of possibilities for different systems and mentioned new methods of mathematical programming and the use of electronic computers to perform the calculations. Using a similar approach, Pinches[2] stated: "Systems engineering in agriculture should start with analysis of farm operations or processes, and proceed through work flow, or process layout, to implementation and farm layout." He pointed out the interaction of processes in the total farm operation. Hall[3] outlined several theoretical methods applicable to the design of materials-handling systems and suggested the use of a flow chart.

DeForest[4] emphasized the need for system design as opposed to piecemeal improvements. He and Forth[5] stressed the system-planning

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[1] Sammet, L. L., "Systems Engineering in Agriculture," Agricultural Engineering Journal, Vol. 11, No. 40, November 1959, pp. 663, 685-687.

[2] Pinches, Harold E., "Management Engineering in Agriculture," Agricultural Engineering Journal, Volume 37, 1956, pp. 747-750, 758.

[3] Hall, Carl W., "Theoretical Considerations in Materials Handling Systems," Agricultural Engineering Journal, Vol. 39, 1958, pp. 524-529, 539, 551.

[4] DeForest, S. S., "The Challenge in Farm Materials Handling," Agricultural Engineering Journal, Vol. 37, 1956, pp. 540-542.

[5] DeForest, S. S., and M. W. Forth, "How to Start Planning a Materials Handling System," Successful Farming, Vol. 59, No. 6, September 1958, pp. 43-47.

approach by developing an illustrated flow chart that showed alternative methods and their interrelationship in the movement of all materials. McKenzie[1] developed system-design fundamentals, including the recommendation of multiple use equipment in a complete system.

Peart[2] used the flow chart as the fundamental method of presenting the problem in his research. He described his flow chart as "a network of directed links that represent alternate methods of performing specific operations such that any complete single path through the network represents a complete system." He defined process as "any regular course of action adhered to in performing work--a plan followed regularly," and method as "a definite system of procedure as to how a work process or any parts thereof are done."[3] He pointed out some limitations in using linear programming and some methods developed for overcoming problems such as non-linear costs, non-integer values of solutions, and determining the cost of multiple-use machines.

The research reported above provided background information, data and ideas to assist in describing the interrelationships between equipment and methods in the analyzed systems in this study. These relationships are analyzed in Chapter II for each alternative method of

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[1] McKenzie, B. A., "The Development of Grain-feed Handling Systems for Livestock Farms," Unpublished M.S. thesis, Michigan State University, 1958

[2] Peart, Robert M., "Optimizing Materials Handling Systems for Livestock Farms," Unpublished Ph.D. thesis, Purdue University, June, 1960.

[3] Ibid.

harvesting and handling corn. The above studies contributed to the method of cost analysis used in evaluating feasible harvesting and drying methods in Chapter V and VI respectively.

CHAPTER II

HARVESTING AND GRAIN HANDLING SYSTEMS

In order to put the entire system of harvesting and grain handling, its numerous alternative methods, and their interrelationships into proper perspective, the flow analysis suggested by Peart has been incorporated in this study.[1] The operations involved in harvesting and handling of corn were divided into six processes. Each of these processes includes one or more alternative methods of performing the operation. All feasible methods of performing the processes were considered in constructing the flow charts (Figures 2 and 3). Each method is represented on the flow chart by a directed link. The method number and a brief description are listed on the directed link for identification purposes. The points of connection between links are called nodes. A particular process may be performed by one of the several alternative methods located between a pair of nodes. The flow charts were constructed so that a single path through each of the processes will comprise a complete system for harvesting and handling corn.

Based on the experience gained in this study and calculations discussed in Chapters V, VI, and VII, the following systems of harvesting and handling ear corn and shelled corn were selected as feasible for the area.

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[1] Ibid.

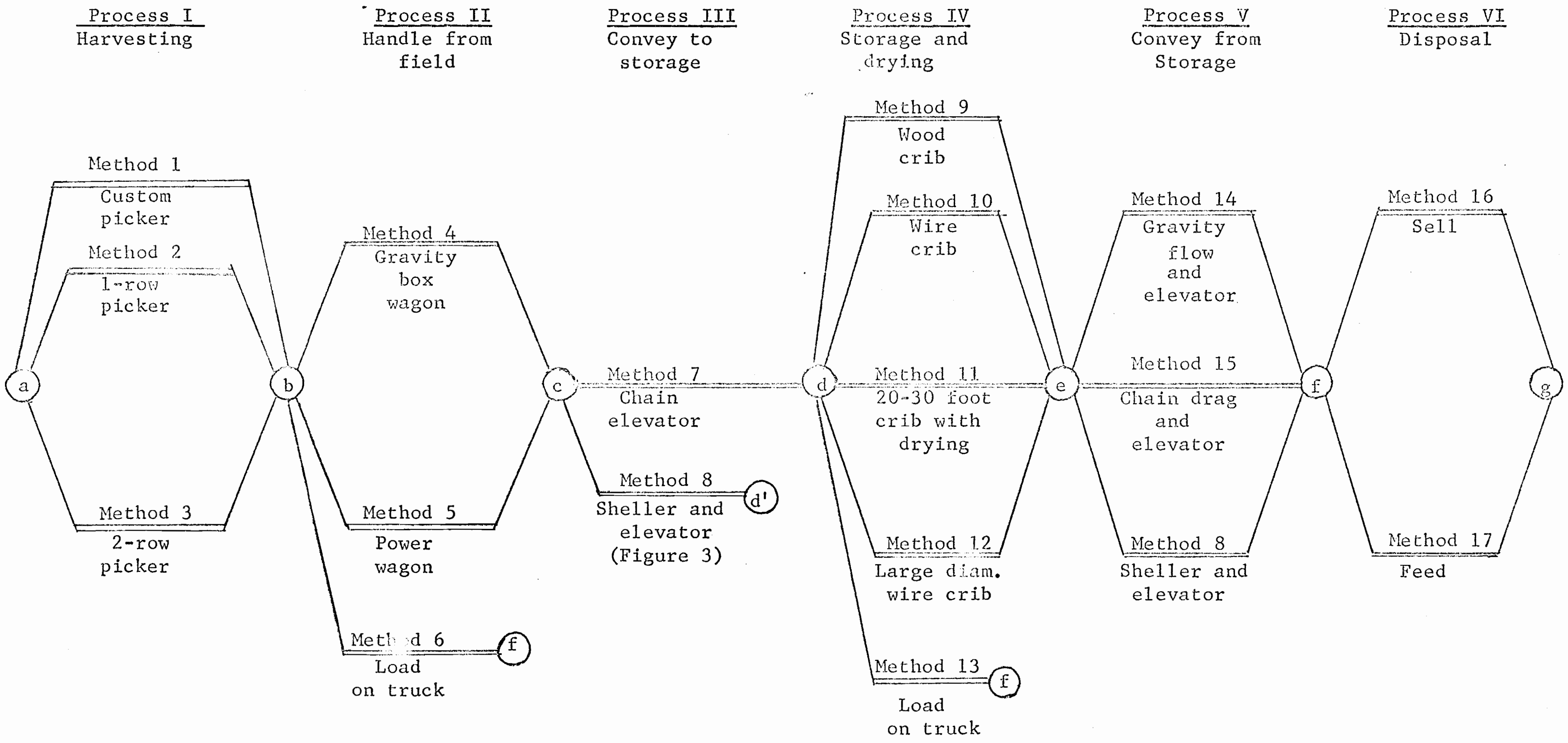

Figure 2. Systems for Harvesting and Handling Ear Corn in Northeastern Virginia

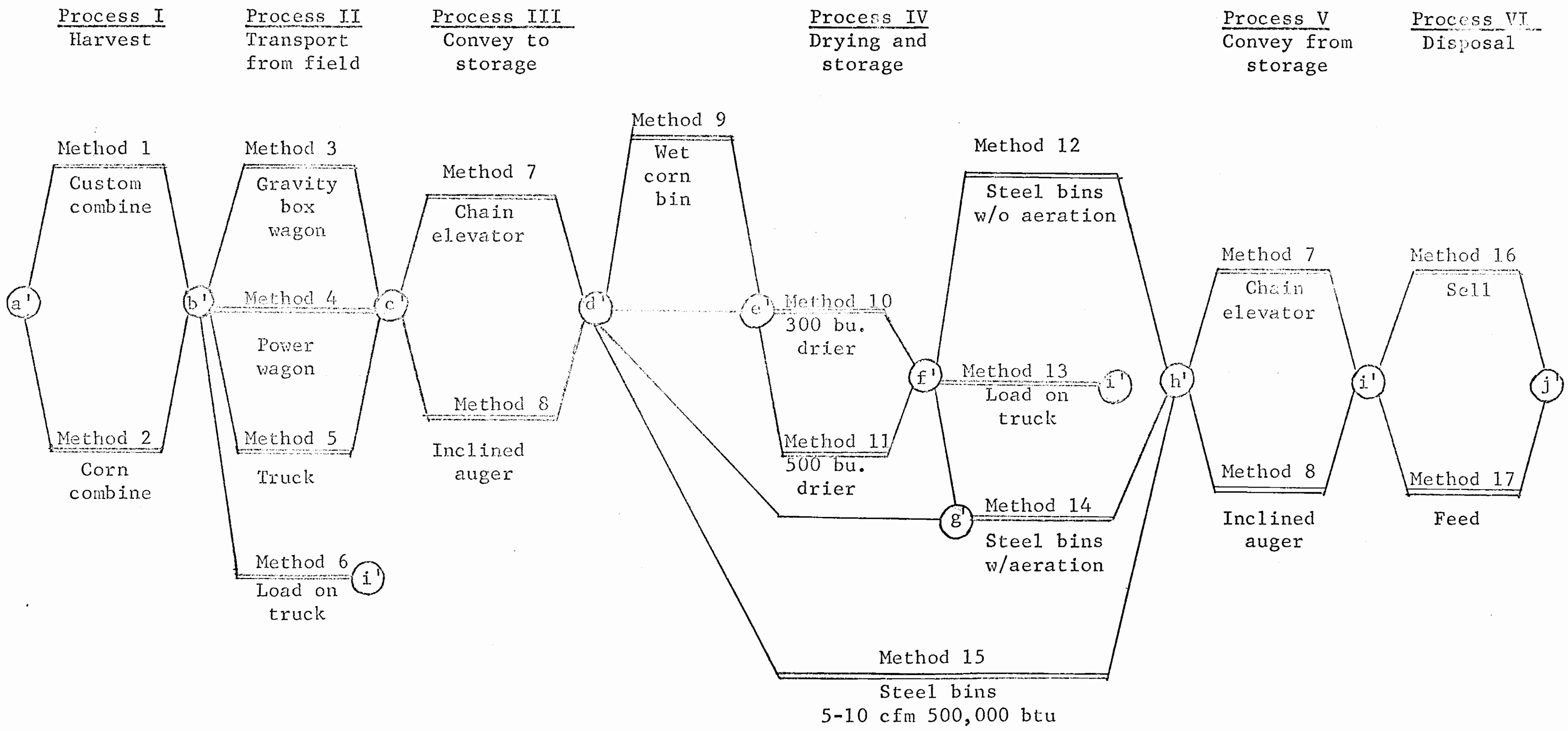

Figure 3. Systems for Harvesting and Handling Shelled Corn in Northeastern Virginia

Ear Corn Systems

Figure 2 considers six ear corn processes: (1) harvesting; (2) transport from the field; (3) conveying to storage; (4) storage and drying; (5) conveying from storage; and (6) disposal.

Selected methods for accomplishing the processes listed in the systems below include specific information that will be developed in Chapters V, VI, and VII. The flow chart includes a number of methods in addition to those selected that could be compared on the basis of cost, matched capacity, and timeliness of the operation. Custom harvesting and drying were compared to the ownership of equipment, but since a selection decision was not required these specific alternatives were not included in the systems outlined.

Direct sale of the corn is a feasible alternative at any point in the system. It should be considered whenever net returns from the enterprise can be increased.

Ear corn system (I) (for field dried corn) includes:

(1) harvest between 1000 and 7000 bushels of 16-22% moisture corn with a one-row picker; at a rate of 50 to 70 bushels per hour.

(2) transport from the field in a gravity-box wagon or power unloading wagon; two or three would be required.

(3) convey into storage with a 36-50 foot chain elevator; use wagon hoist to dump wagons unless power wagons are used;

(4) store in 6-8 foot crib or granary, rodent proofed;

(5) remove from storage by gravity and shovel into elevator or sheller;

(6) load on truck for sale or wagon for feed.

Ear corn system (II) (for field dried or forced natural air drying in storage) includes:

(1) harvest between 3000 and 10,000 bushels of 18-24% moisture corn with a two-row mounted picker; at a rate of 80 to 120 bushels per hour;

(2) transport from field in a gravity-box wagon or power unloading wagon; at least three would be required;

(3) convey into storage with 36-50 foot chain elevator; the length to depend on type of storage;

(4) store in 6-8 foot crib or granary, or 20-30 foot wood or wire crib with forced unheated air drying if harvesting at higher moistures;[1]

(5) remove from storage by gravity and shovel into elevator, unless storage is constructed so that a chain drag may be used, or shelled and elevated;

(6) load on truck for sale or wagon for feed.

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[1]Farmers considering making the complete changeover to shelled corn operation may shell and store in steel bins with drying system rather than construct new ear corn storage.

Shelled Corn Systems

Two systems of alternatives were considered feasible to accomplish the six processes for harvesting and handling shelled corn (Figure 3).

Shelled corn system (I) (for corn dried in storage using limited air flow and some temperature increase) would be as follows:

(1) harvest from 5000 to 15,000 bushels with a corn combine at 25% to 30% moisture; at a rate of 80-140 bushels per hour;

(2) transport with dump trucks or power unloading wagons (two trucks will replace three to five wagons);

(3) into storage, handling with inclined auger or chain elevator;

(4) storage in dual 2200 bushel bin units filled once annually; drying system with 5-10 c.f.m. air flow and 500,000 to 1,000,000 Btu heat unit with humidistat and temperature control;

(5) convey from storage with sweep bin unloader with inclined auger or open ended portable auger;

(6) load on truck for sale or wagon for feed.

Shelled corn system (II) (for corn dried with batch drier and sold or moved to aerated storage) would be as follows:

(1) harvest volumes of 10,000 bushels or more with a corn combine at 25% to 30% moisture; at a rate of 80-140 bushels per hour;

(2) transport with dump trucks or power unloading wagons;

(3) into storage bin or wet corn holding bin, with twice the capacity of the drying unit, handling with an inclined auger;

(4) drying in 300-500 bushel batch drier with 80 to 48 c.f.m. air flow per bushel and heat supply of 300,000 to 5 million Btu with

automatic controls; storage in steel bins with aeration systems with 1/20 c.f.m. per bushel;

(5) convey from storage with sweep bin unloader with inclined auger, or open ended portable inclined auger;

(6) load on truck for sale or wagon for feed.

The corn harvesting equipment in these four systems is built for high capacity. The farmstead grain handling equipment is often limited in capacity. The drying equipment is sized according to the speed of the harvest. The harvesting, handling, drying, and storing capacities need to be matched to each other in order to make efficient use of machines and man-power.[1]

The selected methods described above were found in use in the area studied with the exception of the forced air drying of ear corn.

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[1] Lambert, A. J., "Moving Grain Into and Out of Storage," Agricultural Extension Service, Virginia Polytechnic Institute, Circular 794, April 1963.

CHAPTER III

PRESENT SYSTEMS ON SAMPLE FARMS[1]

The methods and equipment presently in use in Northeastern Virginia were considered in the development of feasible systems for the area.

All the farms in the sample raised some acreage of corn in 1961. Of the 39 farms surveyed 28 percent had less than 51 acres of corn (Table 3). Therefore, even though the farms in the sample averaged 105.2 acres of corn, it is likely that more than one-fourth of the farms were not operating sufficient corn acreage to warrant much of an investment in new practices.

Table 3. Distribution of 39 Farms by Corn Acreage, Northeastern Virginia, 1961

No. of acres	No. of farms	Percent
0-50	11	28.2
51-100	12	30.7
101-150	10	25.7
151-200	4	10.3
over 200	2	5.2
Total	39	100.0

[1]Data presented in this section were taken from both the 178 farm survey and the 39 farm survey in Northeastern Virginia, 1961.

The volume of grain to be handled has a great influence on the system economically feasible to harvest and handle the grain. The average number of bushels produced on the 39 farms in the sample was 7100 bushels and only 15.5 percent of the farms produced more than 10,000 bushels (Table 4).[1]

Table 4. Distribution of 39 Farms by Bushels of Corn Produced, Northeastern Virginia, 1961

No. of bushels	No. of farms	Percent
Under 2000	5	12.8
2001 - 4000	8	20.5
4001 - 6000	3	7.7
6001 - 8000	12	30.8
8001 - 10000	5	12.8
10001 - 12000	0	0.0
12001 - 14000	2	5.2
14001 - 15000	3	7.7
Over 16000	1	2.6
Total	39	100.0

On many of the farms in the sample the soybean and small grain acreage substantially increased the total volume of grain produced on the farm. The multiple-use of machinery, equipment, and storage for the other crops grown on the farm (in addition to corn) assisted in justifying new investment.

[1] Approximately 10,000 bushels were found in this study to be necessary to justify the investment in a corn combine and a dryer to match the rate of harvest.

Ear Corn Harvesting

Of the 39 farms in the sample, 18 harvested some acreage as ear corn (Table 5). Seven farms harvested only ear corn. This indicates that more than half of the 18 farms had partly changed to shelled corn methods. Approximately 61 percent of those farms harvesting some ear corn harvested less than 51 acres.

Table 5. Distribution of 18 Farms Harvesting Ear Corn by Acreage of Ear Corn, Northeastern Virginia, 1961

No. of acres	No. of farms	Percent
1 - 25	5	27.8
26 - 50	6	33.3
51 - 75	1	5.6
76 - 100	4	22.2
101 - 125	1	5.6
126 - 250	0	0.0
Over 250	1	5.6
Total	18	100.0

The average yield for those harvesting ear corn was 59.2 bushels. This was 15.5 bushels less than the average yield on the farms in the study harvesting shelled corn. Since more than half of the farms were harvesting both shelled corn and ear corn, a major portion of this difference in yield may be attributed to greater field losses with ear corn.

Harvested yields are affected by the direct relationship between the field losses encountered and the moisture content of the corn. According to Maddex,[1] there is one bushel lost per acre per week after moisture drops below 35 percent.[2] Harvesting was started on 94 percent of the farms by October 22 when the moisture content of the corn was below 20 percent (Table 6).

In the sample, farmers picked an average of 3.3 acres per day or 196 bushels of ear corn. An average of 19 days were required to complete harvest. The number of days from the beginning of harvest to completion ranged from one to forty-eight days. By the time 88 percent of the farmers finished harvesting, the moisture content of the corn had dropped below 18 percent (Table 7).

On the 178 farms in the survey made in the summer of 1961, 99 operators owned corn pickers, two-thirds of which were one-row pickers. The farmers estimated the life of a corn picker to be between 12 and 13 years. The average estimated remaining life of the pickers in 1961 was five years with a standard deviation of 3.72 years. This indicated that many of these machines would have to be replaced in the next few years (Table 8). When farmers make decisions to replace machinery or buildings, they give serious consideration to revising their methods and systems of operation. Therefore, it was apparent that many farmers

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[1] Maddex, Robert L., Electricity on the Farm, Vol. 36, No. 7, September, 1963, p. 18 (New York, Reuben H. Donnelley Corp.)

[2] While this is a reasonable approximation for Virginia, more accurate data will be used in the later analysis.

Table 6. Distribution of 18 Farms Harvesting Ear Corn by Percentage of Moisture and Date of Beginning Harvest, Northeastern Virginia, 1961

Beginning Date of Harvest	Percent Moisture 13.5-14.0	14.1-16.0	16.1-18.0	18.1-20.0	20.1-22.0	22.1-24.0	24.1-26.0
Sept. 8-15			2	1			
Sept. 16-22				1		1	
Sept. 23-30			2	3			
Oct. 1-7		2	2				
Oct. 8-15							
Oct. 16-22	1	1	1				
Oct. 23-31							
Nov. 1-7		1					

Table 7. Distribution of 18 **Farms** Harvesting Ear Corn by Percentage of **Moisture and Date of** Finishing **Harvest,** Northeastern Virginia, 1961

Finishing Date of Harvest	Percent Moisture 13.0-14.0	14.1-16.0	16.1-18.0	18.1-20.0	20.1-22.0
Oct. 1-7			1		1
Oct. 8-15		4	1		1
Oct. 16-22	1	3	1		
Oct. 23-31	1		2		
Nov. 1-7					
Nov. 8-15					
Nov. 16-30		1			
Dec. 1-15		1			

in this area would need help with these management decisions.

Eleven farmers harvested both ear corn and shelled corn (seven farmers owned corn combines, and four farmers used custom combines). The use of both methods provided flexibility and permitted the use of old storage buildings.

Table 8. Distribution of 99 Farms by Estimated Remaining Life of Corn Pickers, Northeastern Virginia, 1961

Life remaining (years)	No. of farms	Percent
0 - 5	63	64.0
6 - 10	29	29.0
11 - 15	7	7.0
Total	99	100.0

Shelled Corn Harvesting

The 31 farmers harvesting shelled corn averaged 1½ times more acres than those picking ear corn. Only 25.8 percent harvested less than 51 acres compared with 61 percent harvesting less than 51 acres of ear corn (Table 9). This indicated the increased use of the corn combine, where larger acreages are harvested.

Farmers harvested 1.89 times more bushels of shelled corn than those harvesting ear corn. An average of 7060 bushels of shelled corn were produced on these farms with an average yield of 74.7 bushels per

Table 9. Distribution of 31 Farms Harvesting Shelled Corn by Acreage of Shelled Corn, Northeastern Virginia, 1961

No. of acres	No. of farms	Percent
0 - 50	8	25.8
51 - 100	10	32.2
101 - 150	9	29.0
151 - 200	2	6.5
201 - 250	2	6.5
Total	31	100.0

acre. Fifty-one percent of the farms harvested between 4000 and 10,000 bushels (Table 10). Of the 27 farmers owning combines, only one-third harvested more than 8000 bushels. In view of the large acreage of other crops, it would seem that the combines on many of the farms were used to harvest these crops in an effort to justify the investment.

Approximately 30 percent of the farmers started shelling before the moisture content of the corn was below 20 percent (Table 11). Only four farms started shelling when the moisture content was above 24 percent. It has been commonly accepted that the most profitable range of moisture to harvest is between 25 percent and 30 percent. Robert L. Maddex of Michigan State University writes, "The most net dollars per acre results when corn is harvested at 26 percent to 28 percent moisture. This range widens to 25 percent to 30 percent moisture as the volume increases."[1]

[1]Maddex, Robert L., op. cit.

Table 10. Distribution of 31 Farms Harvesting Shelled Corn by Bushels of Shelled Corn, Northeastern Virginia, 1961

No. of bushels	No. of farms	Percent
Under 2000	3	9.7
2001 - 4000	6	19.3
4001 - 6000	3	9.7
6001 - 8000	10	32.2
8001 - 10000	3	9.7
10001 - 12000	1	3.2
12001 - 14000	2	6.5
14001 - 16000	2	6.5
Over 16000	1	3.2
Total	31	100.0

In the sample, farmers combined an average of 4.8 acres per day and 362 bushels compared to those who picked ear corn at an average rate of 3.3 acres and 196 bushels per day.

The moisture was 18 percent or below on 83 percent of the farms at the end of harvest (Table 12). Only two of the thirty-one farms finished harvesting at moistures above 20 percent. This indicated that very few of the farmers were taking advantage of early harvest to reduce field losses and to market early.

In the survey some operators reported corn harvest was delayed because of interference with the harvest of soybeans; consequently, the corn was harvested at the low moistures indicated above. This delay in harvest was typical of the area because of the large acreages of soybeans produced.

Table 11. Distribution of 31 Farms Harvesting Shelled Corn by Percentage of Moisture and Date of Beginning Harvest, Northeastern Virginia, 1961

Beginning Date of Harvest	Percent Moisture								
	14.0-16.0	16.1-18.0	18.1-20.0	20.1-22.0	22.1-24.0	24.1-26.0	26.1-28.0	28.1-30.0	34.1-35.0
Sept. 1-7			2				1	1	
Sept. 8-15	1	1			2				1
Sept. 16-22			2		1	1			
Sept. 23-30	2	5	3	1					
Oct. 1-7	2	1							
Oct. 8-15	1	1		1					
Oct. 16-22		1							
Oct. 23-31									

Table 12. Distribution of 31 Farms Harvesting Shelled Corn by Percentage of Moisture and Date of Finishing Harvest, Northeastern Virginia, 1961

Finishing Date of Harvest	Percent Moisture						
	13.0-14.0	14.1-16.0	16.1-18.0	18.1-20.0	20.1-22.0	22.1-24.0	24.1-26.0
Sept. 16-22				1			1
Sept. 23-30		2	1	2			
Oct. 1-7			1		1		
Oct. 8-15	1	5	5				
Oct. 16-22		2	4				
Oct. 23-31		3					
Nov. 1-7							
Nov. 8-15		1	1				

An average of 19½ days was needed to complete harvest on the farms harvesting shelled corn. The number of harvesting days ranged from one to forty-five. Of the nine farms that started to harvest in the first two weeks of September, four completed harvest the last two weeks of September, three in the first two weeks of October, and one each in the last half of October and first half of November (Table 13).

The starting date and the period of harvest did not fully illustrate the pattern of the harvest operation. Farmers reported starting the harvest on a particular date but did not always accomplish as much as expected. It was found that less than 10 percent of the total acreage and bushels shelled were harvested in the first two weeks (Table 14). Only about 70 percent of the total bushels shelled were harvested in the following four weeks. This did not seem reasonable in view of the average harvest period of less than twenty days. Further analysis, however, indicated that those farmers engaged in harvesting during the first two-week period harvested 34 percent of their total production (Table 15). For those harvesting in the second two-week period, 50 percent of their total production was harvested.

Hauling and Unloading Equipment

Ear corn was usually transported from the field in wagons and elevated into storage by a chain elevator. Most of the wagons were unloaded by elevating the front of the wagon with a hoist or wagon-jack. A few farmers shoveled corn from the wagon into the elevator. The wagon-

Table 13. Distribution of 31 Farms Harvesting Shelled Corn by Beginning Period and Finishing Period of Harvest, Northeastern Virginia, 1961

Period Beginning Harvest	Period Finishing Harvest: Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-15	Farms Total "Started"
Sept. 1-15		4	3	1	1	9
Sept. 16-30		3	6	6		15
Oct. 1-15			4	1	1	6
Oct. 16-31				1		1
Farms Total "Finished"		7	13	9	2	31

Table 14. Percentage of Total Acres and Total Bushels of Shelled Corn Harvested in Each Period, 31 Farms Harvesting in Northeastern Virginia, 1961

Period harvested	Percent of total acres	Percent of total bushels
September 1 - 15	9.32	9.03
September 16 - 30	35.81	33.37
October 1 - 15	35.74	38.15
October 16-31	15.06	15.30
November 1- 15	4.40	4.21

Table 15. Percentage of Acres and Bushels of Shelled Corn Harvested in Each Period by Those Farmers Harvesting During the Period, 31 Farms in Northeastern Virginia, 1961

Period harvested	Percent of acres[1]	Percent of bushels
September 1 - 15	32.62	34.30
September 16 - 30	53.85	49.72
October 1 - 15	54.99	54.69
October 16 - 31	45.65	42.44
November 1 - 15	62.62	57.89

[1]For example, for the period of September 1 - 15 on six farms, 273 acres were harvested out of the 837 acres total production on those six farms.

jacks and hoists were powered by either electric motors, gasoline engines, or a tractor. On at least one farm corn was shoveled directly into storage.

Trucks were used to transport corn from the field on 30 of the 39 farms in the sample. All the trucks, larger than pick-up size, were on farms harvesting a part of the corn as shelled corn. Approximately one-half the trucks were equipped with hydraulic dumps. Two trucks usually replaced three to five wagons depending on the length of haul. Both gravity flow and hydraulic dump wagons were used for shelled corn.

Shelled corn was elevated into storage with either a chain elevator or auger.

Conveying and Elevating Equipment

At least one auger for moving shelled corn into a drier or storage was in use on 23 of the farms. Four or five augers were in use on each of four farms. A chain-drag multipurpose elevator was used on 23 farms, usually for ear corn. Power to operate conveying equipment was furnished by electric motor, gasoline engine, or tractor power take-off. Farmers reported capacity of this equipment was adequate on most farms.

Drying Installations

Drying systems were used on 17 farms in the sample. All were used for drying shelled corn. There were no farms in the area mechanically drying ear corn, although this represented a possible alternative.

Operators dried approximately 70 percent of the shelled corn harvested on their farms (Table 16) and dried an average of 6180 bushels each.

Table 16. Bushels of Shelled Corn Dried and Percentage of Bushels Dried on 17 Farms in Northeastern Virginia, 1961

Item	No. of farms	Mean	S. D.	C. V.
Bushels dried	17	6180	4219	68.27
Percent dried	17	70.64	30.74	43.54

There were two types of driers used in the area, batch driers and bin driers. The four operators with batch driers processed an average of 12,125 bushels compared to only 4300 bushels for the 13 bin driers. Only three operators batch dried more than 7000 bushels (Table 17). Several farmers indicated that they planned to expand their storage and drying capacity.

Farmers with driers used them on the major part of the shelled corn they harvested (Table 18). Six farmers dried all the shelled corn harvested. The fact that six farmers dried less than 50 percent of their crop indicated some hesitancy to adopt this practice.

Operators drying early harvested corn used the driers to the greatest advantage because of the higher moisture, higher prices and lower losses. A comparison of Table 19 and Table 14 indicates that ten farmers recognized this advantage by drying a high percent of the early

Table 17. Distribution of 17 Farms by Bushels of Shelled Corn Dried, Northeastern Virginia, 1961

No. of bushels	No. of farms	Percent of farms
0 - 1000	0	0.0
1001 - 2000	1	5.9
2001 - 3000	3	17.6
3001 - 4000	3	17.6
4001 - 5000	2	11.8
5001 - 6000	1	5.9
6001 - 7000	4	23.6
7001 - 8000	0	0.0
8001 - 9000	0	0.0
9001 - 10000	0	0.0
over 10000	3	17.6
Total	17	100.0

Table 18. Distribution of 17 Farms by Percent of Shelled Corn Dried on Farms with Driers, Northeastern Virginia, 1961

Percent dried	No. of farms	Percent of farms
0 - 10	0	0.0
11 - 20	0	0.0
21 - 30	3	17.6
31 - 40	2	11.8
41 - 50	1	5.9
51 - 60	0	0.0
61 - 70	1	5.9
71 - 80	1	5.9
81 - 90	1	5.9
91 - 100	8	47.0
Total	17	100.0

harvested corn. Over 48 percent of the bushels of shelled corn dried were dried during the first month of harvest.

Table 19. Percentage of Total Bushels of Shelled Corn Processed by Drying in Each Harvest Period, 17 Farms in Northeastern Virginia, 1961

Period of harvest	No. of farms drying	Percent Dried
September 1 - 15	3	8.95
September 16 - 30	7	39.14
October 1 - 15	12	38.57
October 16 - 31	5	9.52
November 1 - 15	1	3.62

In Table 20 the percentage of total bushels dried by those drying during the particular period is shown. During each of three periods, the drier operators dried more than 50 percent of their crop. The November 1 - 15 figure was not significant since only one farm was drying 3800 bushels out of a 5000 bushel total.

The percentages in Table 20 were distorted by the large number of bin driers compared to batch driers in the study. For the smaller volumes dried with the bin driers an average of only 12 days was required to fill the bins. For the average volume dried with the batch driers approximately 33 days were required for the operation. Therefore, the figures in Table 20 are higher than might normally be expected had there been more batch driers.

Table 20. Percentage of Total Bushels Dried by those Farmers Drying During each Harvest Period, 17 Farms in Northeastern Virginia, 1961

Period of harvest	No. of farms drying	Percent dried
September 1 - 15	3	26.11
September 16 - 30	7	56.07
October 1 - 15	12	51.92
October 16 - 31	5	32.05
November 1 - 15	1	76.00

At higher moistures the batch driers have more flexibility because up to 1000 bushels per day can be harvested and dried. Only two of the batch drier operations had wet corn holding bins which would help avoid delays in harvesting.

Two 2200 bushel bins with a fan and heating unit was the most common installation for a bin drier. The bin-type drying structures served a dual purpose--as drying bins and as grain storage after drying was completed. The false perforated floor also permitted air flow both for drying the grain and aeration of the grain after drying.

Three farmers used their driers for small grains, but only dried a total of 3100 bushels. There was very little need to dry the soybeans harvested in the area since the farmers reported selling them at $2.01 per bushel with a standard deviation of only three cents which indicated that their beans were not being discounted. It was not considered feasible to use the production of small grains to justify the investment in a dryer.

Approximately 75 percent of the corn sold was marketed at harvest time. The corn dried in bin driers was marketed after storage, usually between March and June. Additional corn harvested beyond the available storage capacity was sold wet at harvest.

Storage Structures

The construction of more on-the-farm storage was encouraged by professional agricultural workers in the area as an immediate solution to the wet corn problem discussed in the introduction to this study. Of the 31 farms harvesting shelled corn, 14 erected new steel bins in 1961. A total of 31 bins with an average capacity of 1650 bushels was erected. The four reasons most often given for erecting the new steel bins were: (1) need for additional storage capacity, (2) the need to replace worn-out farm cribs, (3) the lower cost of shelled corn storage, and (4) a desire to get higher corn prices.

Although many of the farmers in the study had made some progress in improving their methods and equipment, 60 percent of the operators indicated that improvements were needed in their storage methods or handling equipment. The addition or rearrangement of metal bins and the installation of unloading pits were the most desired improvements.

CHAPTER IV

PRICES AND DISCOUNTS

The price of corn at harvest and the discount schedule in effect in the area greatly influence the decision of whether or not to dry and/or store corn. Many farmers also base their decision on when to start harvesting on market prices and discounts.

Discounts

Both the price and discounts are established on the basis of a grade determined by the Division of Markets using the standards of the USDA Grain Standards Act. Certain factors are used to determine the grade. These factors include: (1) test weight, (2) moisture, (3) foreign material, (4) damage, and (5) condition. The numerical grade of the grain is based on the determination of these factors. Corn grading better than No. 2 for test weight, foreign material, and damage merits a premium. For corn grading below No. 2, discounts are used. Discounts are taken for low test weight, high moisture, high damage, excess foreign material, or out of condition grain.[1]

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[1]Test weight or density of grain refers to the weight of a measured bushel. The maximum moisture content for No. 2 corn is 15.5 percent. Damage content means grain that is not sound, and may be the result of weevil, rot, frost, heat, moisture, etc. The condition factors which may effect the soundness of the grain are: musty, sour, heating, weevil, garlic, and smut.

Each of these conditions may carry a different discount. Weevily grain carries a discount of 2 to 10 cents and in some instances, depending on its ultimate use, may not be acceptable. Similarly, most dealers will not accept sour or musty corn. Discounts for the other conditions are specified in Tables 21 and 22, two discount schedules in common use in the area. It should be noted that the latter is much more favorable for selling high moisture corn in that 25 percent corn is discounted only 28.5 cents compared to 33.5 cents in Table 21.

Moisture content is a big factor in determing the keeping quality of all grains. Wheat, barley, oats, and soybeans, unlike corn, will mature in Virginia and dry to approximately 12 to 14 percent moisture content by harvest. Undor average conditions these small grains can be stored for short periods of time with this moisture content. Moisture discounts are therefore seldom needed for these grains unless there is rain or damp weather during harvest. Corn is different from the above grains in that it can be mature and still contain 16 to 35 percent moisture at harvest time. Corn containing more than 15.5 percent moisture must be dried to permit safe storage or use in a mixed feed.

Whether corn is processed by the farmer, grain handler, feed dealer, or exporter, the discount must cover the following: (1) shrinkage--loss in weight of water removed plus one half of one percent allowance for dry matter loss; (2) drying costs of commercial driers are approximately one cent for each percentage of moisture removed; and (3) other, to include: (a) risk such as souring and heating before or during processing, (b) handling--extra turning or aeration,

Table 21. Discount Schedule for Corn, Northeastern Virginia, 1961 (A)

Test Weight Discount--	1¢ per bushel each pound or fraction thereof below 54 to 52 lbs. 1½¢ each pound or fraction thereof below 52 lbs.
Damage Discount--	1¢ per bushel each 1% or fraction from 5% to 7% 1½¢ per bushel each 1% or fraction from 7% to 10% 2¢ per bushel each 1% or fraction from 10% to 20%
Foreign Material Discount--	1¢ per bushel each 1% or fraction from 3% to 7%
Weevily Discount--	2¢ per bushel
Grading--	Corn musty, sour, or heating will not be accepted
Moisture Discount--	1½¢ per bushel each ½% from 15.5% to 20% 2¢per bushel each ½% from 20% to 35%

Moisture Discount Table

Moisture		Discount
From	To	
15.6	16.0	1½
16.1	16.5	3
16.6	17.0	4½
17.1	17.5	6
17.6	18.0	7½
18.1	18.5	9
18.6	19.0	10½
19.1	19.5	12
19.6	20.0	13½
20.1	20.5	15½
20.6	21.0	17½
21.1	21.5	19½
21.6	22.0	21½
22.1	22.5	23½
22.6	23.0	25½
23.1	23.5	27½
23.6	24.0	29½
24.1	24.5	31½
24.6	25.0	33½

Table 22. Discount Schedule for Corn, Northeastern Virginia, 1961 (B)

Test Weight-----	One (1) cent for each pound of test weight under 53 pounds
Damage-----	One (1) cent for each per cent of damage over 5% to 11% One and a half cent (1½) for each per cent over 11% to 19% One and half cent (1½) for each ½% damage over 19%
Musty-----	10 cents per bushel
Weevily----	10 cents per bushel

Moisture Discount Table

Moisture		Discount
From	To	
15.6	16.0	1½
16.1	16.5	3
16.6	17.0	4½
17.1	17.5	6
17.6	18.0	7½
18.1	18.5	9
18.6	19.0	10½
19.1	19.5	12
19.6	20.0	13½
20.1	20.5	15
20.6	21.0	16½
21.1	21.5	18
21.6	22.0	19½
22.1	22.5	21
22.6	23.0	22½
23.1	23.5	24
23.6	24.0	25½
24.1	24.5	27
24.6	25.0	28½

(c) drying below 15.5 percent, (d) other expenses, and (e) a margin for profit. The following is an example of these discounts:

Corn moisture	25.0% (Corn price $1.20)
Shrink[1]	14.1¢
Drying	9.5¢
Other	9.9¢
Total discount	33.5¢

As would be expected, the "other" part of the discount, which includes risk, increases with increased moisture content.

The moisture content of corn through the fall of 1961 is depicted in Figure 4. The lower curve is fitted to the weighted weekly averages for corn delivered to Tappahannock, Nomini Grove, and Wicomico Church. This weighted average includes corn that was mechanically dried. The upper curve is fitted to the high moisture contents reported at the elevators each week.

The weighted average moisture content of corn decreased 7.5 percent during the first two weeks of September. The high moisture curve shows a decrease of 10.5 percent indicating the extent of natural drying during this period. The high discounts enforced during this period therefore offer the possibility of artifically drying the corn, or delaying harvest as an alternative to selling wet corn.

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[1]Shrinkage = price of No. 2 corn $\left[1 - \left(\frac{\text{100-initial moist. (\%)}}{\text{100-final moist. (\%)}} - .005\right)\right]$

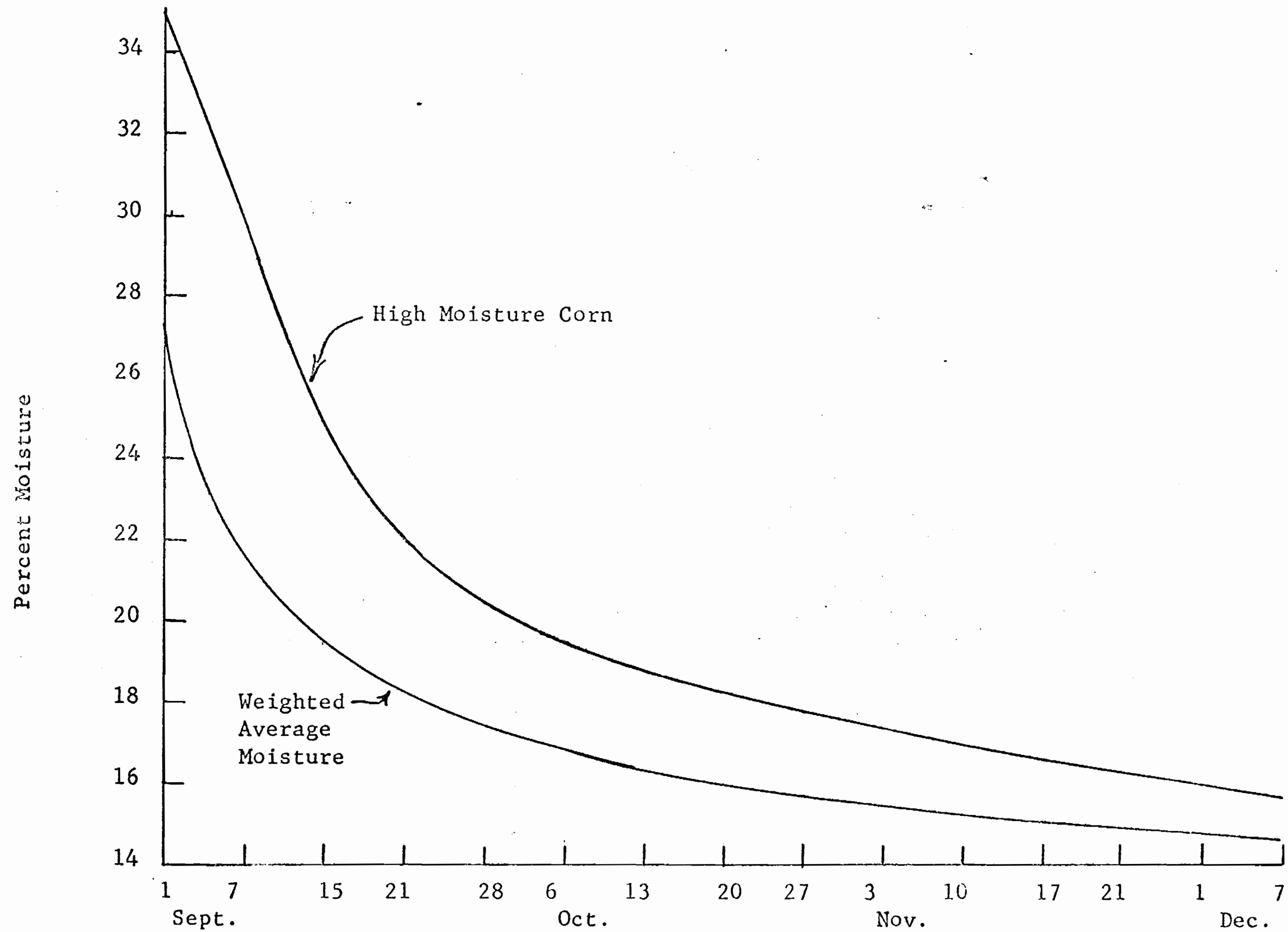

Figure 4. Weighted Average Moisture Content of Corn, Northeastern Virginia, 1961.

Prices

The average prices for each week through the year were computed based on prices for five years furnished by the Division of Markets. Prices for the years, 1959 to 1963 were used for Richmond and Norfolk and three years, 1961 - 1963 for Tappahannock.

The prices for these years were used because they were more relevant to present conditions. The price level has been significantly lower in recent years and the seasonal low during harvest has shifted to earlier in the fall. This latter is due to technological changes.

Since prices are not really known in advance, they must be forecast to make economic decisions. At least a third degree polynomial was needed to approximate the seasonal fluctuation of corn prices. The five degree polynomial equation was found to most nearly approximate the seasonal movement of prices when the irregularity of this movement was considered.

The Model

The model is an over-all function which takes the data for the whole year, and attempts to predict the price in any one week. Thus:

$$P = b_o + b_1t + b_2t^2 + b_3t^3 + b_4t^4 + b_5t^5$$

where:

P = predicted value of price for the t-th week.

t = time (week); $t = 0, 1, 2, \ldots 52$.

b_i = i-th regression coefficient.

Estimation of Parameters

Weekly average prices from Tappahannock, Richmond, and Norfolk were used separately to estimate the five coefficients presented in the equation for each of the three markets. The estimated coefficients, and other relevant information, are given in Table 23. The "student t" values for testing the hypothesis that the coefficients are not significantly different from zero have 46 degrees of freedom for the Richmond and Norfolk estimates and 41 degrees of freedom for the Tappahannock estimates. All coefficients were significant at the five percent level. The multiple correlation coefficient, R^2, for Richmond was 0.95014, for Norfolk 0.90299, and for Tappahannock 0.95534. The multiple correlation coefficient for Tappahannock indicates that 95.5 percent of the total variability in the historical average price can be predicted with the use of the equation.

The average coefficient of variation was 6.36 percent for the Tappahannock prices. The average coefficients of variation for Richmond and Norfolk were 6.75 and 6.63 percent respectively. This indicated that the variation about the mean weekly average in the three series of data was very near the same. The coefficient of variation indicates that about a six percent variation from the mean weekly average price might be expected in two years out of three.

The predicted values for the prices for each location were plotted in Figures 5, 6, and 7. A comparison of figures shows that the Tappahannock price does not drop in the fall as low as prices do in

Table 23. Corn Price Regression Equations for Richmond, Norfolk and Tappahannock

Coefficients	Richmond		Norfolk		Tappahannock	
	Coefficient[1]	Student t	Coefficient[1]	Student t	Coefficient[1]	Student t
b_0	1.31891	-	1.36972	-	1.34279	-
b_1	.06621-	6.99560-	.07252-	5.27437-	.05871-	10.25543-
b_2	.00717	6.42367	.00724	4.46330	.00645	9.47740
b_3	.00030-	5.66373-	.00029-	3.80378-	.00028-	8.53929-
b_4	-5.57142	5.19131	-5.54955	3.43739	-5.54897	8.03277
b_5	-7.40358-	4.92123-	-7.38573-	3.23822-	-7.40002-	7.80663-
R^2	0.95014		0.90299		0.95534	

[1] For coefficients, -5.57142 means 0.57142×10^{-5}. A minus sign following the coefficient indicates a negative value.

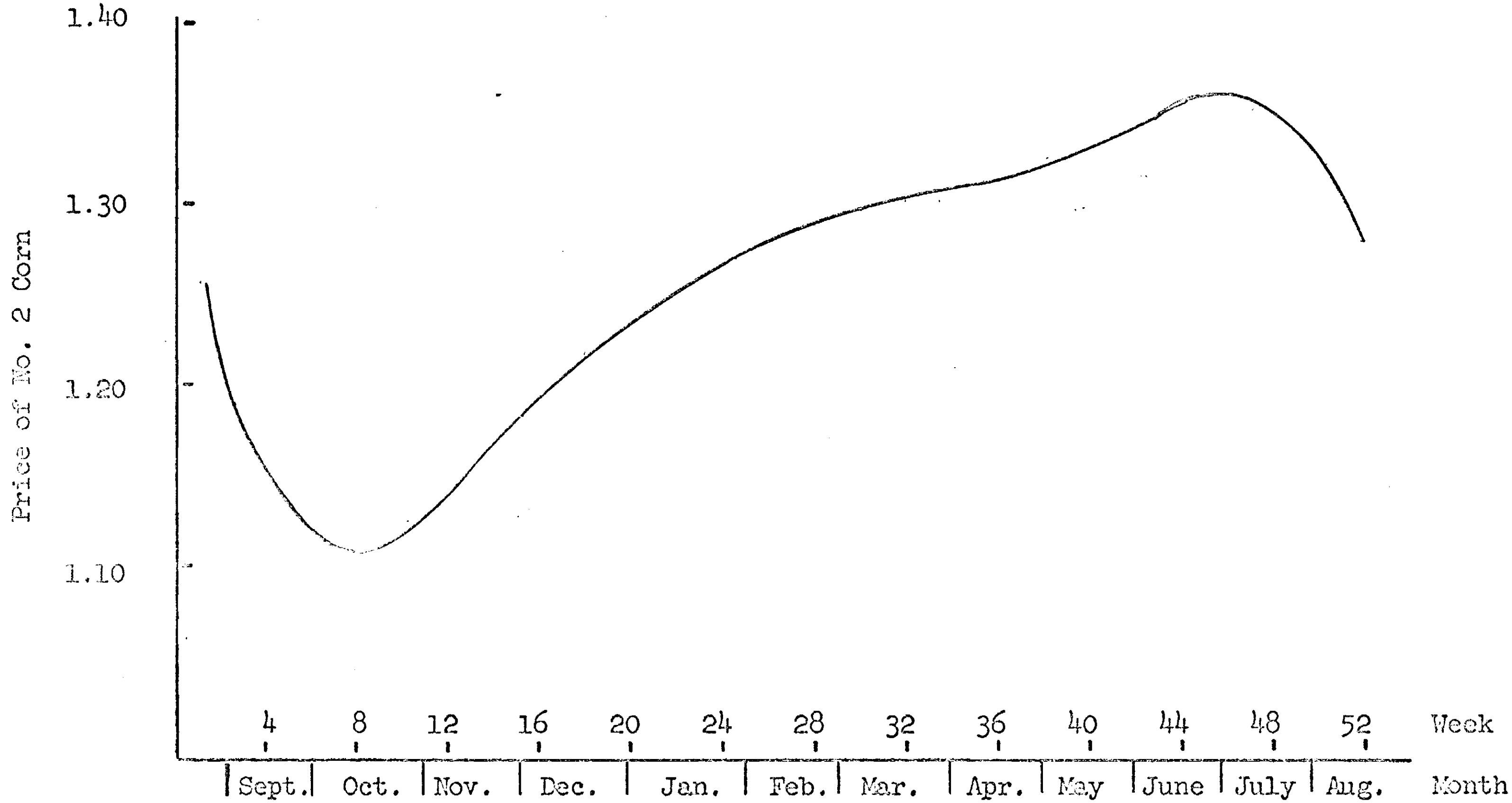

Figure 5. Predicted Prices for Richmond, 1959-1963.

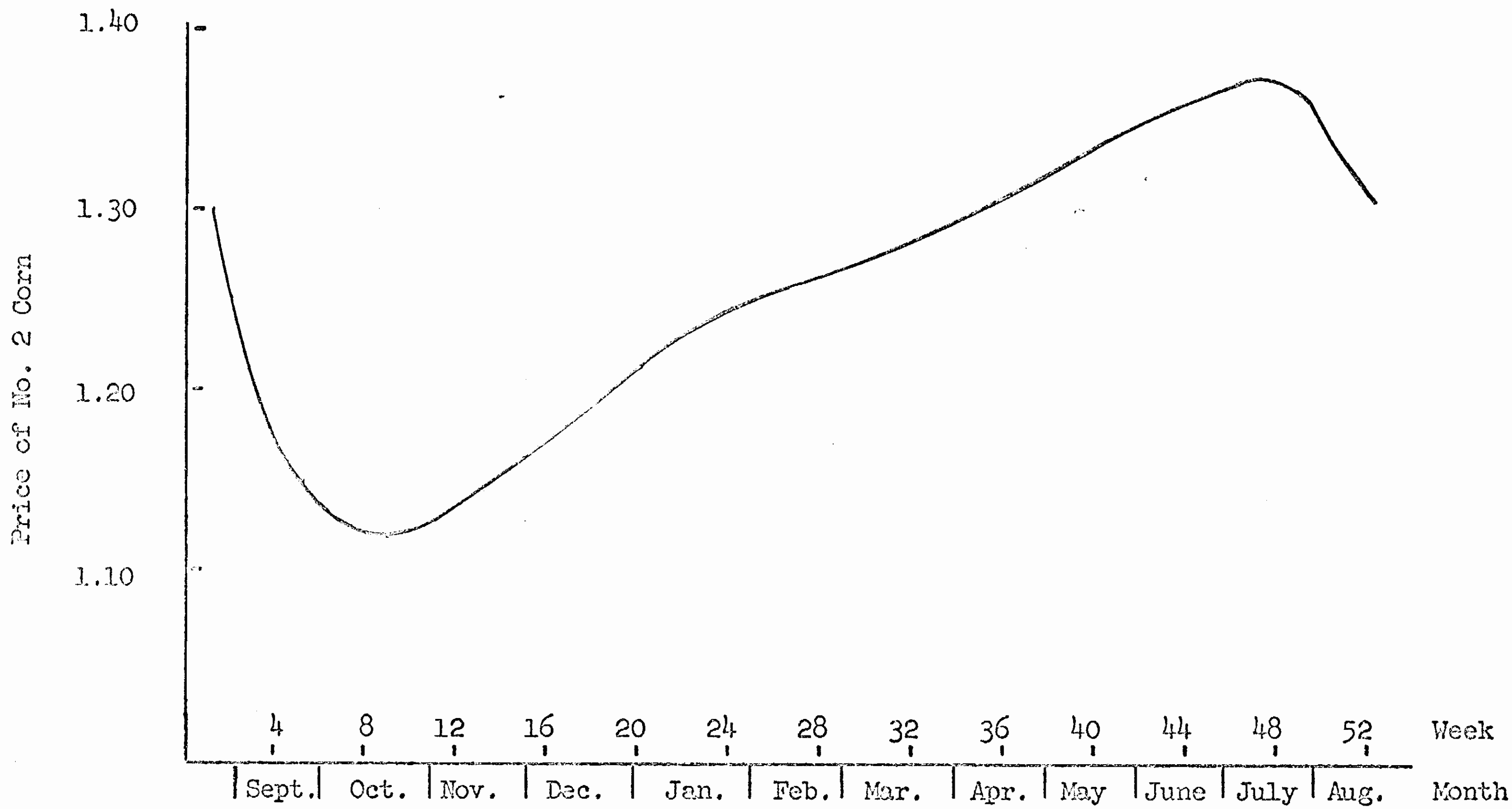

Figure 6. Predicted Prices for Norfolk 1959-1963.

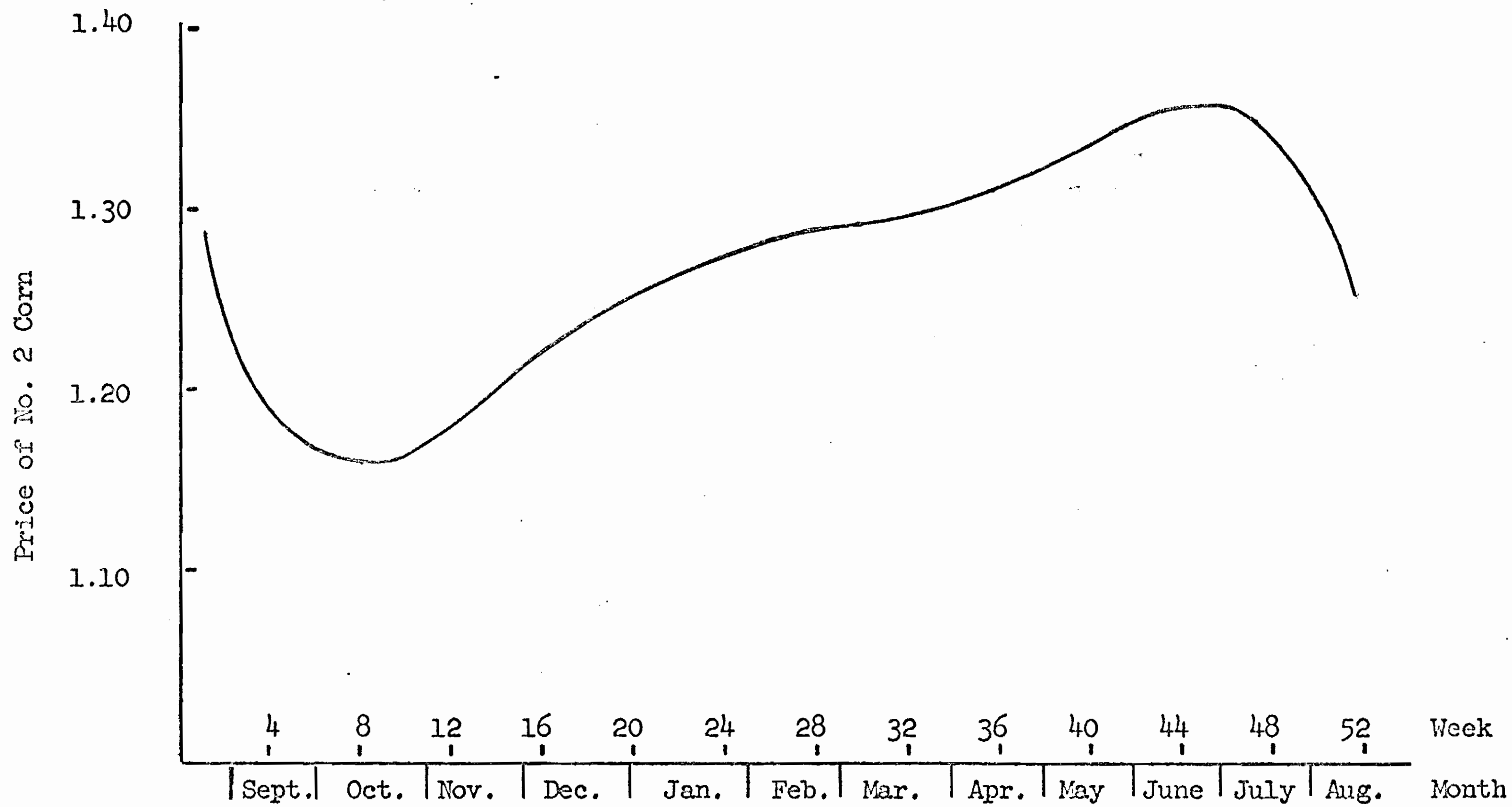

Figure 7. Predicted Prices for Tappahannock, 1961-1963.

Richmond and Norfolk and remains higher through the spring months. This five cent higher price at harvest narrows gradually to equal that at the other two locations by the late spring and summer

These predicted prices were used to determine how long corn should be held in storage to maximize returns. They were also useful as a guide in determining the point in the harvest season that it was likely to be profitable to dry and/or store corn.

Data from the study indicated that there was up to a 10 cent spread in the prices quoted in the area during 1961 and 1962. As noted above, there were considerable differences in the discount schedules applied. Thus, it was quite evident that the simple procedure of picking up the telephone and calling each elevator in the locality to determine the paying price was a logical step in deciding where and when to sell corn.

It should also be pointed out in passing that the discount schedules were relatively less flexible than the prices of corn and often remained the same from year to year. The discount schedules are based on the grade standards and consequently do not need to be changed often.

CHAPTER V

ANALYSIS OF HARVESTING COSTS

Introduction

Conventional equipment cost analysis attempts to determine the annual acreage required to justify the purchase of a machine. Consideration is given to the effect that annual use (acreage harvested) has on the costs of the various alternatives. Labor is valued at the going wage rate in the area, and interest on investment is based on local rates for borrowed capital. This method is useful for a homogeneous group of farms where the opportunity cost of labor and capital are approximately the same for each operator. This is seldom the case, however. For many farm operators the prevailing wage rate and interest rate do not apply. If competent hired help is not available during harvest season, the appropriate value of the farmer's labor is what it can earn in a competing use. For example, the farm operator may be developing a hog enterprise on his farm. Farrowing time could possibly conflict with the time of harvest of his soybeans and corn. His labor may be worth three dollars an hour or more if used to assist with the farrowing. It would then be necessary to place an equivalent value on the additional labor used in harvesting. He must make the decision whether he can afford to harvest and incur the higher cost of harvesting or delay his harvest until his expenses are lowered. He must also consider the additional losses encountered by delaying harvest. The same situation exists in regard to capital. Borrowed funds may bring a much higher return if invested in a new farrowing house than if invested in a new combine. The opportunity cost of capital invested in the farrowing house may be considerably above the rate normally paid for borrowed funds. This would tend to enlarge the competitive advantage of custom combining and restrict the the advantage of investing in a combine. Seldom is capital available to all farmers at the same rate of interest. Banks will charge different rates of interest depending on the financial standing and the risk involved with the borrower. In the area of this study, it was very apparent that the operators were unwilling, though able, to borrow more than limited amounts of money. Many expressed reluctance to borrow money to introduce new enterprises on their farms or to procure new machinery and equipment. The above factors demonstrate how variations in the opportunity costs of labor and capital may affect the choice of least-cost methods.

The Model

The method used in this study makes it possible to consider labor and interest rates. The total cost of performing the harvesting operation is a function of the fixed cost, variable cost, and the value of the labor required. The value of labor is used rather than wage rate to permit consideration of the opportunity cost of labor. If the above relationship is put on a per acre basis, the break-even acreage can be defined by the equation:[1]

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[1] Smith, Edward J., <u>op. cit.</u>, p. 112.

(1) $$\overline{V}_1 = F_2/A + \overline{V}_2 + \overline{L}_2W$$

where; $\overline{V}_1$ = total cost or custom rate (per acre)

F_2 = total fixed cost of machine (depreciation, interest, taxes, insurance, and housing)

A = annual harvested acreage

$\overline{V}_2$ = variable operating cost (per acre)

$\overline{L}_2$ = labor requirement (hours per acre) and

W = the value of labor (per hour)

To solve for A, equation (1) can be rewritten as:

(2) $$A = \frac{F_2}{\overline{V}_1 - \overline{V}_2 - \overline{L}_2W}$$

Corn Harvesting Cost Estimates

Cost data and performance rates for one-row and two-row corn pickers are presented in Table 24. A custom rate of seven dollars per acre for picking ear corn (based on the average reported on sample farms) was used in the calculations. The following analysis will develop the break-even acreages between one-row pickers and custom hiring, two-row pickers and custom hiring and the even-cost line between the one-row picker and the two-row picker. Using the seven dollar custom rate and substituting the data on the one-row picker in Table 24 into equation (2), gives:

(2') $$A = \frac{216}{7.00 - 2.12 - 1.25(W)}$$

Various labor rates were substituted into equation (2') and solved for the break-even acreages.

Table 24. Performance Rates and Costs for One-Row and Two-Row Pickers[1]

Item (1)	One-row picker (2)	Two-row picker (3)
Capacity per hour	0.8 acres	1.53 acres
Labor per acre	1.25 hours	.65 hours
Costs:		
Fixed costs per year:[2]		
Depreciation	$144.00	$252.00
Other	72.00	126.00
Total fixed costs	$216.00	$378.00
Variable costs per acre:		
Machine operating costs	$0.64	$0.77
Tractor operating costs and fuel	.99	.70
Tractor fixed costs (800 hr./yr.)	.49	.34
Total variable costs	$2.12	$1.81

[1]See Appendix A, Table 2.

[2]Depreciation based on 10% salvage and 10 year life; interest at 3% of new cost; insurance, taxes and housing 1.5% of new cost; operating costs based on American Society of Agricultural Engineers 1963 Yearbook with slight revisions for Virginia conditions. Costs and labor requirements for hauling and storing grain are not included under either of the above methods, nor in the custom rates used.

Table 25. Break-even Acreages for One-Row and Two-Row Corn Pickers Compared with $7.00 Custom Rate at Various Labor Rates

Value of Labor per hour	Break-even acreage: One-row picker	Break-even acreage: Two-row picker
(1)	(2)	(3)
$0.00	44	73
.50	51	78
1.00	60	83
1.50	72	90
2.00	91	97
2.50	123	106
3.00	190	117

This same procedure was followed for the two-row picker. Data from column (3) in Table 24 were substituted in equation (2) and the break-even acreages calculated. The break-even acreages resulting from the calculations are shown in Table 25 for the one-row and two-row pickers. Each acres column should be considered separately to compare the individual machine with custom hiring.

When the acreages and labor rates are plotted on a graph, Figure 8, they separate those combinations of labor rate and acreage for which custom harvesting is cheaper from those where it cost less to own a picker. The curves in Figure 8 should be read independently. The curve for the one-row picker divides the zone of advantage for the one-row

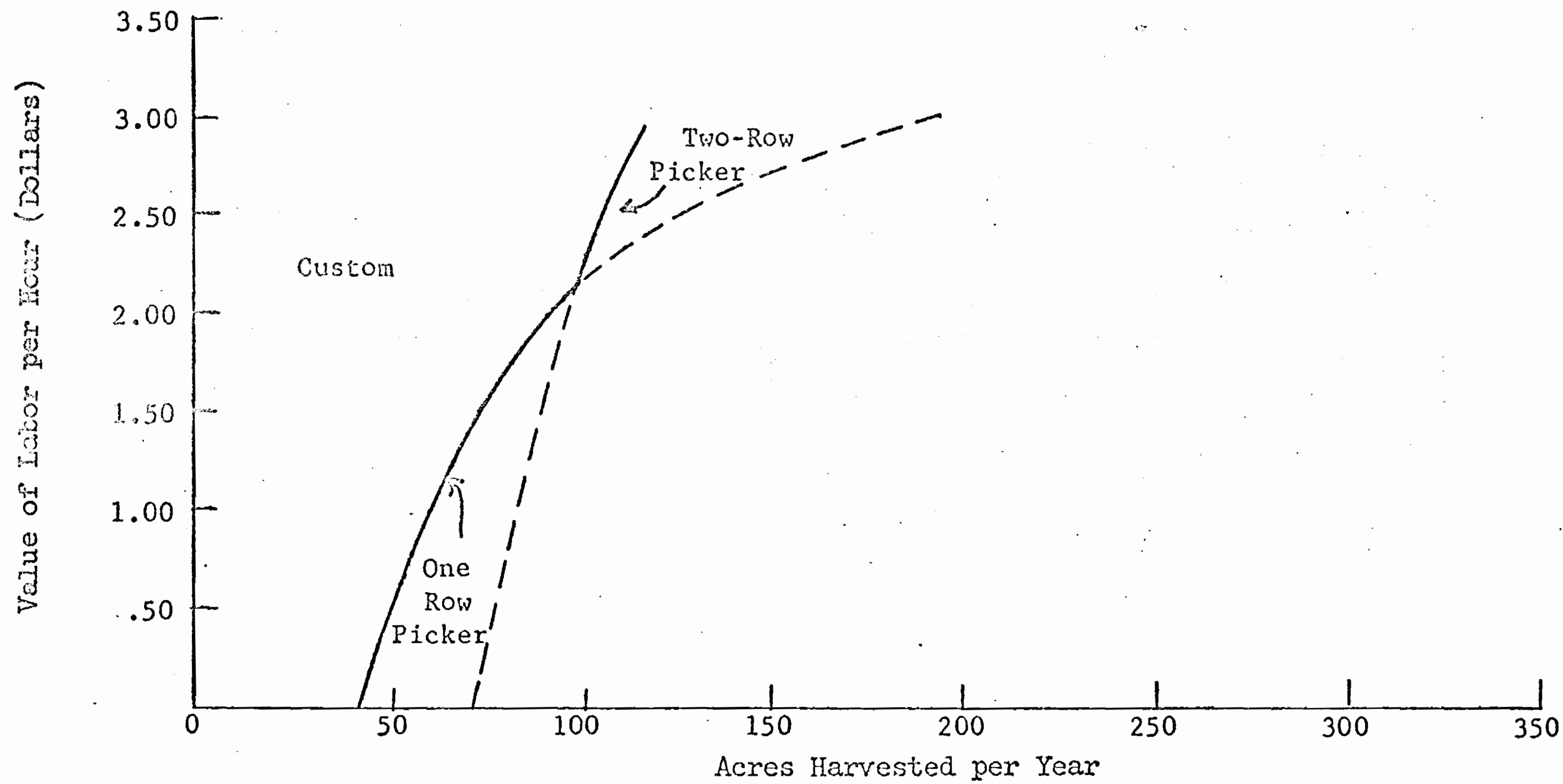

Figure 8. Zones of Cost Advantage: One-Row Picker, Two-Row Picker and Custom Rate at $7.00 per Acre.

picker and custom hiring. The curve for the two-row picker divides the zone of advantage for the two-row picker and custom hiring. For all acreage and labor-rate combinations to the left of, and above, the solid line in Figure 8, it was less expensive to custom hire a picker. For the combinations to the right of and below the solid line it cost less to own the machine. The break-even point between the one-row picker, the two-row picker, and custom-hiring was at approximately 100 acres and a labor rate of about $2.20 per hour. At a fifty cent per hour labor rate (assuming a $7.00 custom charge) the cost of owning a one-row picker and the cost of custom hiring a picker were equal at approximately 50 acres. During harvest time the use of his own picker takes more of the farm operator's labor than hiring a custom machine. Therefore, as the value of labor increases, so does the per acre cost of using his own picker. The competitive advantage of custom picking is increased at the higher labor rates, hence larger acreages are required to justify owning a picker.

If a farmer does not have enough labor to harvest his crops, he has no alternative but to custom hire. However, if his labor is not restricted to that degree, but has a rather high opportunity cost, another alternative might be considered--at larger acreages the use of a two-row picker (which requires only half the labor per acre) could be substituted for the one-row picker at little increase in cost.

Tractor fixed costs were included under variable costs per acre in the analysis (see Table 24). This charge (based on 800 hours of use per year) was included to take into account the need for an additional tractor above the requirement for custom hiring. If the charge were omitted, or just the differences in the charges of 15 cents added to the one-row picker, the effect would be to move the curves in Figure 8 to the left slightly. For example, omitting the charge, at $1.00 per hour for labor, the break-even point for the one-row picker would be 52 acres and for the two-row picker 77 acres.

The equal-cost line between a one-row picker and a two-row picker was determined by setting the individual cost functions in equation (1) equal to each other. The equation for determining the equal-cost line between two machines thus becomes:

$$(3) \qquad F_{21}/A + \overline{V}_{21} + \overline{L}_{21}W = F_{22}/A + \overline{V}_{22} + \overline{L}_{22}W$$

where the notation is the same as for equation (1) and the additional subscript designates the particular machine.

Substituting data from Table 24 and solving for A, equation (3) becomes:

$$(3') \qquad A = \frac{162}{0.31 + 1.25(W) - 0.65(W)}$$

Various labor rates were substituted in equation (3') and the following equal-cost acreages calculated (Table 26). With labor valued at $1.50, the cost of owning a one-row picker was less than owning a two-row picker up to 134 acres.

The equal-cost line provided by these computed values is presented graphically in Figure 9. Below and to the left of the line the combinations of acreage and labor rate made the one-row picker the least cost alternative. For all combinations to the right of and above the curve it was less expensive to operate a two-row picker.

Table 26. Equal-Cost Acreages for One-Row and Two-Row Pickers at Various Labor Rates

Value of labor per hour	Acres
$0.50	266
1.00	178
1.50	134
2.00	107
2.50	90
3.00	77

In Figure 10 the computed values from Table 25 for a $7.00 custom rate and Table 26 for even-cost acreages are plotted on one diagram. This combines the information presented in Figure 8 and Figure 9 and illustrates the zones of advantage for the three alternatives: one-row picker vs. custom, two-row picker vs. custom, and owning a one-row vs. two-row picker.

Performance rates and costs for a two-row self-propelled corn combine are presented in Table 27. Column (2) represents a corn combine with all of the fixed costs charged to corn. Column (3) is a corn

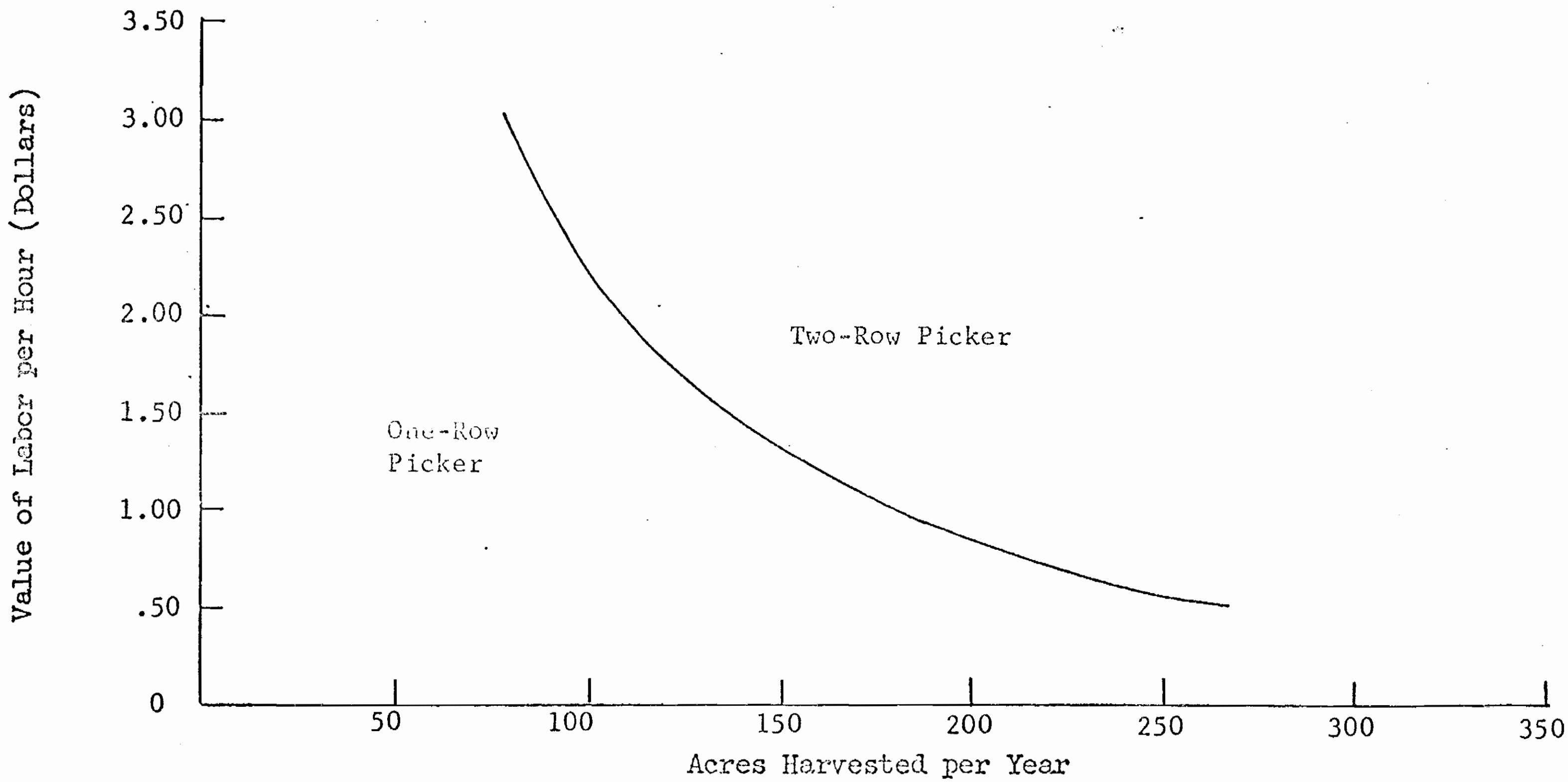

Figure 9. Equal-Cost Line Between One-Row Picker and Two-Row Picker.

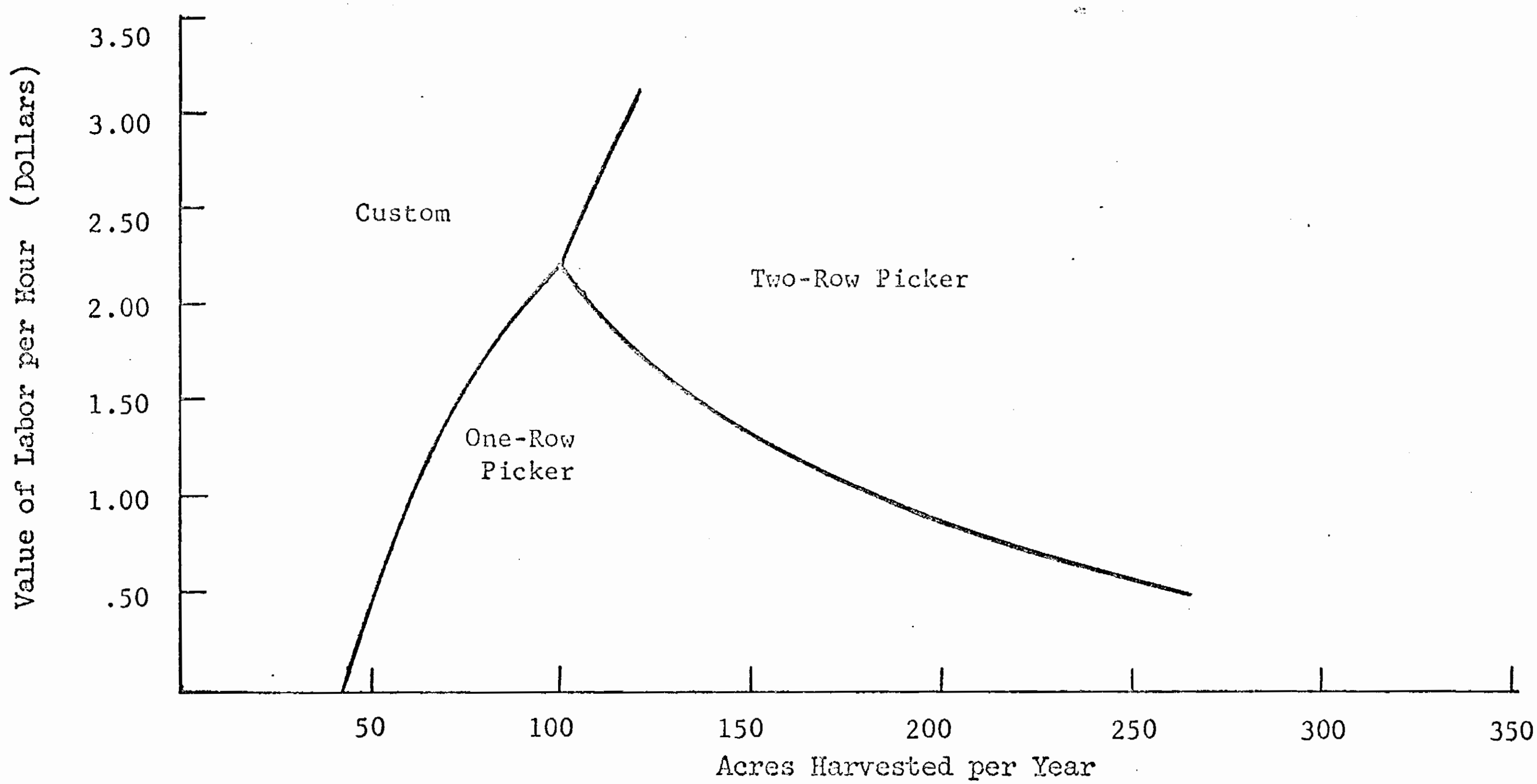

Figure 10. Zones of Cost Advantage: One-Row Picker vs. Two-Row Picker vs. Custom Picking at $7.00 per Acre.

Table 27. Performance Rates and Costs for a Two-Row Self-Propelled Corn Combine

Item (1)	Two-row corn combine (100% fixed cost)[1] (2)	Two-row corn combine (40% fixed cost)[1] (3)
Capacity per hour	1.59 acres	1.59 acres
Labor per acre	0.53 hours	0.63 hours
Costs:		
Fixed costs per year:[2]		
Depreciation	$702.00	$383.00
Other	351.00	192.00
Total fixed costs	$1053.00	$575.00
Variable costs per acre:		
Machine operating costs	$1.33	$1.33
Engine operating costs and fuel	.53	.53
Total variable costs	$1.86	$1.86

[1]See Appendix A, Table 3.

[2]Depreciation based on 10% salvage and 10 year life; interest at 3% of new cost; insurance, taxes and housing 1.5% of new cost; operating costs based on American Society of Agricultural Engineers 1963 Yearbook with slight revisions for Virginia conditions. Costs and labor requirements for hauling and storing grain are not included under either of the above methods, nor in the custom rates used.

combine with forty percent of the fixed costs charged to the corn operation.[1] The combine used in this analysis was a $5900 basic machine with a $1900 corn head for harvesting shelled corn and a $1200 grain head for harvesting small grains.

Fixed costs were apportioned on the basis of farm data from the area subsample. As noted earlier, these farms averaged two acres of soybeans plus one acre of other small grains, for each acre of corn grown. It was assumed that the machine depreciated at twice the rate while harvesting corn as compared to other crops,[2] because of the weight and volume of corn. While this complicated the analysis, the method used in this study permitted consideration of this additional variable.

An analysis was made of the break-even acreage for the self-propelled combine. Substituting cost data and performance rates into equation (2):

$$(2'') \qquad A = \frac{575}{9.00 - 1.86 - .63(W)}$$

and using a custom rate of $9.00 per acre, the break-even computed values as a function of labor value are presented in Table 28.

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[1] The $5900 basic machine was allotted 40% to corn. The $1900 corn head was all allocated to corn. The 40% of $5900, or $2360, was determined on the basis of harvesting one acre of corn for each three acres of soybeans and small grains. It was assumed that the machine would depreciate at twice the rate for each acre of corn as for each acre of small grains. Therefore, the basic machine was allocated 2/5 to corn and 3/5 to small grains.

[2] Based on an interview with E. S. Smith, Agricultural Engineering Department, V. P. I., March 18, 1964.

Table 28. Break-Even Acreages for Self-Propelled Corn Combine (40% Fixed Cost to Corn) Compared to $9.00 Combine Custom Rate, at Various Labor Rates

Value of labor per hour	Acres
$0.00	81
0.50	84
1.00	88
1.50	93
2.00	98
2.50	103
3.00	109

Data on the two-row picker and the self-propelled corn combine were substituted into equation (3) and the equal-cost acreages computed. Since the product from the two machines is not the same, a $2.00 shelling cost was added to the variable cost of the picker. Equation (3) then becomes:

$$(3'') \qquad A = \frac{575 - 378}{1.81 + 2.00 - 1.86 + .65(W) - .63(W)}$$

The computed values for equation (3'') for the various labor rates are presented in Table 29.

The computed values for the two-row picker were taken from Table 24; the values for the corn combine from Table 27; and the break-even cost acreages from Table 29. These curves are graphically summarized

Table 29. Equal-Cost Acreages for Two-Row Picker and Corn Combine (40% Fixed Cost to Corn) at Various Labor Rates

Value of labor per hour	Acres
$0.00	101.0
0.50	100.5
1.00	100.0
1.50	99.5
2.00	99.0
2.50	98.5
3.00	98.0

in Figure 11. A shelling cost of $2.00 per acre was added for the picker. The almost vertical equal-cost line results from the approximately equal labor requirements for the two machines. The zone to the left and above the solid line included combinations of acreage and labor rate for which custom hiring was the cheapest alternative. The broken lines are extensions of the solid lines indicating the break-even cost acreages between each machine and custom hiring. All combinations starting at the combine area and to the left of the nearly vertical line represent the area in which the two-row picker was the least cost alternative. Corn combines were the least expensive alternative to the right of the vertical line.

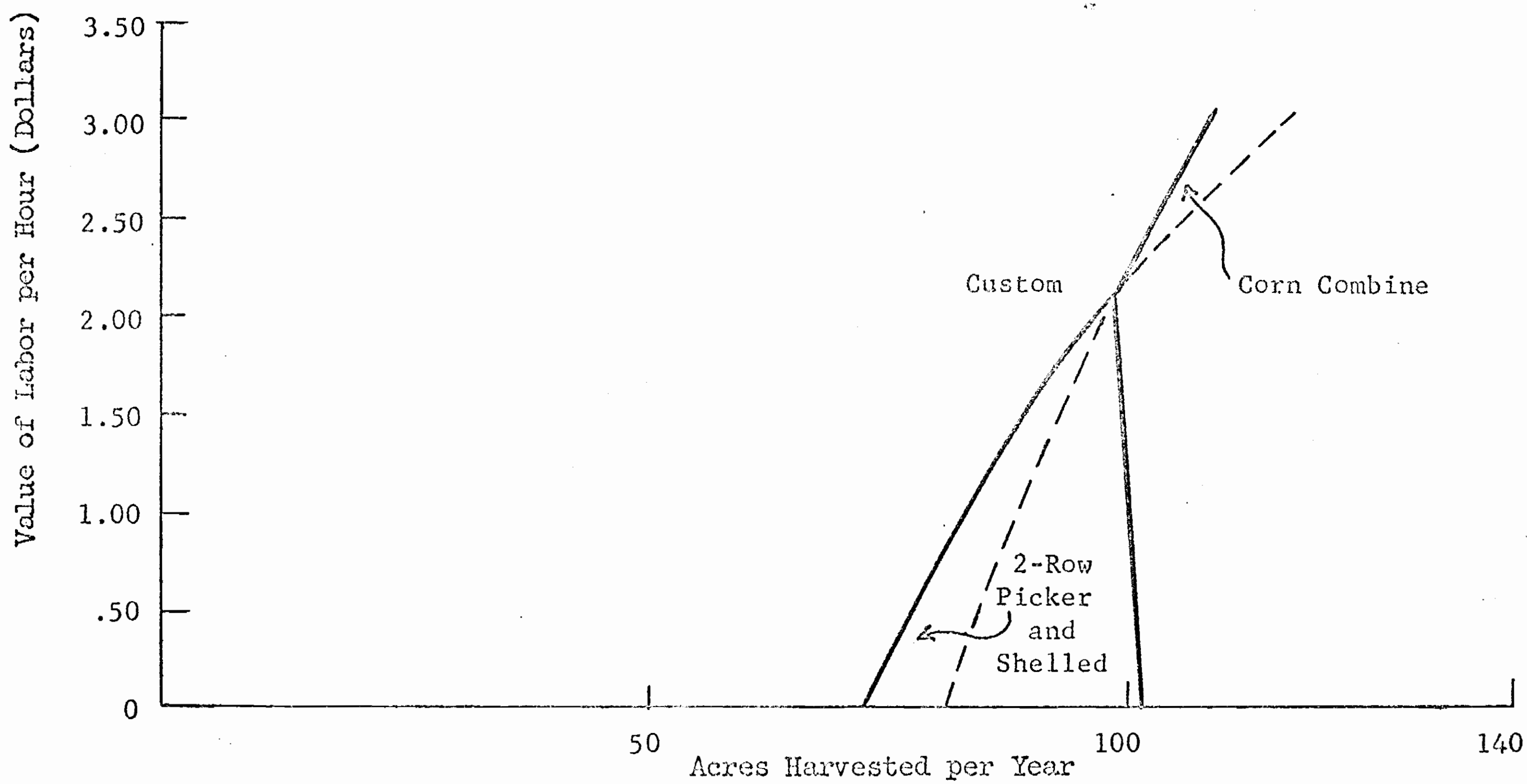

Figure 11. Zones of Cost Advantage: Two-Row Picker vs. Corn Combine vs. Custom Harvesting at $9.00 per Acre, Shelled Corn End Product.

Varying Custom Rates

In the above analysis the annual acreage and the wage rate were considered variables and everything else was held constant. For the following analysis cost data and performance rates were substituted in equation (2) with the value of labor held constant. Substituting various custom rates ($\overline{V}_1$) in the equation permitted the estimation of least-cost zones for custom hiring vs. picking and combining. Using the data for a one-row picker (Table 24) and solving for A, equation (2) becomes:

$$(3''') \qquad A = \frac{216}{\overline{V}_1 - 2.12 - 1.25(1.00)}$$

The solid line in Figure 12 was plotted from the computed values, using $1.00 per hour labor. Thus, with a custom charge of $7.00, it was less expensive to custom hire corn picking up to 60 acres. For more than 60 acres the fixed costs of the owned picker were spread over enough acres so that this machine takes over as the least cost choice and holds this advantage to the maximum capacity of the machine. The broken line was plotted using $0.50 per hour labor. In this situation with the $7.00 custom charge, it was less expensive to custom hire up to 50 acres.

The cost data and performance rates for a two-row picker (Table 24) were used in equation (2) and the computed values plotted in Figure 13. With a custom rate of $7.00 the solid line ($1.00 labor rate) indicates custom harvesting was the least-cost choice up to 83 acres. At larger acres owning a two-row picker would be justified.

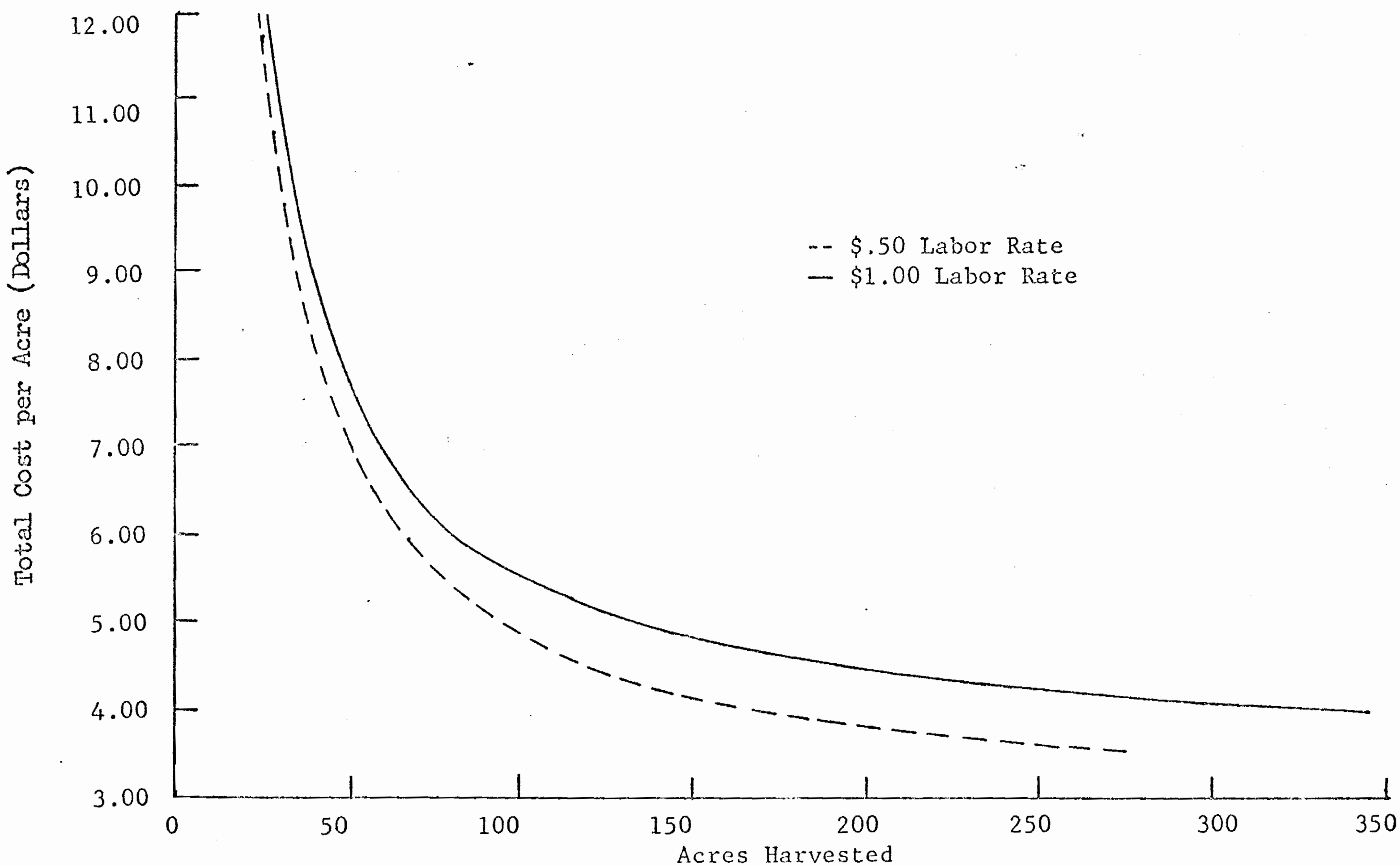

Figure 12. Cost per Acre for Picking Corn with One-Row Picker.

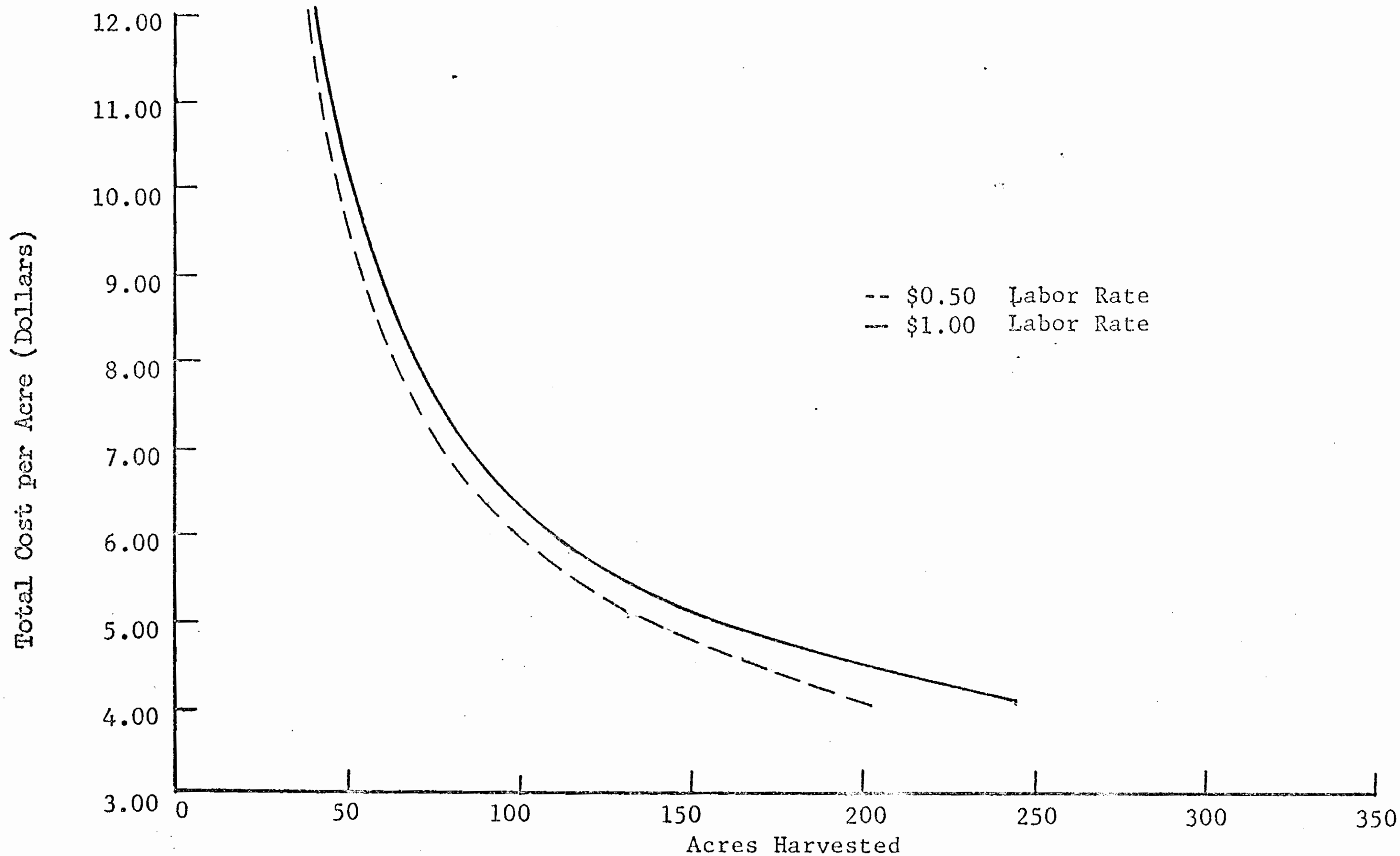

Figure 13. Cost per Acre for Picking Corn with Two-Row Picker.

A direct comparison of Figures 12 and 13 indicates that the break-even point between a one-row picker and a two-row picker at $1.00 per hour labor is 178 acres and approximately a $4.60 custom rate.

In Figure 14 the least-cost zones for custom combining and owning a self-propelled combine were computed using two labor rates. The cost data and performance rates from Table 27 (column (2)) were used in equation (2) for computing the values. The combine cost used in this figure was for all of the fixed costs charged to corn. At the prevailing combining custom rate of $9.00 per acre, the least-cost choice was custom combining up to 162 acres (with labor at $1.00 per hour). Only at larger acreages could owning a combine for corn alone be justified.

As noted earlier, the fixed costs on the combine in column (3) of Table 27 were apportioned forty percent to corn. The least-cost zones in Figure 15 were plotted using that data. At a $9.00 custom rate and $1.00 per hour for labor, the least-cost zone for custom combining extended to 88 acres. Owning a combine would be the least-cost alternative at larger acreages. The curves were shifted to the left because the fixed costs were spread over more total acres.

The $2.00 labor charge was included in Figures 14 and 15 to permit comparison with Figure 11, where it was noted that the break-even point between the two-row picker plus shelling, and the corn combine was at approximately 100 acres and a $2.00 labor rate. With a $9.00 custom rate and $2.00 per hour for labor in Figure 15, the least-cost zone extended to approximately 100 acres.

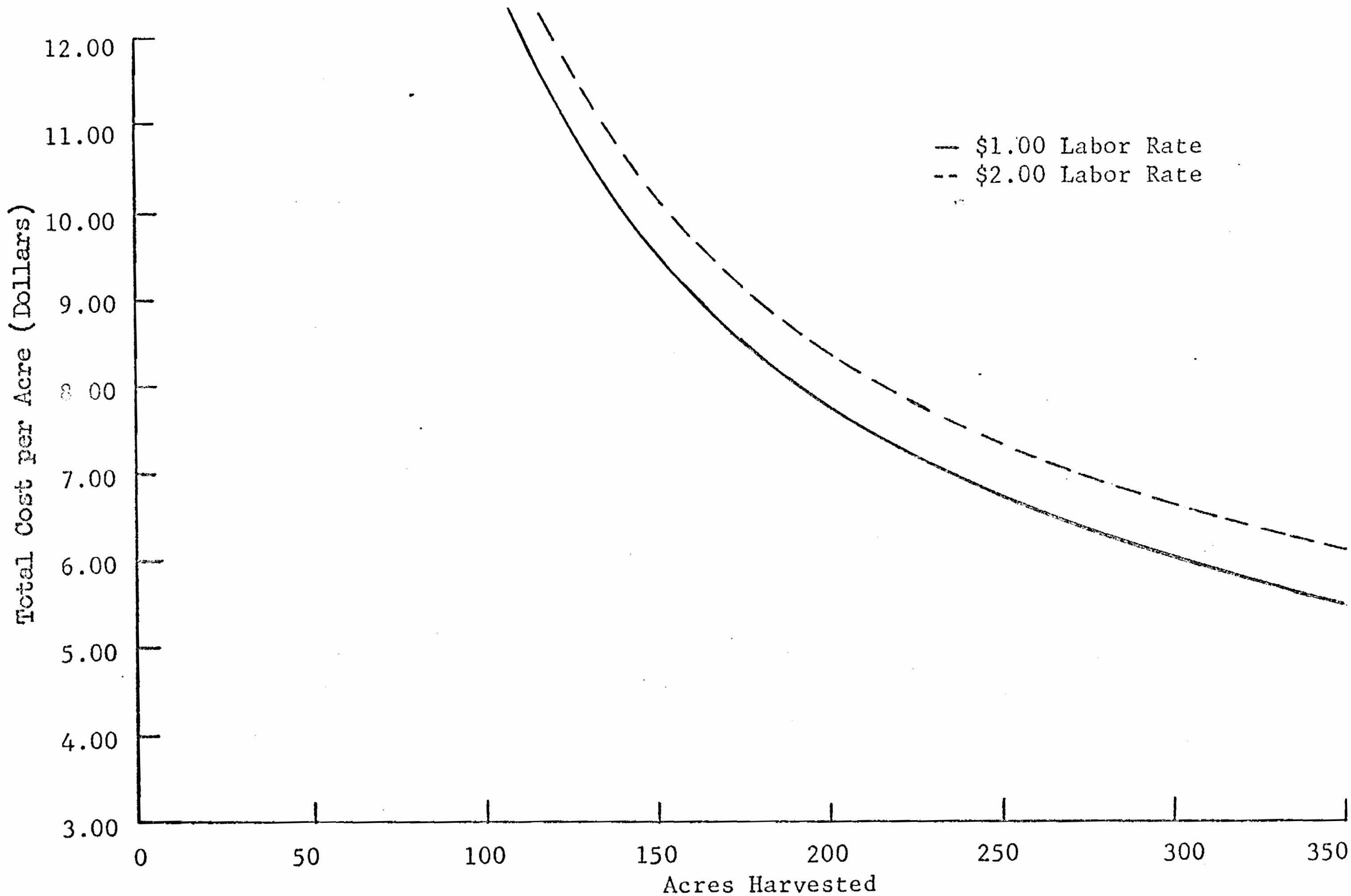

Figure 14. Costs per Acre for Combining with Self-Propelled Combine. Combine Used for Corn Only.

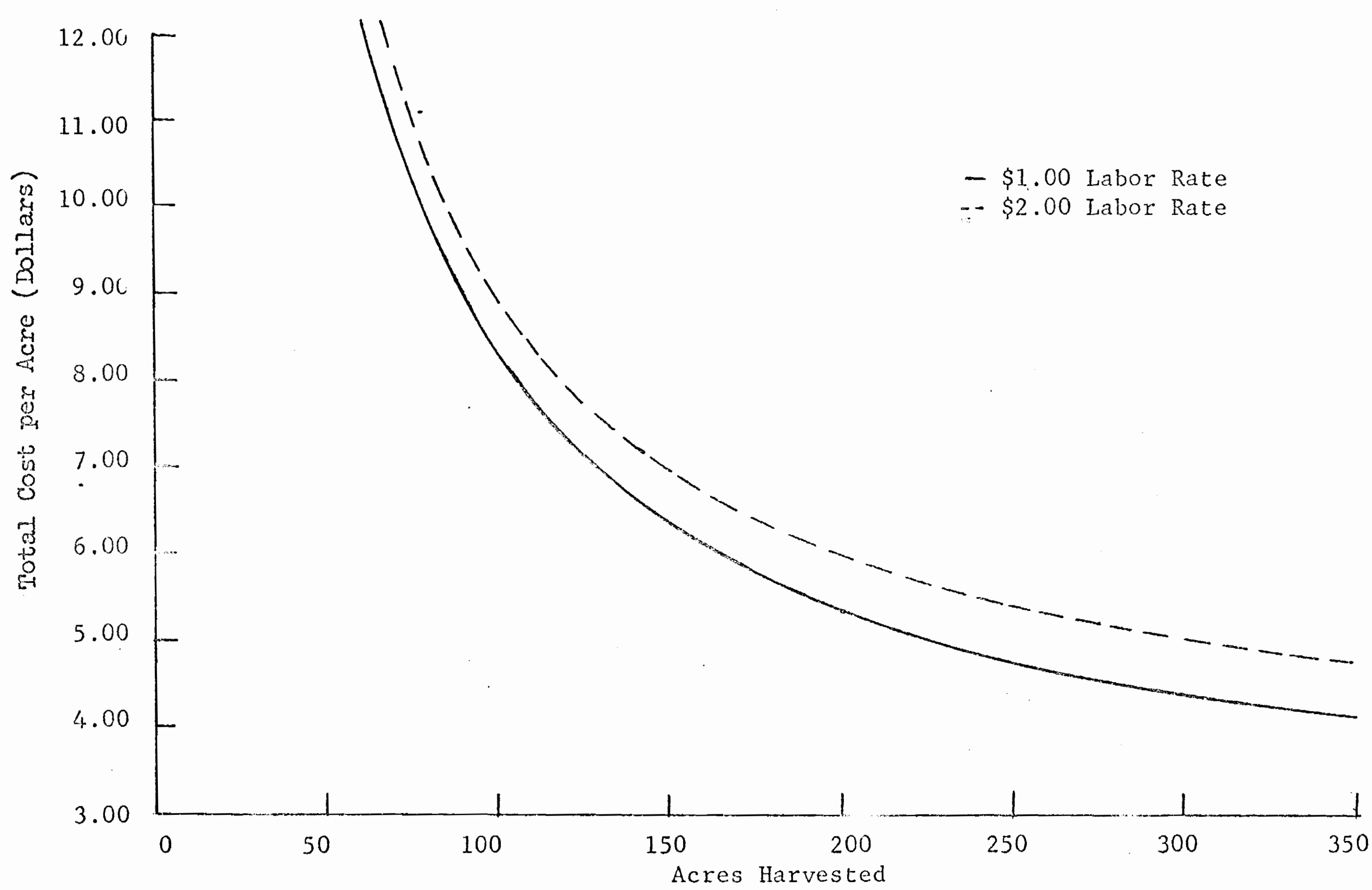

Figure 15. Costs per Acre for Combining Corn with Self-Propelled Combine. Combine Used for Both Corn and Small Grain. (40% Fixed Cost to Corn).

Small Grain Harvesting Cost Estimates

Keeping in mind that one of the major purposes of this paper was to consider alternative equipment systems; recognizing the fact that corn is an integral part of the entire cropping system; and considering the multiple use features of much of the equipment in use; it seems imperative that alternatives related to harvesting both corn and small grains be considered. Before developing these alternatives, however, it is necessary to consider the least-cost zones for custom combining and owning a self-propelled combine for grain only.

The cost data and performance rates used for a 12-foot self-propelled combine with a grain head to harvest soybeans and small grain are presented in Table 30. The fixed costs for the combine in column (2) were all allocated to the small grain harvesting operation. The combine in column (3) had sixty percent of the fixed costs on the basic machine charged to the harvest of soybeans and small grain and forty percent to the corn harvesting operation.

Figure 16 depicts the resulting least-cost zones. With $1.00 per hour for labor and a $6.00 per acre custom rate, 198 acres were required before owning a combine was less expensive than custom hiring.

The least-cost zones in Figure 17 were computed in the same manner as above. The relevant comparison, however, was between custom combining grain or owning a 12-foot self-propelled combine to harvest both corn and small grains. The fixed costs of the basic machine were apportioned sixty percent to the grain and forty percent to corn. The fixed cost on

Table 30. Performance Rates and Costs for a Self-Propelled 12-Foot Grain Combine[1]

Item (1)	12-ft. grain combine (100% fixed cost) (2)	12-ft. grain combine (60% fixed cost) (3)
Capacity per hour	3.16 acres	3.16 acres
Labor per acre	0.32 hours	0.32 hours
Costs:		
Fixed costs per year:[2]		
Depreciation	$639.00	$427.00
Other	310.00	213.00
Total fixed costs	$949.00	$640.00
Variable costs per acre:		
Machine operating costs	$0.61	$0.61
Engine operating costs and fuel	.27	.27
Total variable costs	$0.88	$0.88

[1]See Appendix A, Table 4.

[2]Depreciation based on 10% salvage and 10 year life; interest at 3% of new cost; insurance, taxes and housing 1.5% of new cost; operating costs based on American Society of Agricultural Engineers 1963 Yearbook with slight revisions for Virginia conditions. Costs and labor requirements for hauling and storing grain are not included under either of the above methods, nor in the custom rates used.

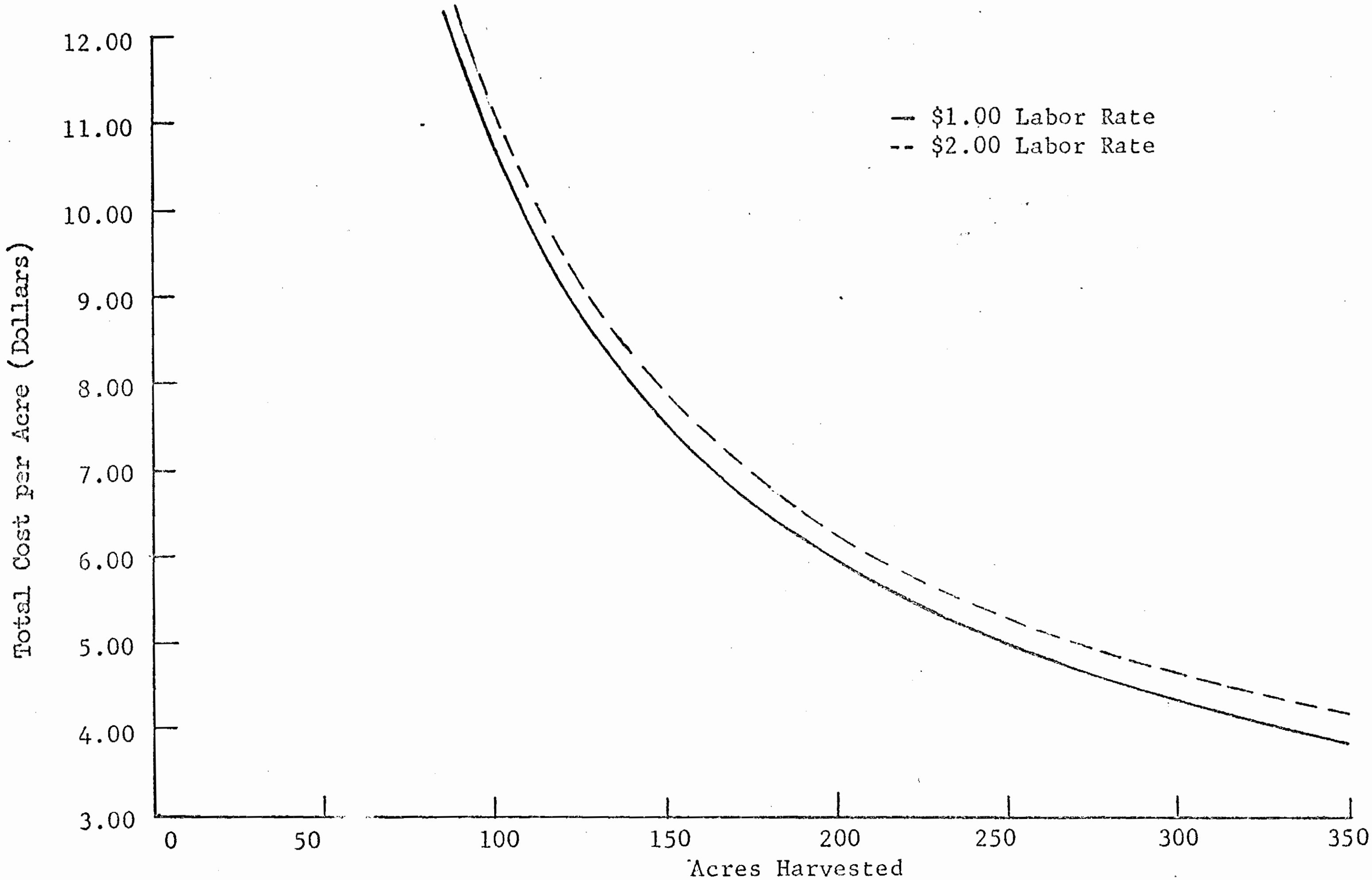

Figure 16. Costs per Acre for Combining Small Grain with 12-Foot Self-Propelled Combine. Combine Used for Small Grain Only.

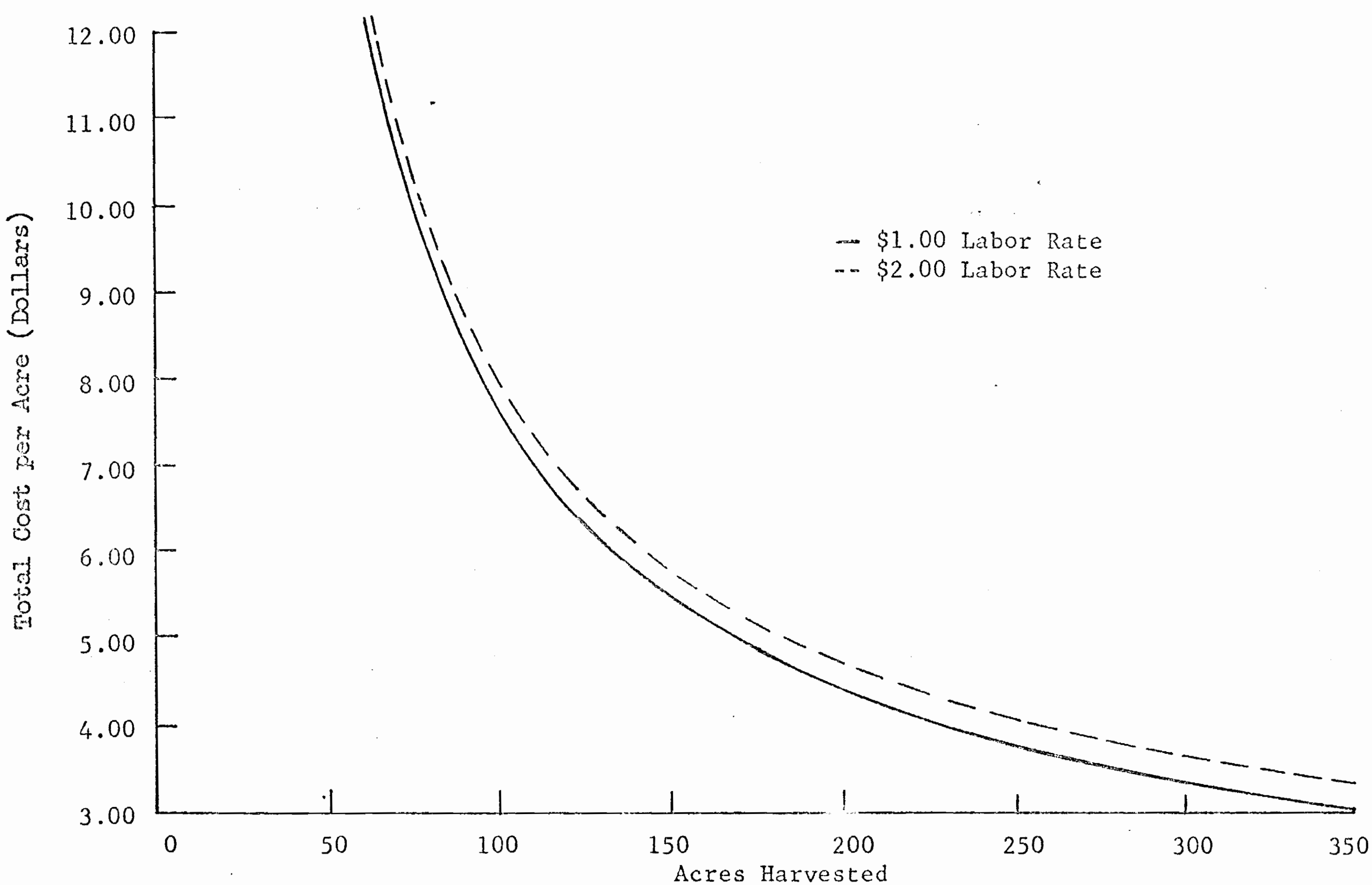

Figure 17. Costs per Acre for Combining Grain with 12-Foot Self-Propelled Combine. Combine Used for Both Corn and Small Grain. (60% Fixed Cost to Grain).

the grain head is all charged to grain. The owned combine was the least-cost choice for more than 133 acres if the custom rate was $6.00 (labor valued at $1.00).

Table 31 gives the cost data and performance rate for a 7-foot pull-type combine used to harvest soybeans and small grain. Since there are a limited number of pull-type combines manufactured with interchangeable corn head and grain head and these were not readily available in the area, only the grain combining alternative was considered in this investigation. Substituting the data from Table 31 into equation (2), the computed values for the least-cost zones are presented in Figure 18. At the $6.00 custom rate, 96 acres was the break-even point between custom combining and owning a 7-foot combine ($1.00 labor rate).

Corn and Small Grain Harvesting Cost Estimates

Zones of least-costs per acre of harvesting corn and small grain in the ratio of one acre to three acres are shown in Figure 19. Labor was valued at one dollar per hour. Method (1) harvested corn and grain with a self-propelled combine with a corn head and a grain head. The fixed cost on the basic combine machine was allotted on a forty to sixty percent ratio as explained previously. Method (2) employed a two-row mounted corn picker and a 7-foot pull-type grain combine. Method (3) used a two-row mounted corn picker and custom combined the small grain at a charge of $6.00 per acre. Method (4) picked corn with a one-row picker and custom combined grain at $6.00 per acre. Method (5) employed the one-row picker and 7-foot pull-type combine.

Table 31. Performance Rates and Costs for a Pull-Type 7-Foot Grain Combine[1]

Item	7-ft. grain combine (pull-type)
Capacity per hour	1.85 acres
Labor per acre	0.54 hours
Costs:	
Fixed costs per year:[2]	
Depreciation	$252.00
Other	126.00
Total fixed costs	$378.00
Variable costs per acre:	
Machine operating costs	$0.68
Tractor operating costs and fuel	.56
Tractor fixed costs (800 hr./yr.)	.28
Total variable costs	$1.52

[1] See Appendix A, Table 5.

[2] Depreciation based on 10% salvage and 10 year life; interest at 3% of new cost; insurance, taxes and housing 1.5% of new cost; operating costs based on American Society of Agricultural Engineers 1963 Yearbook with slight revisions for Virginia conditions. Cost and labor requirements for hauling and storing grain are not included under either of the above methods, nor in the custom rates used.

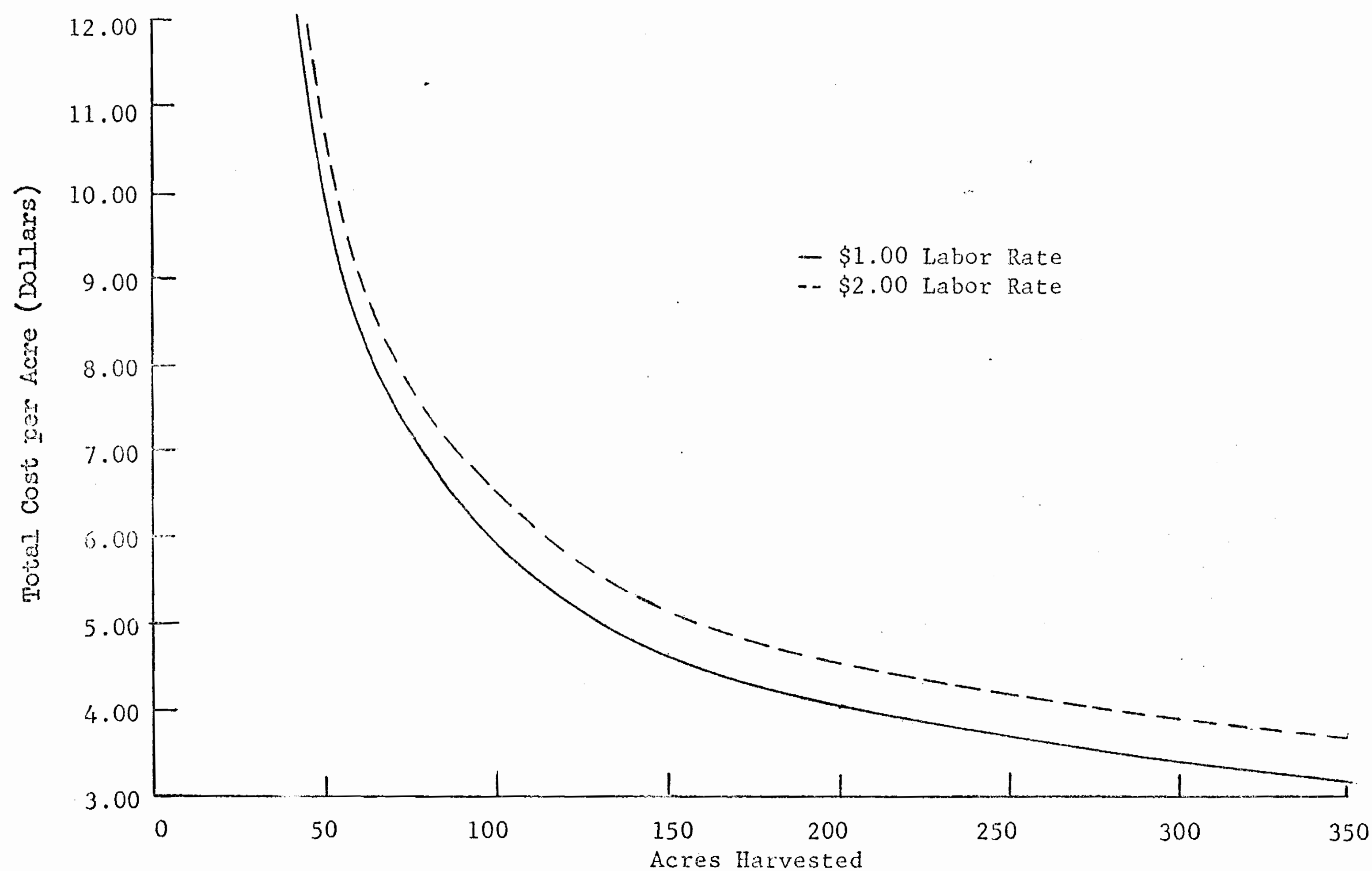

Figure 18. Costs per Acre for Combining Grain with 7-Foot Pull-Type Combine.

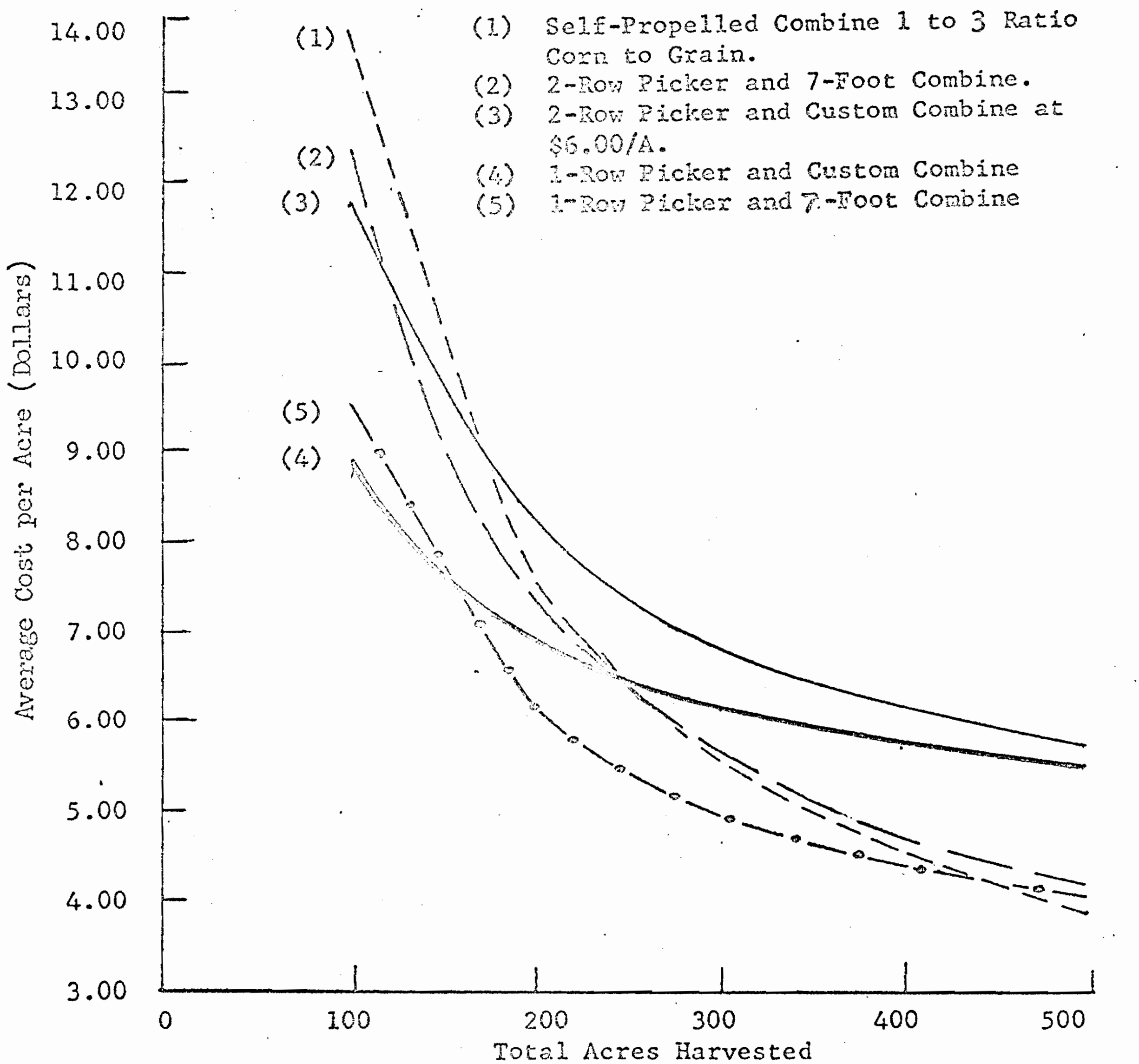

Figure 19. Cost per Acre for Harvesting Corn and Small Grain in the Ratio of One Acre of Corn to Three Acres of Grain for Different Methods. (Labor is valued at $1.00 per Hour).

The cost of shelling the ear corn from the pickers was not included in Figure 19. The one-row picker and custom combining were the least-cost combination for smaller acreages up to about 140 acres. It should also be noted that the $6.00 custom charge per acre of grain combined did not permit the cost of Methods (3) and (4) to decrease at the same rate as the costs of the other methods while the fixed costs of the other three methods decreased at approximately the same rate as the acreage increased. Harvesting a little more than 140 acres of corn and small grain reduced the cost of owning a one-row picker and 7-foot combine sufficiently to make it the least-cost method up to 450 acres. At the larger acreages consideration must be given to the timeliness of accomplishing the harvest.

In Figure 20 the above Methods (2), (3), (4) and (5) were adjusted by $2.00 per acre for shelling the ear corn. Under these circumstances, owning a self-propelled combine, Method (1), was the least-cost alternative at any acreage above 240 acres of grain (any combination of more than 60 acres of corn and 180 acres of small grain). Methods (4) and (5) were still the cheapest means of owning equipment below 135 and 240 acres respectively. However, if Methods (4) and (5) were compared with custom combining corn at $9.00 per acre and grain at $6.00 per acre or an average cost of $6.75 per acre, custom combining was the least-cost combination up to a total of 225 acres of grain. At the larger acreages, Method (1) was at least one dollar per acre cheaper than any other alternative.

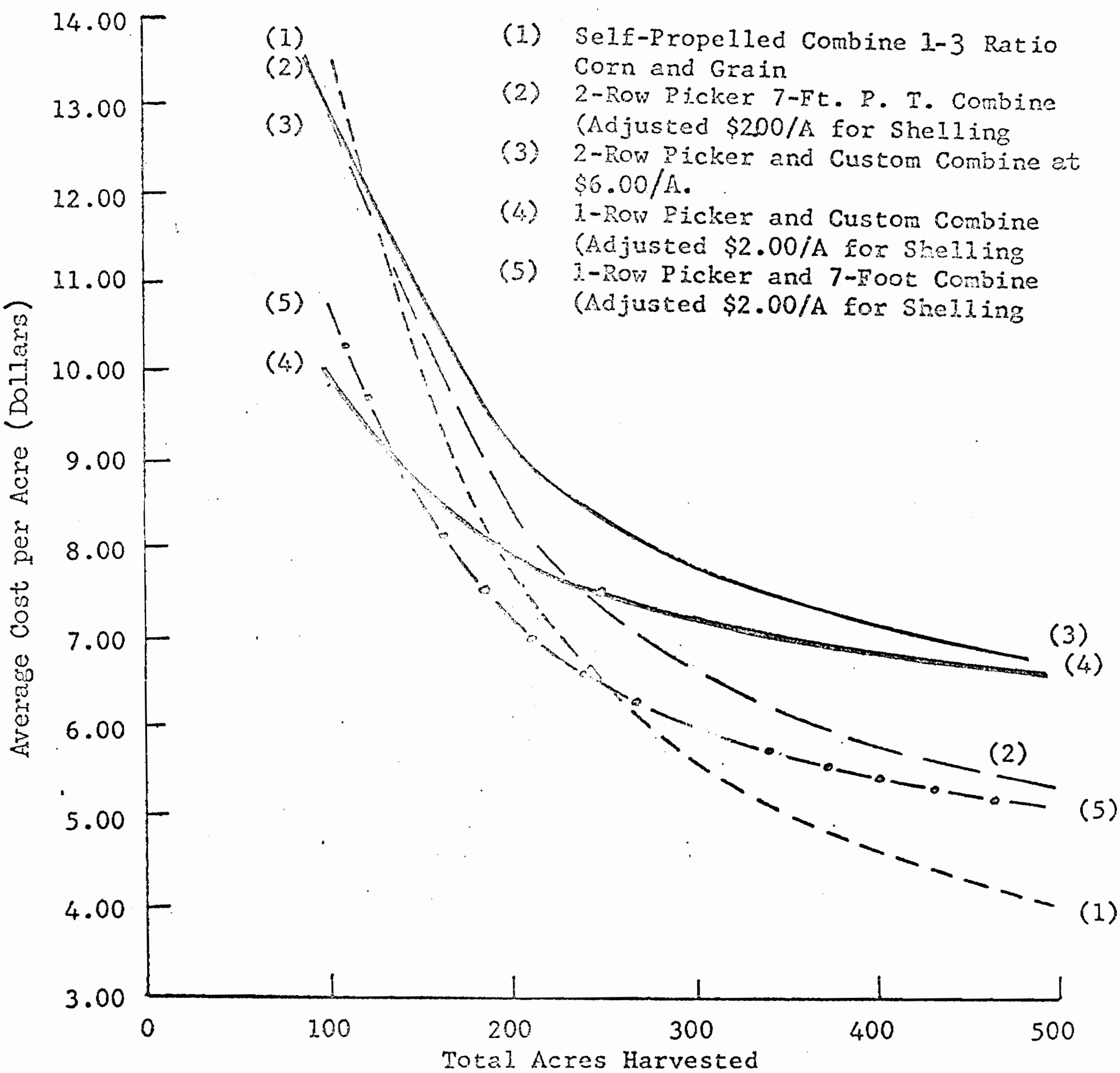

Figure 20. Cost per Acre for Harvesting Corn and Small Grain in the Ratio of One Acre of Corn to Three Acres of Grain for Different Methods. (Adjusted for Shelling Corn) (Labor is Valued at $1.00 per Hour).

With the information presented on the various tables and figures above it was possible to analyze methods using different machines and develop figures showing the competitive advantage zones for a given interest rate and a range of per hour value for labor. In the same manner the zones of competitive advantage of the alternative machines for a given per hour value of labor and a range of interest rates could have been determined. In this case F_2 in equation (1) becomes:

$$F_2 = 0.9C_2/Y_2 + C_2r/2 + tC_2 \tag{4}$$

where: F_2 = annual fixed cost of the owned machine (depreciation, interest, taxes, insurance and housing)

C_2 = original cost of the owned machine

Y_2 = expected useful life of the owned machine (in years)

r = opportunity cost of capital, or the annual interest rate

t = annual cost of taxes, insurance, and housing (0.015)

Therefore, equation (2) becomes:

$$\bar{V}_1 = \frac{0.9C_2/Y_2 + C_2r/2 + tC_2}{A} + \bar{V}_2 + \bar{L}_2W \tag{5}$$

As noted earlier, with capital rationing and competing uses for capital, the opportunity cost of capital may be considerably above the rate paid by farmers on borrowed funds. A higher interest rate will increase the area of advantage of custom work or the machines involving lower investments relative to those requiring a higher capital outlay.

If one wished to determine the break-even cost of a machine (with a given custom rate, interest rate, labor rate, acreage, and useful life), equation (5) might be solved for C_2 so that:

(6) $$C_2 = \frac{A\,(\overline{V}_1 - \overline{V}_2 - \overline{L}_2W)}{(0.9/Y_2 + r/2 + t)}$$

Although the expected useful life in this study was 10 years for a combine, it might be useful to know the number of years of service the owned combine would need to give to make it competitive with custom hiring a combine. To determine the break-even number of years, equation (5) would be solved for Y_2, i. e.:

(7) $$Y_2 = \frac{0.9C_2}{A(\overline{V}_1 - \overline{V}_2 - \overline{L}_2W) - C_2\,(r/2 + t)}$$

Other Harvesting Costs

Other harvesting costs were analyzed in lesser detail in the study but sufficient data were obtained to indicate labor costs were slightly lower for hauling and unloading shelled corn compared to ear corn. The following table presents some average costs for hauling and shelling corn.

Table 32. Average Corn Handling Charges

Operation	Cost per bushel[1]
Haul shelled corn from field and unload	$0.025
Haul ear corn from field and unload	0.032
Shell ear corn	0.025

[1]Van Fossen, Larry, and Stoneberg, E. G., op. cit. p. 2.

The Effect of Field Losses on Harvesting Cost

Another harvesting cost considered was the cost of field losses. There are inherent losses in corn harvesting even under ideal conditions. Factors that influence field losses include ground speed of the machine used, skill of the machine operator, the state of repair and adjustment of the machine, corn variety, insect infestations, and stalk and weather conditions both before and at the time of harvest.

Farmer's estimates of field losses in this study were summarized in Table 33.

Table 33. Estimated Field Losses in Bushels per Acre in Northeastern Virginia, 1961

Item	No. of farms	Mean	S. D.
Ear corn	8	3.08	1.54
Shelled corn	21	2.80	1.98

The above estimates were not very reliable even though instructions for making field checks on losses were left with the co-operators before the 1961 harvest season. Loss estimates ranged up to five bushels per acre for ear corn and seven bushels per acre for those farmers harvesting shelled corn. Field checks by the enumerators, however, indicated that farmers in the area were not too concerned about field losses and were either not checking in the field or were very conservative in their estimates. For example, one farmer had been operating two combines in a field for two days and when visited on the third day it was obvious from just walking across the field that one machine was causing exceptionally large losses. A count in several locations in the field indicated losses of approximately fifteen bushels per acre.

The data in Table 33 show larger losses from the pickers than those from the combines. This is likely if the harvest of shelled corn is started earlier than the harvest of ear corn. A high percentage of lodged corn appeared to be the most important harvesting condition affecting losses. A number of farmers in the area expressed concern about hurricane weather but this did not influence their planning. Only thirteen percent started harvesting shelled corn the first week in September.

Experience gained from this study suggested that there was a need for some carefully controlled research in field losses to include moisture content before and during the harvest season with accurate counts on lodged stalks, ear drop, and machine loss of both ear and shelled corn.

Figure 21 shows the estimated field losses for different gross yields when corn was harvested at different moisture contents.[1] With a corn yield of 100 bushels per acre, for example, the field losses average about 13 bushels per acre at twenty percent moisture. At one dollar a bushel this would be a thirteen dollar per acre cost. Farmers in the study estimated losses at only one-third to one-fourth those in Figure 21. The estimated losses indicated in Figure 21 are related to the moisture of

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[1] Ibid.

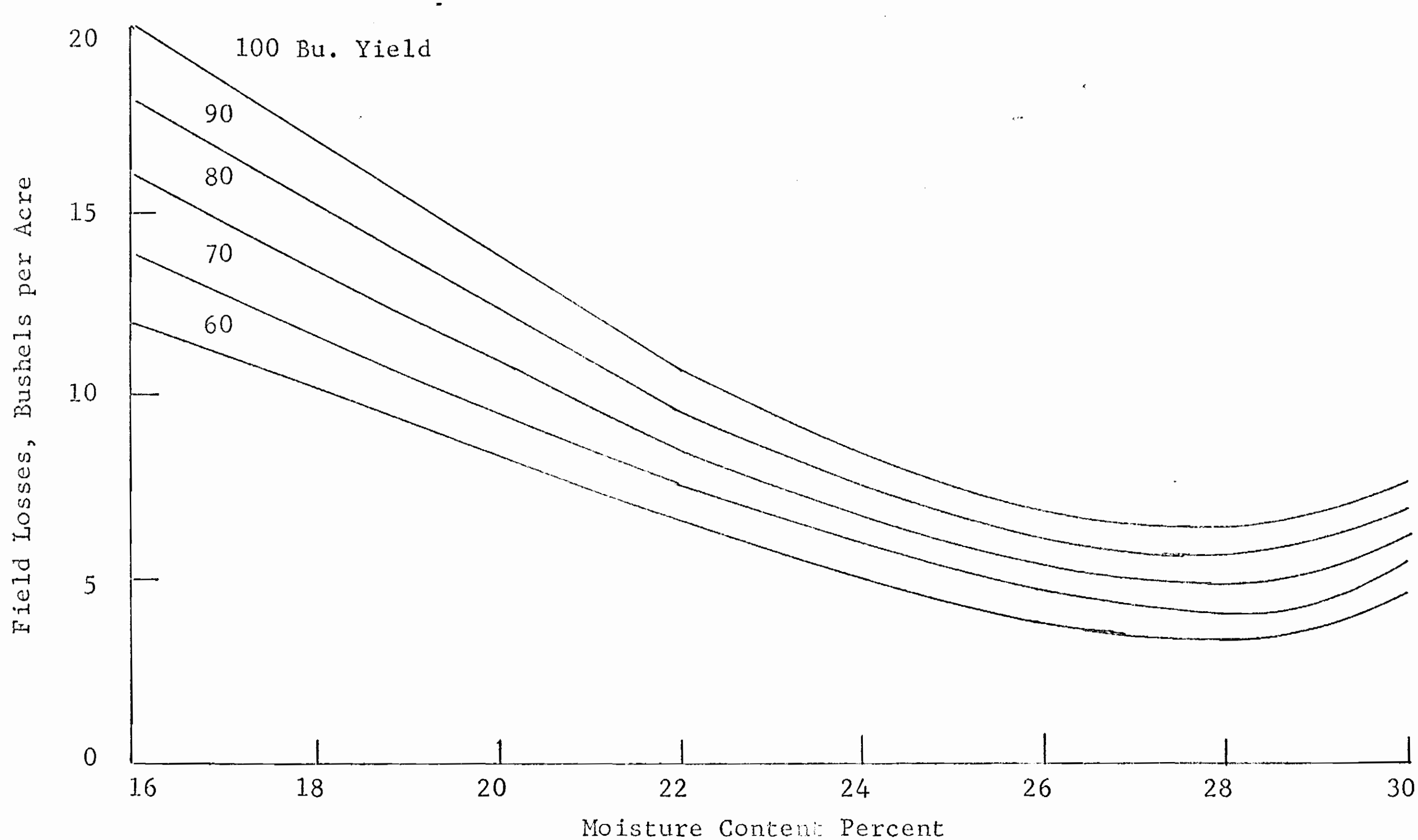

Figure 21. Expected Harvesting Losses Related to Moisture Content.

corn harvested in the fall of 1961 and assume an 80 bushel per acre yield (Figure 22). After the middle of September there is a 1.4 bushel average increase in losses per week. It should be noted that the moisture content for each week was based on the average of highest moistures offered for sale each week. Possibly a more realistic average estimate (Figure 22) would be portrayed if the curve were shifted to the left by one week. However, the more conservative figures were used.

The effect of the estimated field losses on the cost of harvesting is depicted in Figure 23. The solid line (A) at the bottom of the graph shows the cost of harvesting the various acreages of corn with a two-row self-propelled combine when used for both corn and small grain. The upper solid line (B) is the total cost of harvesting corn with the estimated field losses. This additional cost varies from $5.50 per acreat 125 acres to $11.00 per acre at 350 acres with corn valued at one dollar per bushel. The computations were based on a 12.8 acres per day rate of harvesting with a 25 percent adjustment to allow for bad weather, breakdowns, delays, etc. The parenthetic numbers indicate the estimated days required to harvest the various acreages. The broken lines (C) and (D) depict the cost of harvesting with a one-row picker adjusted for shelled corn and the total cost of harvesting including the estimated field losses, respectively. The numbers in parenthesis are the estimated days to harvest the various acreages.

The cost of harvesting with one, two or three combines can be compared by multiplying the cost per acre times the number of acres per machine and the number of machines. In harvesting 300 acres it is

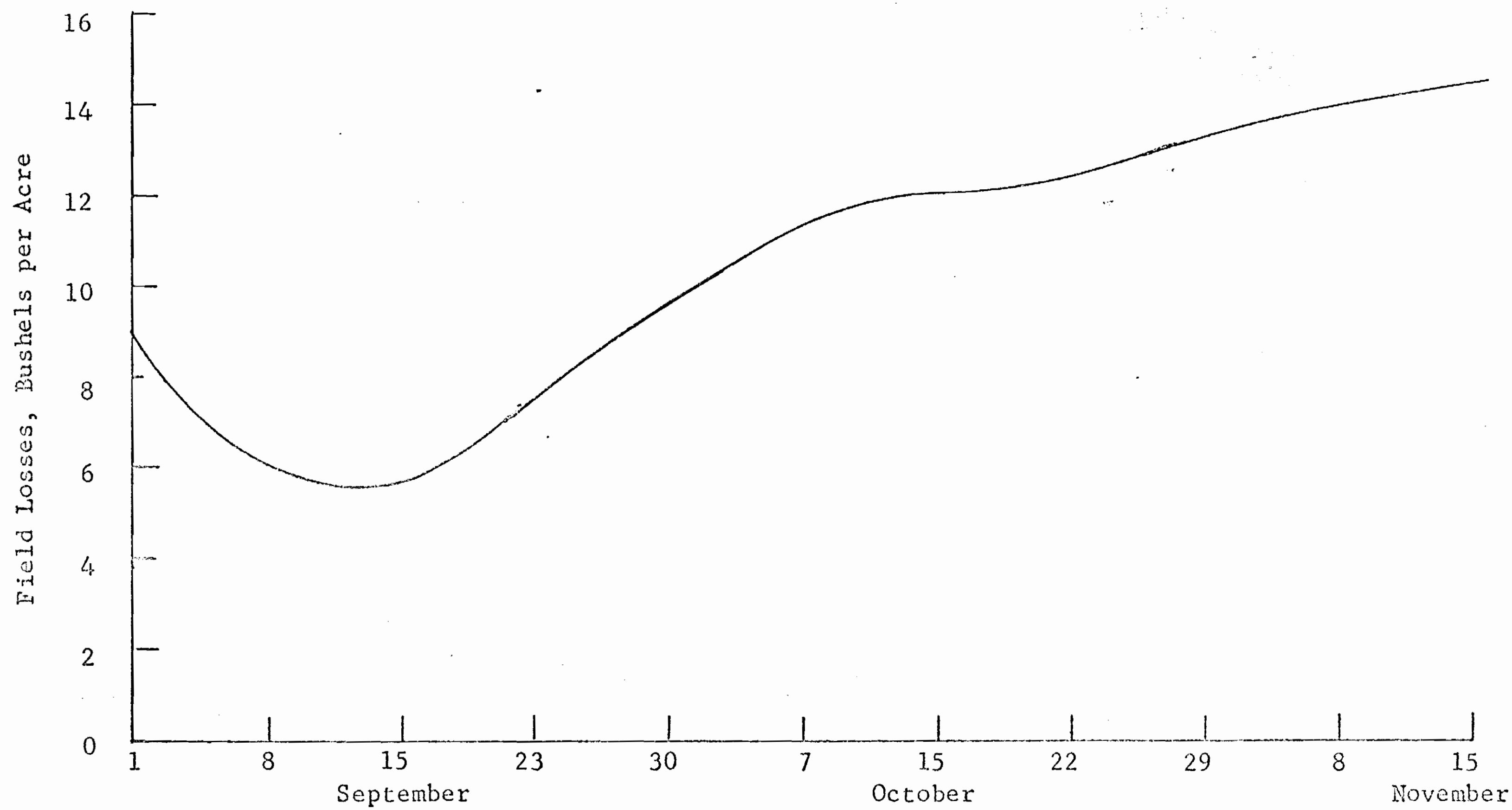

Figure 22. Estimated Total Field Losses on Date of Harvesting Corn, 1961.

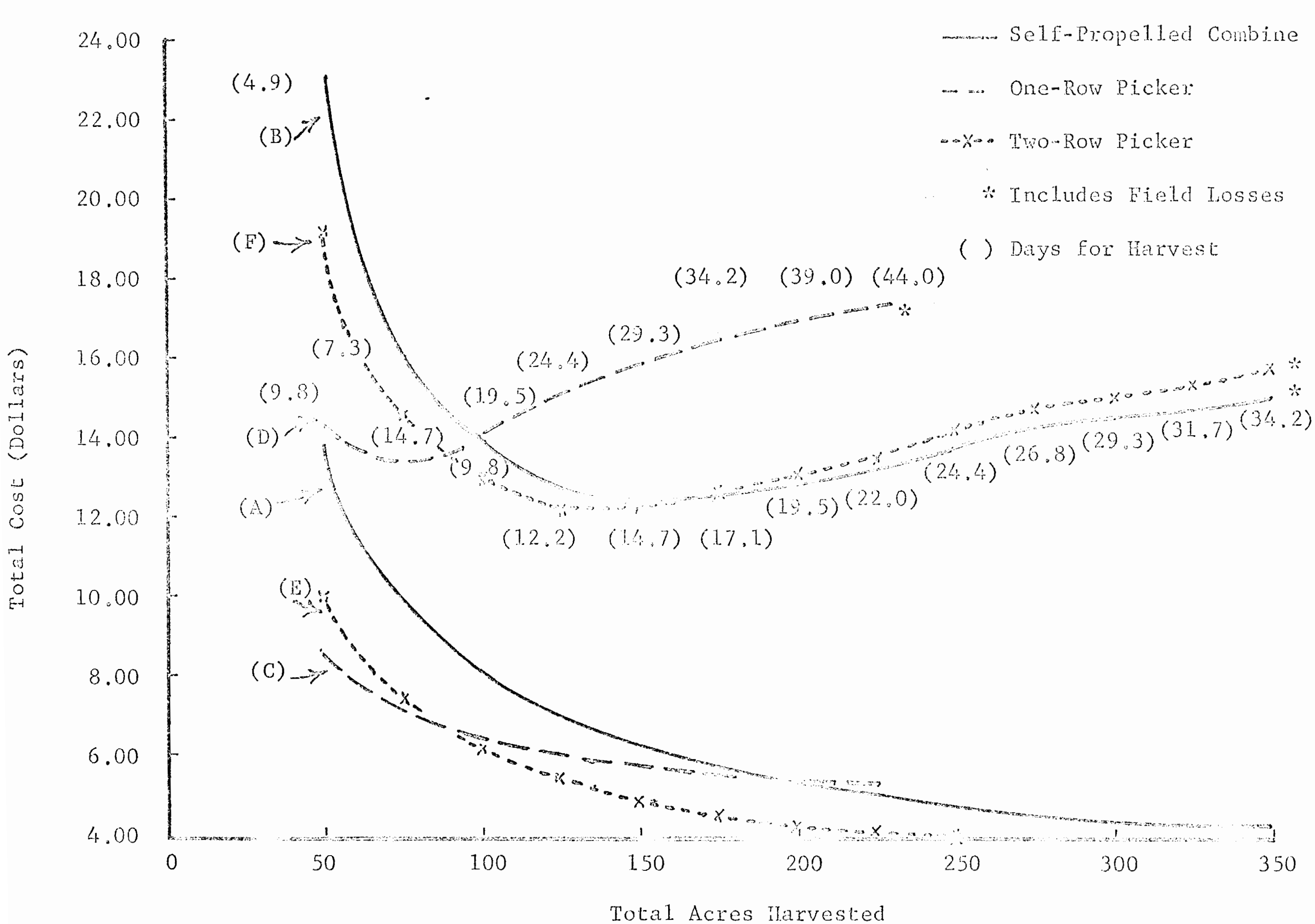

Figure 23. Total Cost of Harvesting Corn per Acre Including Field Losses and Shelling for Self-Propelled Combine, One-Row Corn Picker and Two-Row Corn Picker.

cheaper to use two machines ($12.50 x 150 x 2 = $3750) harvesting 150 acres each, rather than one machine ($14.50 x 300 x 1 = $4350) harvesting 300 acres or three machines each harvesting 100 acres ($14.50 x 100 x 3 = $4200). Similarly, if a one-row corn picker were used, two pickers would be cheaper for any acreage over 115 acres.

It should be noted that with one combine the labor of one man would be used for four weeks, with two machines the labor of two men would be required for two weeks, and with three machines the labor of three men would be needed for one and one-half weeks. Also, the harvesting costs of the combine and the picker were based on harvesting three acres of small grains for each acre of corn.

Comparing the self-propelled combines with the corn pickers indicated that the one-row picker was the cheapest alternative to harvest less than 80 acres. The two-row picker was the cheapest machine between 80 and 175 acres (See Appendix A, Table 8). At larger acreages up to 350 acres the combine was approximately 50 cents cheaper.[1]

When timeliness of harvesting becomes a factor because of larger acreages, the use of custom machinery may result in lower costs if the service is available. Regardless of which method appears lowest cost, ownership for timeliness of harvest may offset any apparent cost advantage of custom work.

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[1]If the cost of harvesting the small grains were included, the cost differences would be considerably greater, as noted earlier.

CHAPTER VI

ANALYSIS OF DRYING COSTS[1]

A farm operator must decide whether he should sell high-moisture corn at a market discount, invest in drying equipment, or wait until corn is dry in the field. There are six major factors to be considered in arriving at a decision: (1) initial cost of the drying equipment, (2) drier operating costs, (3) average moisture content of corn before drying, (4) prices and discounts for high-moisture corn, (5) annual volume of corn to be dried, and (6) field and harvesting losses.

Shrinkage and Break-even Costs

In analyzing the profitability of drying corn for direct marketing, careful consideration must be given to the pertinent data involving moisture content, discount rates, and weight losses. It is erroneous to assume that the full difference between the discounted price and the basic bid for No. 2 corn is a loss to the farmer. For example, the price discount for 25 percent moisture corn is 33.5 cents a bushel (Table 34). Drying the same bushel of corn to 15.5 percent moisture results in a weight loss of 6.58 pounds (including 0.5 percent invisible loss of dry matter and the actual water removed). The shrinkage is worth 11.7 cents per bushel when No. 2 corn sells at $1.00 per bushel. The drier operating costs for removing 6.58 pounds of water are 3.6 cents per bushel. The

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[1]All bushels reported were assumed to weigh 56 pounds per bushel regardless of moisture content.

Table 34. Shrinkage and Break-Even Drying Costs Based on $1.00 per Bushel Corn

Initial moisture content (%)	Lbs. water / bu.		Equiv. value[3]	Discounted price[4]	Gross gain if dried	Drier operating cost[5]	No. of wet bu. to break-even	
	Total[1]	Excess[2]					$1200/ year[6]	$360/ year[7]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
15.5	8.68	0.00	$1.000	$1.000	$0.000	$0.000	-	-
16.0	8.96	0.61	.989	.985	.004	.003	-	-
17.0	9.52	1.27	.977	.955	.022	.007	80,000	24,000
18.0	10.08	1.94	.965	.925	.040	.011	41,379	12,414
19.0	10.64	2.60	.953	.895	.058	.014	27,273	8,182
20.0	11.20	3.26	.942	.865	.077	.018	20,339	6,102
21.0	11.76	3.93	.930	.825	.105	.021	14,286	4,286
22.0	12.32	4.59	.918	.785	.133	.025	11,111	3,333
23.0	12.88	5.25	.906	.745	.161	.029	9,090	2,727
24.0	13.44	5.91	.894	.705	.189	.032	7,643	2,293
25.0	14.00	6.58	.883	.665	.218	.036	6,593	1,978
26.0	14.56	7.24	.871	.625	.246	.040	5,825	1,748
27.0	15.12	7.90	.859	.585	.274	.043	5,195	1,558
28.0	15.68	8.56	.847	.545	.302	.047	4,706	1,412
29.0	16.24	9.23	.835	.505	.330	.050	4,286	1,286
30.0	16.80	9.89	.823	.465	.358	.054	3,947	1,184
31.0	17.36	10.55	.812	.425	.387	.058	3,647	1,094
32.0	17.92	11.22	.800	.385	.415	.062	3,399	1,020

Table 34. Footnotes

[1] Based on 56 lb. wet bu. at moisture content indicated in column (1).

[2] Excess water plus dry matter loss $= 56 \left[1 - \left(\frac{100 - \text{initial moisture } (\%)}{100 - \text{final moisture } (\%)} - .005 \right) \right].$

[3] Shrinkage = price of No. 2 corn $\left[1 - \left(\frac{100 - \text{initial moisture } (\%)}{100 - \text{final moisture } (\%)} - .005 \right) \right].$

[4] Moisture discount; 1½¢ per bu. for each ½% added moisture between 15.5% and 20%; 2¢ per bu. for each ½% added moisture between 20% and 35%.

[5] Operating costs based on data from study; $0.04 fuel cost, $0.01 electricity, $0.004 labor and repairs; or $0.054 total cost for removal of 9.89 lb. water/bu.

[6] Based on $7500 investment; 16% of purchase price annual cost or $1200/yr. Bu/yr. to break-even equals annual fixed cost divided by net gain from drying (column (6) - column (7)).

[7] Based on $3000 investment; 12% of purchase price annual cost or $360/yr. Bu/yr. to break-even equals annual fixed cost divided by net gain from drying (column (6) - column (7)).

loss from selling 25 percent moisture corn compared to drying it to 15.5 percent moisture equals the market discount minus the sum of shrinkage and operating costs: 18.2 cents per bushel (33.5 - (11.7 + 3.6) = 18.2). This is the net gain from drying which can be applied toward the fixed cost of drying. Dividing the annual fixed cost of the drier by the net gain from drying gives the bushels per year required to break-even. For example a $7500 investment in drying equipment requires 6,593 bushels of 25 percent corn annually to break-even. See Table 34, Column (8).

The break-even volumes may serve as guides, but they must be carefully interpreted to avoid misleading conclusions. It would be difficult to make a drier pay if the average initial moisture content were below 20 percent. On the other hand, it appears that no more than 4000 bushels are needed to make a drier profitable at an average of 30 percent moisture. This would be true if the corn were all harvested at an average of 30 percent moisture which is unlikely because of natural drying. The investment would be impracticable for such a small volume of corn. Since high-moisture standing corn may lose an average of one-half of one percent moisture per day, it is seldom necessary to harvest small acreages at high moisture contents in order to get the crop harvested.

The advantages of harvesting corn at lower moisture must be weighed against the possibility of hazardous weather and the occurrence of significant field losses (Figures 21 and 22). The longer corn is left in the field during the fall the greater the probability these losses will occur. A farmer with a large acreage may begin to harvest with the moisture at 30 percent but it will probably be below 20 percent before he finishes harvesting. The average moisture at the beginning of harvest for 31 farms in this study shelling corn was 19.98 percent. There were only nine of these farms which began harvesting at moistures that were profitable for drying, unless they were expecting to profit by holding corn for a price increase.

As noted earlier the price of corn and the discount schedules are both subject to change but the discount schedule is much less flexible than the price of corn. With a relatively rigid discount schedule, drying becomes more favorable the lower the market price. For example, in Table 35 at $1.35, 25 percent moisture corn has a discount of 33.5 cents per bushel. The shrinkage, however, is worth 15.8 cents per bushel. Thus the loss from selling corn at 25 percent moisture compared to drying it to 15.5 percent moisture is the market discount minus the sum of shrinkage and the drier operating cost: 33.5 - (15.8 + 3.6) = 14.1 cents per bushel. This net gain of 14.1 cents per bushel for drying corn with the price at $1.35 per bushel compares with a net gain of 18.2 cents per bushel with corn at $1.00 per bushel.

It is assumed that corn can be dried to exactly 15.5 percent to avoid a discount but accuracy with which this can be done is questionable. Daily farm records indicated that the controls and operating procedures used by the farmers did not permit such accuracy.

Drying Costs

Drying costs were influenced primarily by the original investment in equipment, annual volume of corn dried, and the quantity of water removed per bushel. Operating costs were based on data from the study for drying 30 percent corn. Fuel was the most significant operating cost. Approximately four cents worth of fuel (average price paid for LP gas in the area was 19 cents per gallon) was required to remove 9.89 pounds of water per bushel. Electrical power costs (at seven cents per horsepower-hour of use) amounted to approximately one cent per bushel. Labor (at $1.00 per hour) averaged about four-tenths of a cent per bushel for a total cost of $0.054 per bushel.

The same operating costs were applied to the batch drier in column (8) and the bin-type drier in column (9) of Tables 34 and 35. The effect of the lower investment ($3000) for the bin drier than for the batch drier ($7500) can be seen by comparing the quantities of corn necessary to break-even in column (8) and (9).

A detailed analysis of the shrinkage, harvesting and drying costs involved in harvesting 125 acres (10,000 bushels) of corn at the rate of 31.25 acres per week between September 1 and September 30 is presented in Table 36. The prices used for this period were based on the predicted prices at Tappahannock, Virginia (Figure 7). The initial moisture content was based on a curve fitted to the area weekly averages reported by the Division of Markets (Figure 4). The losses from natural drying during the month of September were based on a 56 pound wet bushel at the moisture contents indicated in column (3). Natural drying in the field reduced the 10,000 bushels to 9,197 bushels remaining for harvest during the four week period as indicated in column (5). Harvest losses, based on an 80 bushel yield (Figures 21 and 22), further reduced to

Table 35. Shrinkage and Break-Even Drying Costs Based on $1.35 per Bushel Corn[1]

Initial moisture content (%)	Lbs. water / bu.		Equiv. value	Discounted price	Gross gain if dried	Drier operating cost	No. of wet bu. to break-even	
	Total	Excess					$1200/ year	$360/ year
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
15.5	8.68	0.00	$1.350	$1.350	$0.000	$0.000	-	-
16.0	8.96	0.61	1.335	1.335	0.000	.003	-	-
17.0	9.52	1.27	1.319	1.305	.014	.007	171,428	51,428
18.0	10.08	1.94	1.303	1.275	.028	.011	70,588	21,177
19.0	10.64	2.60	1.287	1.245	.042	.014	42,857	12,857
20.0	11.20	3.26	1.272	1.215	.057	.018	24,490	7,347
21.0	11.76	3.93	1.256	1.175	.081	.021	20,000	6,000
22.0	12.32	4.59	1.239	1.135	.104	.025	15,190	4,557
23.0	12.88	5.25	1.223	1.095	.128	.029	12,121	3,636
24.0	13.44	5.91	1.207	1.055	.152	.032	10,000	3,000
25.0	14.00	6.58	1.192	1.015	.177	.036	8,511	2,553
26.0	14.56	7.24	1.176	.975	.201	.040	7,453	2,236
27.0	15.12	7.90	1.160	.935	.225	.043	6,593	1,978
28.0	15.68	8.56	1.143	.895	.248	.047	5,970	1,791
29.0	16.24	9.23	1.127	.855	.272	.050	5,405	1,622
30.0	16.80	9.89	1.111	.815	.296	.054	4,959	1,488
31.0	17.36	10.55	1.096	.775	.321	.058	4,563	1,369
32.0	17.92	11.22	1.080	.735	.345	.062	4,240	1,272

[1]See footnotes on Table 34.

Table 36. Analysis of Shrinkage, Harvesting, and Drying Costs in Northeastern Virginia, 1961
(125 Acres, 10,000 Bu., Harvesting 31.25 acres per week)

Week (1)	Ave. price ($)[1] (2)	Initial moisture (%)[2] (3)	Added bu. lost natural drying[3] (4)	Bu. left to harvest (5)	Harvest loss (bu/acre)[4] (6)	Loss 31.25 acres per week (bu.) (7)	Net bu harvest (8)	Operating cost ($/bu)[5] (9)	Variable cost of drying ($) (10)	Fixed cost[6] ($) (11)	Total cost of drying ($) (12)	Bu. lost drying (13)	Bu. for sale (14)	Value of corn sold dry ($) (15)	Net after drying ($) (16)	Value of corn sold wet[7] ($) (17)	Profit by drying ($) (18)
Sept. 1	1.273	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.237	30.0	59.38	2441	6.0	187.5	2254	.054	121.69	300	421.7	398	1856	2296	1874	1582	292
Sept.8	1.200	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.194	26.0	115.51	2325	5.5	171.9	2153	.040	86.12	300	386.1	278	1875	2239	1853	1763	90
Sept.15	1.188	24.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.182	23.0	82.62	2242	7.5	234.4	2008	.029	58.23	300	358.2	188	1820	2151	1793	1861	-68
Sept.23	1.175	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.179	21.0	52.85	2189	9.5	296.9	1892	.021	39.73	300	339.7	133	1759	2074	1734	1900	-166
Sept.30	1.183	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total				9197		890.6	8307		305.77	1200	1505.8	997	7310	8760	7254	7106	148

[1] Prices based on predicted price for No. 2 yellow corn at Tappahannock (Figure 7).
[2] Moisture content based on curve fitted to weekly averages for Tappahannock, Nomini Grove, and Wicomico Church in 1961 (Figure 4).
[3] Loss from drying based on calculations of moisture loss (Footnote 2 for Table 34).
[4] Harvest losses based on Figure 21 and 22.
[5] Operating costs based on data from study: \$0.04 fuel cost, \$0.01 electricity, \$0.004 labor and repairs; or \$0.054 total cost for removal of 9.89 lb. water/bu from 30 percent moisture corn.
[6] Fixed cost based on \$7500 investment; 16% of purchase price, annual cost of \$1200/yr.
[7] See discount schedule Table 21.

8,307 the bushels harvested during the month. The losses from drying with the batch drier (column (13)) were computed with the formula in Footnote 2 of Table 34. The drying costs were the same as used previously (Table 34). The value of the corn sold wet was determined with the discount schedule in Table 21.

Of the 10,000 bushels of corn in the field on September 1, approximately 8,300 bushels were harvested from the 125 acres. As estimated, 803 bushels were lost by natural drying and 890 bushels during harvest. The total cost of drying the 8307 bushels was $1505, or 18.1 cents per bushel. As indicated in column (18), selling the corn after drying made a profit of $148 above the returns that would have been realized if the corn had been sold wet at harvest. The first two weeks of drying with moisture content exceeding 24 percent were the most profitable.

Drying costs were analyzed for a 250 acre operation harvesting 20,000 bushels at the rate of 62.5 acres per week. See Table 37. Under average weather conditions the 250 acres could be harvested in the four weeks. The losses were computed in the same manner as previously. The volume was double that in the previous analysis and the fixed cost of the batch drier was spread over 16,613 bushels. This resulted in a profit for the operation of $1496 (ten times the profit when only 8300 bushels were dried). The average cost of drying was 10.8 cents per bushel. Drying a larger volume of high moisture corn, lower harvesting losses, a slightly better corn price early in the month, and the greater differential between the value of the corn and the discounted price, were largely responsible for the greater profit.

Table 37. Analysis of Shrinkage, Harvesting, and Drying Costs in Northeastern Virginia, 1961 (250 Acres, 20,000 Bu., Harvesting 62.5 acres per week)[1]

Week	Ave. price ($)	Ini-tial mois-ture (%)	Added bu. lost natural drying	Bu. left to harvest	Har-vest loss (bu/acre)	Loss 62.5 acres per week (bu.)	Net bu. har-vest	Oper-ating cost ($/bu)	Vari-able cost of drying ($)	Fixed cost ($)	Total cost of drying ($)	Bu. lost dry-ing	Bu. for sale	Value of corn sold dry ($)	Net after dry-ing ($)	Value of corn sold wet ($)	Profit by drying ($)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Sept. 1	1.273	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.237	30.0	118.75	4881	6.0	375	4506	.054	243.00	300.00	543.00	796	3711	4591	4048	3164	884.00
Sept. 8	1.200	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.194	26.0	231.00	4650	5.5	344	4306	.040	172.00	300.00	472.00	556	3750	4478	4006	3527	479.00
Sept.15	1.188	24.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.182	23.0	165.00	4485	7.5	469	4016	.029	116.00	300.00	416.00	376	3640	4302	3886	3723	163.00
Sept.23	1.175	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.179	21.0	106.00	4379	9.5	594	3785	.021	79.00	300.00	379.00	266	3519	4149	3770	3800	-30.00
Sept.30	1.183	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total				18,395		1782	16,613		610.00	1200.00	1810.00	1994	14,620	17,520	15,710	14,214	1496.00

[1] Footnotes same as Table 36.

Differences in profit are further emphasized in Table 38. The 125 acre operation represented in this table indicated that with 10,000 bushels harvested in the first two weeks of September a profit of $762 was obtained. The average cost of drying was 18.3 cents per bushel, but five times the profit was obtained compared to the analysis in Table 36.

In the last two examples it was noted that under average weather conditions the farmer could expect to harvest 62.5 acres per week. The chances of successfully harvesting 10,000 bushels in two weeks are much more likely than that of harvesting 20,000 bushels in four weeks.

The alternative suggested by the analysis in Table 37 is to use two combines to harvest the 250 acres of corn and two driers to process the corn during the first two weeks of September. This alternative was not feasible since the additional combining and drying costs would not be offset by the decreased harvesting losses and the higher prices. However, the increased flexibility and insurance obtained by use of the two combines and driers are relevant considerations particularly for large operators.

Table 39 summarizes the data presented in Table 37 for an operation in which 250 acres are harvested with one combine harvesting corn during the four week period in September. Corn dried with one batch drier resulted in a profit of $1496 (Table 37). The $1200 cost of harvesting 250 acres (Figure 15) with one combine leaves a net profit of $296.

The alternative of harvesting the 250 acres in the first two weeks of September is summarized in Table 40 (based on the figures in Table

Table 38. Analysis of Shrinkage, Harvesting, and Drying Costs in Northeastern Virginia, 1961
(125 Acres, 10,000 Bu., Harvesting 62.5 acres per week)

Date[1] (1)	Fixed cost $7500-$1200 year ($) (2)	Variable cost of drying ($) (3)	Total cost of drying ($) (4)	Bu. lost in drying (5)	Bu. for sale (6)	Value of corn sold dry[2] ($) (7)	Net after drying ($) (8)	Value of corn sold wet[3] ($) (9)	Profit by drying ($) (10)
Sept. 1	-	-	-	-	-	-	-	-	-
Ave.	600.00	243.4	843.4	796	3711	4591	3747	3164	583
Sept. 8	-	-	-	-	-	-	-	-	-
Ave.	600.00	172.2	772.2	556	3750	4478	3706	3527	179
Sept. 15	-	-	-	-	-	-	-	-	-
Total	1200.00	415.6	1615.6	1352	7461	9069	7453	6691	762

[1]Between Sept. 1 and Sept. 8, 4507 bushels were harvested, and between Sept. 8 and September 15, 4306 bushels were harvested.

[2]The average price the first week was $1.237 and the second $1.194 per bu.

[3]See discount schedule Table 21.

Table 39. Estimated Returns and Costs for Harvesting 250 Acres of Corn and Drying in Northeastern Virginia in Four Weeks in September

Item	Quantity	Unit	Amount
Income:			
Corn	14,620 bu.		$17,520[1]
Total receipts			$17,520
Expenses:			
Harvesting	250 acres	1 combine	$ 1,200[2]
Drying	16,613 bu.	1 batch drier	$ 1,810[3]
Value of corn sold wet	14,620 bu.		$14,214[4]
Total expenses			$17,224
Total receipts minus total expenses			$ 296

[1] Based on average weekly price (see Figure 7).

[2] Based on $4.80 per acre cost of harvesting 250 acres (see Figure 15).

[3] See Table 37.

[4] See Table 37.

Table 40. Estimated Returns and Costs for Harvesting 250 Acres of Corn and Drying in Northeastern Virginia in Two Weeks in September

Item	Quantity	Unit	Amount
Income:			
Corn	14,922 bu.		$18,138[1]
Total receipts			$18,138
Expenses:			
Harvesting	250 acres	2 combines	$ 1,775[2]
Drying	17,626 bu.	2 batch driers	$ 3,231[3]
Value of corn sold wet	14,992 bu.		$13,382[4]
Total expenses			$18,389
Total receipts minus total expenses			$ -251

[1]Based on average weekly price (see Figure 7).

[2]Based on $7.10 per acre cost of harvesting 125 acres (see Figure 15).

[3]See Table 38 ($0.183/bu.).

[4]See Table 38.

38). Two combines and two batch driers are used and, as noted above, the additional combining and drying costs incurred a net loss of $251. However, if in addition to the operation presented in Table 40 the operator were to custom combine another 250 acres of corn the last two weeks of September and dry 15,600 bushels of purchased wet corn, he would net $2451 (Table 41). Since the fixed costs of the two batch driers were charged off to drying corn produced on the farm, only the variable cost of drying and the additional handling were charged to the purchased corn.

It should be noted that in each of the above examples the harvesting costs of the combine were based on an allocation of 40 percent of the fixed cost of the combines charged to corn which assumes that three acres of small grain would be harvested for each acre of corn harvested. Therefore, only a very large operator could benefit from the alternatives suggested.

Another feasible alternative is to extend harvesting into late October. By harvesting 31.25 acres per week, a total of 219 acres (17,500 bushels) could be harvested between the first week in September and the last week of October, as noted in Table 42. When the drying operation was extended into October, it was more profitable to sell the wet corn harvested in October and to dry only the corn harvested in September (Table 36). With the negative returns during the last four weeks, the only reason for drying the late harvested corn would be for storage and sale or for feed at a later date. The average cost of drying the 13,611 bushels was 11.6 cents per bushel.

Table 41. Estimated Returns and Costs for Harvesting 500 Acres of Corn and Drying in Northeastern Virginia in Four Weeks in September[1]

Item	Quantity	Unit	Amount
Income:			
Corn (own)	14,922 bu.		$18,138
Corn (purchased)	14,318 bu.		16,902
Custom combine	250 acres		2,250[2]
Total receipts			$37,290
Expenses:			
Harvesting	500 acres	2 combines	$ 2,400[3]
Drying (own)	17,626 bu.	2 driers	3,231[4]
Drying (purchased)	15,600 bu.		390[5]
Addition Handling (purchased)	15,600 bu.		390[6]
Value of (own)corn sold wet	14,922 bu.		13,382[7]
Purchase price of corn	15,600 bu.		15,046[8]
Total expenses			$34,839
Total receipts minus total expenses			$ 2,451

[1]Operator harvesting and drying 250 acres of own corn first two weeks, purchase 15,600 bushels of corn and dry during last two weeks and custom combine 250 acres.

[2]Based on $9.00 custom combining rate.

[3]Based on $4.80 per acre cost of harvesting 250 acres.

[4]See Table 38 ($0.185/bu.).

[5]Average variable cost for periods ($0.025/bu.).

[6]See Table 32 ($0.025/bu.).

[7]See Table 38.

[8]See Table 37.

Table 42. Analysis of Shrinkage, Harvesting, and Drying Costs in Northeastern Virginia, 1961 (219 Acres, 17,500 Bu., Harvesting 31.25 acres per week)[1]

Week	Ave. price ($)	Initial moisture (%)	Added bu. lost natural drying	Bu. left to harvest	Harvest loss (bu/acre)	Loss 31.25 acres per week (bu.)	Net bu. harvest	Operating cost ($/bu)	Variable cost of drying ($)	Fixed cost ($)	Total cost of drying ($)	Bu. lost drying	Bu. for sale	Value of corn sold dry ($)	Net after drying ($)	Value of corn sold wet ($)	Profit by drying ($)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Sept. 1	1.273	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.237	30.0	59.38	2441	6.0	187.5	2254	.054	121.69	171.43	293.12	398	1856	2296	2003	1582	420
Sept. 8	1.200	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.194	26.0	115.51	2325	5.5	171.9	2153	.040	86.12	171.43	257.55	278	1875	2239	1981	1763	218
Sept.15	1.188	24.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.182	23.0	82.62	2242	7.5	234.4	2008	.029	58.23	171.43	230.00	188	1820	2151	1921	1861	60
Sept.23	1.175	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.179	21.0	52.85	2189	9.5	296.9	1892	.021	39.73	171.43	211.00	133	1759	2074	1863	1900	-37
Sept.30	1.183	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.178	19.8	32.64	2156	11.5	359.4	1797	.017	30.24	171.43	201.67	99	1698	2000	1798	1874	-76
Oct. 7	1.172	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.170	19.3	12.70	2143	12.0	375.0	1768	.015	26.58	171.43	198.00	87	1681	1967	1769	1856	-87
Oct.15	1.168	19.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	1.167	18.8	12.62	2130	12.5	391.0	1739	.013	22.61	171.43	194.00	76	1663	1941	1747	1847	-100
Oct.21	1.165	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seven week total				15,625		2016.0	13,611		385.20	1200.00	1585.30	1259	12352	14668	13082	12683	398

[1]See footnotes on Table 36.

The bin-type driers were the most numerous in the area of the study. In Table 43 a drying operation with four bins and two driers and a total initial investment of $6000 was analyzed. This table is an extension of Table 36 with the exception of the changed fixed cost. The average cost of drying was 12.3 cents per bushel.

If the corn were sold each week, there would be a profit of $629. With the bins then empty, it would be possible to buy corn on the market and fill the bins again. Another alternative to this would be to sell the corn dried the first two weeks, then refill the bins and hold for later sale.

For the smaller operator with only 5000 bushels, the first two weeks of the operation presented in Table 43 with two bins and one drier would be practical. With a $3000 investment and an annual charge of $360, he could approximate the first two weeks operation. Drying costs would average 12.9 cents per bushel. Depending on the moisture conditions, however, he might not be able to fill the bins as fast as indicated. The operator with four bins could spread the grain over the four drying areas as drying required and acquire comparable flexibility in his operation to those operators using batch driers.

Farm operators with batch driers and bin-type driers frequently sold only part of their corn at harvest and stored the remainder. If the drier is owned primarily for storing part of the corn (with the fixed costs charged to that operation), the farmer should determine the moisture level at which it pays to dry corn for market rather than to sell at the discount price. In this instance, only the operating costs

Table 43. Analysis of Shrinkage and Drying Costs Using Bin-Type Driers in Northeastern Virginia, 1961 (125 Acres, 10,000 Bu., Harvesting 31.25 acres per week)[1]

Week	Net bu. harvest	Fixed cost ($)[2]	Variable cost of drying ($)	Total cost of drying ($)	Bu. lost drying	Bu. for sale	Value of corn sold dry ($)	Net after drying ($)	Value of corn sold wet ($)	Profit by drying ($)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Sept. 1	-	-	-	-	-	-	-	-	-	-
Ave.	2254	180.00	121.69	300.69	398	1856	2296	1995	1582	413
Sept. 8	-	-	-	-	-	-	-	-	-	-
Ave.	2153	180.00	86.12	266.12	278	1875	2239	1973	1763	210
Sept. 15	-	-	-	-	-	-	-	-	-	-
Ave.	2008	180.00	58.23	238.23	188	1820	2151	1913	1861	52
Sept. 23	-	-	-	-	-	-	-	-	-	-
Ave.	1892	180.00	39.73	219.73	133	1759	2074	1854	1900	-46
Sept. 30	-	-	-	-	-	-	-	-	-	-
TOTAL	8307	720.00	305.77	1,025.00	997	7310	8760	7735	7106	629

[1] See footnotes on Table 36.

[2] Fixed cost based on $6000 investment in four bins and two driers, annual cost of $720 per year.

of drying and additional labor costs need to be considered since the fixed costs have already been committed. If the operator can dry corn and recover his operating costs, he is justified in drying.

Ear corn drying incurs approximately the same fixed and operating costs as bin drying but significantly higher storage costs are involved.[1] Natural air or heated air drying of ear corn can be used with most existing ear corn cribs. There is usually not as much advantage to drying ear corn since it can be stored directly from the field and if dried the moisture must be removed from the cobs. Also, there are additional handling costs with ear corn over those for shelled corn.

Farmers harvesting their corn early had the advantage of better prices, decreased harvesting losses, and higher value of their corn over the moisture discount price. The total volume of corn dried in relation to the fixed costs of drying, the volume of corn dried early at moistures between 24 and 30 percent, and the higher prices in early September had the largest influence on the returns from drying.

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[1]Van Fossen, Larry and Stoneberg, E. G., op. cit.

CHAPTER VII

ANALYSIS OF STORAGE COSTS FOR CORN

There are two major cost items involved in storing grain on the farm. The first is the annual cost of the storage structure, including depreciation, interest on investment, taxes, and repairs and maintenance. These costs will vary according to (1) differences in original cost of the structure, (2) size, (3) extent of utilization, and (4) length of life. Second is the cost and risk incurred from holding the grain rather than selling at harvest. This includes interest, insurance, additional handling, insect control, taxes on the grain, and the possibility of shrinkage, lower quality and unfavorable price movements.

The ranges in prices for the various sizes of circular steel bins, including the initial cost of materials, foundation, and construction labor, are presented in Table 44. The average cost per bushel was $0.50 for a 1500 bushel bin, $0.40 for a 2200 bushel bin, and $0.40 per bushel for a 2500 bushel bin.

Table 44. Range of Cost of Steel Bins in Northeastern Virginia, 1961

Rated capacity	Total cost per bushel[1]
1000 - 1500	$0.48 - 0.58
2200 - 2300	0.38 - 0.44
2500 - 2550	0.35 - 0.47

[1]Based on reports from 17 farmers erecting bins in 1961.

The effect of the degree of utilization of the storage capacity on the annual fixed costs per bushel is shown in Table 45. There was an eight-tenths cent difference per bushel for a 2200 bushel bin when the bin was 80 percent full, or approximately 20 dollars per year.

Cost of Storing Shelled Corn

The analysis presented in Table 36 noted that the farm operator could not profitably sell artifically dried corn during the last two weeks of September. However, he could consider the alternative of storing the corn for later sale at a higher price. This decision must be made at the time of harvest since the moisture content cannot exceed 13 percent if the corn is to be stored safely for six months or more. Since No. 2 corn is based on 15.5 percent moisture, with no premium for lower moisture, the excess drying and shrinkage is an additional cost of storage. Table 46 summarizes the relevant costs that must be considered in determining whether or not storage is economically feasible. In brief, this analysis indicates that a price increase of 13.8 cents per bushel would be needed to cover storage costs for a nine month period. With an expected average increase in price of approximately 17 cents (Figure 7), the net return above storage costs would be about $111.

A bin-type drier was used in Table 43 to process the corn. It was assumed that the operator could use the bins as a batch drier and sell the dried corn at harvest. However, it was noted that there was a profit of only six dollars on the drying the last two weeks of September. If the corn harvested during the later part of September were stored at

Table 45. Annual Ownership Costs of Steel Bins in Northeastern Virginia, 1961

Rated capacity (bushels)	Initial cost		Total annual fixed cost[1]	Annual fixed costs per bushel	
	Total	per bushel		100% full	80% full
1500	$ 750.00	$0.50	$58.75	$0.039	$0.048
2200	880.00	0.40	68.93	0.031	0.039
2500	1000.00	0.40	78.33	0.031	0.039

[1] Depreciation costs were based on an expected life of 30 years for the steel bins. Other fixed costs include interest at 6%, taxes and insurance at 1% (½ of the purchase price), and repairs at 1%.

Table 46. Analysis of Storage Costs for Corn Harvested and Dried September 15-30, Northeastern Virginia, 1961 (3579 bushels)

Two - 2000 bushel bins with investment of $1600 for 3579 bushels harvested and dried September 15-30, 1961[1]

Depreciation (30 years)	$53.33	
Interest 6% (½ purchase)	48.00	
Taxes and insurance 1% (½ purchase)	8.00	
Repairs 1%	16.00	
Annual overhead	$125.33	
Annual charge (per bushel $0.035) (with bins 100% full $0.031/bu.)		$125.33
Nine months interest on corn worth $4225 (at harvest) at 6%		190.13
Additional drying cost (15.5% to 13%)		35.79[2]
Additional shrinkage		105.63[3]
Taxes on corn ($3.00 per $100 on 20% valuation)		25.35
Total storage costs for 3490 bu.		$482.23[4]
Expected returns for storing corn		593.30[5]
Expected returns above storage costs		$111.07

[1]See Table 36 for analysis of harvesting and drying.

[2]Drying cost from 15.5 to 13 percent moisture $0.01/bu.

[3]Removal of 1.4 lbs. of water per bushel at average price for week.

[4]Need 13.8 cents higher price at end of nine months storage to break-even.

[5]Expected price increase of 17 cents ($0.17 x 3490 bu. = $593.30).

a cost of 10.2 cents per bushel and a seasonal price increase of 17 cents were forthcoming prior to the time of sale, there would be a net profit of $236.40 (Table 47). This was possible since the cost of the bins had already been charged off to the drying operation.

Since only 3490 bushels of the 8800 bushel capacity (four 2200 bushel bins Table 43) would be used by the above alternative, the farmer might find it profitable to buy sufficient corn during the first three weeks of October to fill his bins, dry, and store for approximately eight to nine months (Table 48). The variable costs of drying plus any additional labor and handling involved would be the only charges considered in the drying operation since the fixed charges were already considered. The storage costs would be comparable to those for storing his own grain because fixed costs were accounted for previously.

Ear Corn Storage

Some farmers prefer to harvest ear corn and this may be the most practical system for some operators (usually with small acreages). Drying ear corn does permit early harvest and a reduction of field losses. If additional ear corn storage is needed, it is advisable to select an inexpensive type (60 cents per bushel)[1] that may easily be adapted to drying. The main disadvantage of ear corn storage rather than shelled corn storage is the higher cost of permanent storage. Building twice

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[1] Van Fossen, Larry, and Stoneberg, E. G., op. cit.

Table 47. Analysis of Storage Costs for Corn Harvested and Dried September 15-30, Northeastern Virginia, 1961 (3579 Bushels of Corn Stored in Bins Used for Drying)[1]

Nine months interest on corn worth $4225 (at harvest) at 6%	$190.13
Additional drying cost (15.5% to 13%)	35.79
Additional shrinkage	105.63
Taxes on corn ($3.00 per $100 on 20% valuation)	25.35
Total storage costs for 3490 bu.	$356.90[2]
Expected returns for storing corn	$593.30
Expected returns above storage costs	$236.40

[1]See footnotes on Table 46.

[2]Need 10.2 cents higher price at end of nine months storage to break-even.

Table 48. Analysis of Storage Costs for Corn Harvested and Dried October 1-21, Northeastern Virginia, 1961 (5300 Bushels of Corn Stored in Bins Used for Drying)[1]

Nine months interest on corn worth $5577 (at harvest) at 6% (see column (17) Table 42)	$250.97
Variable cost of drying (5300 bushels) (See column (10) Table 42)	79.43
Additional handling @ 2.5 cents per bu.	132.50
Additional drying cost (15.5% to 13%)	53.00
Additional shrinkage	147.71
Taxes on corn ($3.00 per $100 on 20% valuation)	33.33
Total storage costs on 5174 bu.	$696.94[2]
Expected returns for storing corn	879.58
Expected returns above storage costs	$182.64

[1] See footnotes on Table 46.

[2] Need 13.5 cents higher price at end of nine months storage to break-even.

the storage space required for shelled corn is a high price to pay to store cobs.

Aeration of Shelled Corn

Ear corn will normally dry while stored in a well constructed crib whereas stored shelled corn does require cooling by aeration if it is to be held into the spring months. Aeration equipment was used to either pull cold air down through the grain or, where the bin-type drier was used, the cool air was blown up through the grain. The purpose of aeration for shelled corn storage is to lower the temperatures of the grain and prevent moisture migration in the grain. Spoilage and crusting of the grain is prevented in this way.

The requirements for air delivery are many times lower for the aeration of grain than for drying. The cost per hour of aeration can be estimated by multiplying the average cost of a kilo-watt hour of electricity times the horse-power on the fan.

CHAPTER VIII

SUMMARY

The major purposes of this study were to:

1. Determine the available resources and their restrictions for harvesting, handling, drying and storing corn.

2. Consider admissible combinations of machinery and equipment for harvesting, handling, drying and storing corn.

3. Determine the proper combinations of resources to use in a system with a given quantity of corn under alternative typical resource and price conditions.

4. Identify the chief management problems involved in harvesting, drying, and storage of corn.

It was hypothesized that:

1. There are important differences among farms in Northeastern Virginia in the returns above harvesting and subsequent costs per bushel of corn due to:

   a. the time of sale and seasonal fluctuations in price;

   b. quantity and quality of corn for disposal;

   c. resources and methods used to harvest, dry, and store corn.

2. There is a minimum number of acres or bushels of corn required to make the ownership of harvesting, handling, and drying equipment economically feasible.

3. The most economical individual item of equipment required to perform an operation is not necessarily the item of equipment that will fit the most profitable system.

4. The combination of this equipment into an optimum system from the standpoint of profit maximization is a function of the size of operation and resources available with some consideration given to timeliness, risk, and uncertainty.

Using the data obtained from a survey of 178 farms in the summer of 1961 and a follow-up survey of 50 farms in the fall of 1961, an analysis was made of the harvesting, drying, and storage of corn in Northeastern Virginia.

The flow analysis shown in Figure 2 for ear corn and in Figure 3 for shelled corn was constructed in order to put the entire system of harvesting and grain handling, its numerous alternative methods, and their interrelationships into proper perspective. Methods for performing the above operations were selected from those found in use in the area studied.

Prices

The decision of whether or not to dry and/or store corn is influenced by prices and discounts in effect in the area. Therefore, a model for approximating the seasonal movement of prices was developed. Weekly average prices from Tappahannock, Richmond, and Norfolk were used separately in the five degree polynomial equation to estimate the five coefficients for each of the three markets. The multiple correlation coefficient for Tappahannock indicated that 95.5 percent of the total variability in the historical average price could be predicted with the use of the equation. The coefficient of variation indicated that about a six percent variation from the five year mean weekly average price might be expected in two years out of three.

Harvesting Costs

An analysis of harvesting costs was made using an equation that permitted consideration of variations in the opportunity costs of labor and capital. The least-cost zones for custom hiring vs. picking and combining were also estimated using various custom rates. Five methods of harvesting corn and small grain in the ratio of one acre to three acres were developed for comparison. Labor was valued at one dollar per hour. Method (1) harvested corn and small grains with a self-propelled combine (both a corn and a grain head were included in this analysis). Forty percent of the fixed cost on the basic combine was allocated to corn harvesting and sixty percent to grain harvesting. Method (2) employed a two-row mounted corn picker and a 7-foot pull-type grain combine. Method (3) used a two-row mounted corn picker and custom combined the small grain at a charge of six dollars per acre. Method (4) picked corn with a one-row picker and custom combined grain at six dollars per acre. Method (5) employed the one-row picker and 7-foot pull-type combine.

In Figure 20 the above methods were adjusted using a two dollars per acre charge for shelling the ear corn. Under these circumstances, owning a self-propelled combine, Method (1), was the least-cost alternative at any acreage above 240 acres of grain (any combination of more than 60 acres of corn and 180 acres of small grain). Methods (4) and (5) were the cheapest means of harvesting below 135 and 240 acres respectively. However, if Methods (4) and (5) were compared with the cost of custom combining corn at nine dollars per acre and grain at six dollars per acre (a weighted average cost of $6.75 per acre), custom combining was the least-cost combination up to a total of 225 acres of grain. At the larger acreages, Method (1) using the self-propelled combine was at least one dollar per acre cheaper than any other alternative.

The effect of the estimated field losses on the cost of harvesting, assuming an 80 bushel per acre yield, was depicted in Figure 23. If the corn were valued at one dollar per bushel, the additional cost due to field losses in harvesting with the self-propelled combine varied from $5.50 per acre at 125 acres to $11.00 per acre at 350 acres. The ownership of the self-propelled combine for timeliness of harvest on 150 acres of corn was worth $3.50 per acre compared with using the one-row picker. Similarly, there was a $3.60 per acre cost advantage for a two-row picker over the one-row picker when additional field losses were considered on 150 acres.

Drying Costs

Six major factors were included in the analysis of drying costs: (1) initial cost of the drying equipment, (2) drier operating costs,

(3) average moisture content of corn before drying, (4) prices and discounts for high-moisture corn, (5) annual volume of corn to be dried, and (6) field and harvesting losses.

Drying costs were primarily affected by the original investment in equipment, annual volume of corn dried, and the quantity of water removed per bushel. Operating costs of $0.054 per bushel were based on data from the study for drying 30 percent moisture corn to 15.5 percent moisture. The basic analysis of drying costs was made on 125 acres of corn with a yield of 80 bushels per acre or 10,000 bushels in the field on September 1. An estimated 803 bushels were lost by natural drying during the four week harvesting period and an additional 890 bushels were lost in the harvesting operation. For the 8,307 bushels harvested, the total cost of drying was $1505 or 18.1 cents per bushel. A net return of $148 was realized above the returns that would have accrued if the corn had been sold wet at harvest.

In Table 37 the drying costs were analyzed for a 250 acre operation with 20,000 bushels harvested at the rate of 62.5 acres per week. The losses were computed in the same manner as above. The volume was double that in the previous analysis and the fixed cost of the batch drier (based on a $7500 investment) was spread over the 16,613 bushels harvested. This resulted in a profit of $1496 (ten times the profit when only 8300 bushels were dried). The average cost of drying was 10.8 cents per bushel. Drying a larger volume of high moisture corn (between 24 and 28 percent), lower harvesting losses, a slightly better corn price early in the month, and the greater differential between the value of the corn and the discounted price, were largely responsible for the greater profit.

Bin-type driers were the most numerous in the area. For a 10,000 bushel drying operation with four bins and two driers the average cost of drying was 12.3 cents per bushel.[1] If the corn were sold each week, there would be a profit of $629 for the drying operation. Corn dried in this manner, however, was generally held for later sale.

For the smaller operator with only a 5000 bushel crop, two bins and one drier would be practical. In this operation a $3000 initial investment, would average 12.9 cents drying costs per bushel for the 4400 bushels harvested. A profit to drying of $623 would be realized if the harvesting were accomplished in the first two weeks of September.

This study suggests that farmers using bin-type driers did not harvest and dry early enough to make the drying operation particularly profitable, but they did experience a sufficient price increase on the stored corn to produce a nominal profit on the overall operation.

Corn dried with batch driers was usually sold at harvest, although operators could expect small additional returns from holding the corn for later sale. It was significant that in Table 48, with the fixed costs of the bins charged to the drying operation, there was only a

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[1]With a total initial investment of $6000 the operator could spread grain over four drying areas as required. This would enable him to acquire some of the flexibility in his operation inherent in the operation of batch driers.

three percent expected return on the investment in purchased corn held for later sale. The profits from storing corn on the farm were not large enough to encourage great numbers of the smaller operators to invest in storage.

Budgeting the Corn Enterprise

The enterprise budget presented in Table 49 was prepared as an example for preparing budgets and estimates for specific farm situations with conditions similar to those existing in the area of this study. Input and output data, as well as prices, appropriate to a specific farm situation may be substituted in order to estimate the relative profitability of a corn enterprise on a farm having different conditions.

Under average management conditions 125 acres of corn yielding 80 bushels per acre or 10,000 bushels in the field on September 1, was typical for the area. These farms also produced 375 acres of soybeans and small grains.

The analysis accompanying Figure 20 indicated that harvesting the above acreage with a self-propelled combine was the least-cost method. With harvesting losses for corn and timeliness of harvest taken into consideration as in Figure 23, it was evident that harvesting the corn crop as shelled corn was advantageous. The system for harvesting and handling shelled corn for this example is included in the flow chart in Figure 3. The cost of harvesting corn with the self-propelled combine was determined from Figure 15 for use in the budget in Table 49. Other costs and input requirements were based on averages from data acquired

Table 49. Estimated Returns, Costs and Input Requirements for One Acre of Continuous Corn for Grain (Mechanically Dried but not Stored), Northeastern Virginia

Unit	Price ($)	Quantity	Unit	Amount ($)
Income:				
Corn	1.20[1]	58.5[1]	bu.	70.20
Total receipts				70.20
Expenses:				
Seed	0.20	11	lb.	2.20
Fertilizer: N	0.12	57	lb.	6.84
P_2O_5	0.06	68	lb.	4.08
K_2O_5	0.05	73	lb.	3.65
Lime (spread)	7.50	.33	ton	2.50
Spray material	5.80	1	acre	5.80
Machinery (non-harvesting)	1.35	3.0	hr.	4.05
Growing expenses				29.12
Drying	0.181[1]	66.5[1]	bu.	12.30
Harvesting machinery cost (self-propelled combine)	6.37[1]	1	acre	6.37
Sub-total expenses				47.79
Land	255.00	6	%	15.30
Labor	0.90	5.4	hr.	4.86
Total expenses				67.95
Return to land, labor, and management				22.41
Total receipts minus total expenses				2.25
Net receipts per acre				2.25
Net receipts per hour of labor				1.32

Seasonal labor requirements	Hours
February - April	3.0
September	2.4
Total	5.4

[1]Based on data from Table 36 and Figure 15.

in the farm surveys made in 1961.[1] The handling equipment would be selected to accommodate the volume and speed of harvest.

In Table 36 and Table 38, the analysis of shrinkage, harvesting, and drying the corn from 125 acres was presented. For Table 49, the 18.1 cents cost of drying, the $1.20 per bushel price, and 58.5 bushels of dried corn were taken from Table 36. The total net receipts for the 125 acres of corn in Table 49 was $301.25. The net receipts per acre would be reduced by approximately 50 percent if the corn had been sold wet at harvest. If the corn were harvested in a two week period and the following data (Table 38) were used: 18.3 cents per bushel drying cost, $1.21 per bushel average price, and 59.7 bushels of dried corn, the total net receipts would be $461.25 ($3.69 per acre).

Consideration may be given to the storage of the corn harvested the last two weeks of September as in Table 46. In this case the total net receipts for the 125 acres of $301.25 based on the estimation in Table 49 could possibly be increased by $111.07 with an additional investment in storage facilities of $1600.

Conclusions

The hypotheses were substantiated. Significant differences were found among the farms in Northeastern Virginia in the returns from the corn enterprise. These differences were due to the time of sale,

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[1] Chambliss, R. Lee, Jr. and Hoepner, Paul H., Op. Cit.

seasonal fluctuations in price, the quality and quantity of corn disposed, and the methods and resources used to harvest, dry, and store corn. A certain minimum number of acres or bushels were required to make the ownership of harvesting, handling, and drying equipment economically feasible. The most economical individual item of equipment, for example the one-row corn picker, was not necessarily the item of equipment that would fit the most profitable system. It was found that the size of the operation, the resources available, risk and uncertainty, and timeliness must be considered in order to select an optimum system from the standpoint of profit maximization.

For farmers to realize a profit from their corn enterprise much greater emphasis must be placed on the maintenance and analysis of accurate farm records, the utilization of efficient systems of production and processing, and the development of better marketing procedures.

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VITA

The author, Donald Robert Burrowbridge, was born to Ruth A. and Clarence J. Burrowbridge (deceased) on October 24, 1919 at Madison, Wisconsin.

He attended Madison West High School and graduated in 1937. He entered the University of Wisconsin in September 1937, and received a Bachelor of Science Degree in Agriculture with a major in Agricultural Engineering in June 1947. He was commissioned a 2nd Lieutenant in the Infantry in 1941, served until June 1946 in the United States Army and is now a Colonel in the United States Army Reserve.

He was employed by the Public Service Company of Northern Illinois from 1947 to 1957 as Agricultural Sales Engineer. He was employed as Director of the Thor Research Center for Better Farm Living in 1957 and 1958. In 1958 he was employed as Coordinator of the Virginia Farm and Home Electrification Council until August 1962 and is presently Assistant Director of the Cooperative Program in Engineering and Science at Virginia Polytechnic Institute.

He married Marian Ryan of Rockford, Illinois and has seven children.

He entered the graduate school at Northern Illinois University and transferred to Virginia Polytechnic Institute.

APPENDIX A

Tables

Table 1. Estimated Life and Operating Cost of Farm Machinery[a]

Machine	Years until obsolete	Wear-out life, hours	Hourly operating costs (% of new cost)
Tractors:			
Tractor, track	15	12,000	.007[b]
Tractor, wheel	15	12,000	.010[b]
Planting:			
Endgate seeder	20	800	.038
Grain drill	20	1,200	.080
Row crop planter	15	1,200	.070
Harvesting:			
Combine, 5-7 ft.	10	2,000	.045
Combine, self-propelled	10	2,000	.027[b]
Corn picker	10	2,000	.032[c]
Field chopper, aux. eng.	10	2,000	.024[b]
Field chopper, PTO	10	2,000	.029
Forage blower	12	2,000	.025
Mower	12	2,000	.120
Hay conditioner	10	2,500	.040
Windrower, self-propelled	8	2,500	.040[b]
Dump rake	10	1,500	.017
Side delivery rake	12	2,500	.070
Hay loader	10	1,200	.021
Baler, aux. eng.	10	2,500	.022[b]
Baler, PTO	10	2,500	.032
Rotary cutter	12	2,000	.020
Miscellaneous:			
Feeder grinder	15	2,000	.013
Field sprayer	10	1,500	.020
Manure loader	10	2,000	.013
Manure spreader	15	2,500	.010
Portable elevator	15	1,500	.010
Wagon	15	5,000	.018

Table 1. Footnotes

[a]Agricultural Engineers Yearbook, 1963, American Society of Agricultural Engineers, St. Joseph, Michigan, with slight revisions for Virginia conditions.

[b]Does not include fuel, grease, oil, antifreeze, and oil filters for tractors and auxiliary engines. An estimate of the per hour cost of these items for gasoline tractors and engines can be calculated by multiplying 0.07 times the maximum belt or PTO horsepower times the fuel cost per gallon. For diesel equipment, use 0.06 times the maximum belt or PTO horsepower times the fuel cost per gallon. The operating cost does not include the cost of twine for balers.

[c]Add a total of .01 percent of new cost each time machine is mounted and dismounted (normally once a year).

Table 2. Fixed and Variable Costs for One-Row and Two-Row Corn Pickers

Item	One-row picker	Two-row picker
New cost	$1600	$2800
Salvage (10%)	$160	$280
Fixed costs per year:		
Depreciation (10 years)	$144	$252
Interest (3% new cost)	48	84
Insurance, taxes and housing (1½% new cost)	24	42
Total fixed cost	$216	$378
Operating cost (machine)	$0.51/hr.	$1.18/hr.
Operating cost (tractor)	0.30/hr.	0.40/hr.
Fuel, etc.	0.49/hr.	0.63/hr.
Total variable cost	$1.30/hr. or $1.63/acre	$2.21/hr. or $1.44/acre

Table 3. Fixed and Variable Costs for Two-Row Self-Propelled Corn Combine

Item	Two-row corn combine (100% fixed cost)	Two-row corn combine (40% fixed cost)
New cost	$5900	$2360
Corn head	1900	1900
Total new cost	$7800	$4260
Salvage (10%)	$780	$426
Fixed costs per year:		
Depreciation (10 years)	$702	$383
Interest (3% new cost)	234	128
Insurance, taxes and housing (1½% new cost)	117	64
Total fixed cost	$1053	$575
Operating costs	$2.11/hr.	$2.11/hr.
Fuel, etc.	0.84/hr.	0.84/hr.
Total variable cost	$2.95/hr. or $1.86/acre	$2.95/hr. or $1.86/acre

Table 4. Fixed and Variable Costs for Self-Propelled 12-Foot Grain Combine

Item	12-ft. grain combine (100% fixed cost)	12-ft grain combine (60% fixed cost)
New cost	$5900	$3540
Grain head	1200	1200
Total new cost	$7100	$4740
Salvage (10%)	$710	$474
Fixed costs per year:		
Depreciation (10 years)	$639	$427
Interest (3% new cost)	213	142
Insurance, taxes and housing (1½% new cost)	107	71
Total fixed cost	$949	$640
Operating costs	$1.92/hr.	$1.92/hr.
Fuel, etc.	0.84/hr.	0.84/hr.
Total variable cost	$2.76/hr. or $0.88/acre	$2.76/hr. or $0.88/acre

Table 5. Fixed and Variable Costs for Pull-Type 7-Foot Grain Combine

Item	7-ft. grain combine (pull-type)
New cost	$2800
Salvage (10%)	$280
Fixed costs per year:	
Depreciation (10 years)	$252
Interest (3% new cost)	84
Insurance, taxes and housing (1½% new cost)	42
Total fixed cost	$378
Operating cost (machine)	$1.26/hr.
Operating cost (tractor)	0.40/hr.
Fuel, etc.	0.63/hr.
Total variable cost	$2.29/hr. or $1.24/acre

Table 6. Cost of Harvesting Corn, Including Field Losses for Self-Propelled Combine[1]

No. of acres	Days for harvest	Days adjusted 125%	Bu. lost 80 bu. yield	Harvest cost per acre	Harvest cost plus field losses
50	3.90	4.88	9.00	14.00	23.00
75	5.86	7.33	6.00	10.16	16.16
100	7.81	9.77	5.75	8.24	13.99
125	9.76	12.20	5.50	7.09	12.59
150	11.72	14.65	6.20	6.32	12.52
175	13.67	17.09	6.90	5.78	12.68
200	15.62	19.53	7.50	5.37	12.87
225	17.58	21.98	8.20	5.05	13.25
250	19.53	24.40	9.00	4.79	13.79
275	21.40	26.75	9.75	4.58	14.33
300	23.44	29.30	10.10	4.41	14.51
325	25.39	31.74	10.50	4.26	14.76
350	27.34	34.17	11.00	4.13	15.13

[1]Based on beginning harvest on September 1 and harvesting at a rate of 1.6 acres per hour or 12.8 acres per day. Field losses valued at $1.00 per bushel. Harvesting cost from Figure 15.

Table 7. Cost of Harvesting Corn, Including Field Losses for One-Row Picker[1]

No. of acres	Days for harvest	Days adjusted 125%	Bu. lost 80 bu. yield	Harvest cost per acre	Harvest cost plus field losses
50	7.80	9.75	5.75	8.69	14.44
75	11.72	14.65	6.20	7.25	13.45
100	15.62	19.53	7.50	6.53	14.03
125	19.52	24.40	9.00	6.10	15.10
150	23.44	29.30	10.10	5.81	15.91
175	27.34	34.18	11.00	5.60	16.60
200	31.24	39.05	11.50	5.45	16.95
225	35.16	43.95	12.00	5.33	17.33

[1]Based on beginning harvest on September 1 and harvesting at a rate of 0.8 acres per hour or 6.4 acres per day. Field losses valued at $1.00 per bushel. Harvesting cost from Figure 12, plus shelling charge.

Table 8. Cost of Harvesting Corn, Including Field Losses for Two-Row Picker[1]

No. of acres	Days for harvest	Days adjusted 125%	Bu. lost 80 bu. yield	Harvest cost per acre	Harvest cost plus field losses
50	4.08	5.10	9.00	11.02	19.02
75	6.12	7.65	6.00	8.50	14.50
100	8.16	10.20	5.80	7.24	13.04
125	10.21	12.76	5.75	6.48	12.23
150	12.25	15.31	6.40	5.98	12.38
175	14.29	17.86	7.10	5.62	12.72
200	16.33	20.41	7.75	5.35	13.10
225	18.38	22.98	8.40	5.14	13.54
250	20.42	25.53	9.25	4.97	14.22
275	22.46	28.08	10.00	4.83	14.83
300	24.50	30.63	10.30	4.72	15.02
325	26.55	33.19	10.75	4.62	15.37
350	28.59	35.74	11.30	4.54	15.84

[1]Based on beginning harvest on September 1 and harvesting at a rate of 1.53 acres per hour or 12.24 acres per day. Field losses valued at $1.00 per bushel. Harvesting cost from Figure 13, plus shelling charge.

APPENDIX B

Survey Forms

NORTHEASTERN VIRGINIA FARM ADJUSTMENT STUDY

CONFIDENTIAL

Farm Code No.____________________

Department of Agricultural Economics
Virginia Agricultural Experiment Station
Blacksburg, Virginia

Enumerator____________________

Date____________________

I. LAND

	Owned	Rented in	Rented out	Operated (net)
1. Total farm acreage	____	____	____	____
a. Total open land	____	____	____	____
b. Crop land	____	____	____	____
c. Land suitable for pasture only	____	____	____	____
d. Tillable pasture	____	____	____	____
e. Woodland, waste farmstead, etc.	____	____	____	____

2. How much of your open land is suitable for: (Total should equal total open land.)

   a. continuous corn _______________acres

   b. pasture only_______________acres

   c. normal rotation_______________acres

   d. other (specify)_______________ _______________acres

3. What is your normal rotation? a. ______, ______, ______, ______

   b. ______, ______, ______, ______, ______, ______

   c. ______, ______, ______, ______, ______, ______

4. a. What would you have to pay for additional land reasonably close to your farm?

	Cropland	Pasture
1) Rent	\$______per a.	\$______per a.
2) Buy	\$______per a.	\$______per a.

   b. What would you be willing to pay?

	Cropland	Pasture
1) Rent	\$______per a.	\$______per a.
2) Buy	\$______per a.	\$______per a.

   c. Comments (availability and willingness to buy and/or rent):

____

____

III. BEEF CATTLE ENTERPRISE, MAY 1, 1960 - APRIL 30, 1961

Do you have beef cattle on this farm? Yes ☐ No ☐ IF NO: OMIT REST OF PAGE.

A. Cow-Calf herd

1. Average number of beef brood cows ___________.

2. How do you feed your cows during the winter. rough through ☐ some grn ☐

3. Please describe your cow feeding practices (amount, type, length of feeding):

____

4. How many calves were:

a) born on this farm ___________

b) creep fed on pasture ___________

c) sold in 1960-61 at weaning age ___________

d) price received per cwt ___________

e) put in feedlot on this farm after weaning ___________

f) carried over on this farm ___________ (too young for feed lot or sale on April 30, 1961)

B. Feeder cattle:

1. Please describe your beef cattle fattening operation in terms of:

	Lot I	Lot II	Lot III
a) no. of raised feeders	______	______	______
b) no. of purchased feeders	______	______	______
c) price paid for feeders per cwt.	______	______	______
d) date going on feed	______	______	______
e) age at beginning	______	______	______
f) av. wt. at beginning	______	______	______
g) grade at beginning	______	______	______
h) date at end of feeding	______	______	______
i) number at end of feeding	______	______	______
j) av. wt. at end of feeding	______	______	______
k) grade at end of feeding	______	______	______
l) price received per cwt.	______	______	______

m) type, quantity, and length of feeding and pasture ______________

____

____

IV. HOG ENTERPRISE - MAY 1, 1960 - APRIL 30, 1961

Do you have any hogs on this farm? Yes /__/ No /__/ IF NO: OMIT REST OF PAGE.

A. Breeding herd:

	Fall 1960	Spring 1961
1. average number of brood sows	______	______
2. no. of litters farrowed	______	______
3. no. of pigs weaned	______	______
4. average age sold as feeder pigs	______	______
5. average wt. sold as feeder pigs	______	______
6. average price received per feeder pig	______	______

7. Sows kept: (a) on pasture /__/, (b) in confinement /__/
Describe your sow feeding operation ______________________________

____

____

____

B. Fattening hogs:

Please describe your hog fattening operation in terms of:

	Lot I	Lot II	Lot III
1. number of raised feeder pigs	______	______	______
2. number of purchased feeder pigs	______	______	______
3. price paid for purchased pigs (per head)	______	______	______
4. date going on feed	______	______	______
5. weight at beginning	______	______	______
6. date sold	______	______	______
7. number sold	______	______	______
8. average weight at sale	______	______	______
9. price received per cwt.	______	______	______

10. Please describe kind and amount of feed and any special conditions

____

____

____

____

V. OTHER LIVESTOCK: MAY 1, 1960 - APRIL 30, 1961

What other livestock do you have on this farm? IF NONE: OMIT REST

Livestock	Average number	Sales May 1, 1960 - April 30, 1961		Purchases May 1, 1960 - April 30, 1961	
		No.	Lbs.	No.	Lbs.
1. Ewes					
2. Feeder lambs	XXXX				
3. Fat lambs	XXXX				
Wool sold	XXXX	XXXX		XXXX	XXXX
4. Dairy cows			XXXX		XXXX
Cwt. milk sold	XXXX		XXXX	XXXX	XXXX
5. Veal calves	XXXX				
6. Heifers			XXXX		XXXX
7. Laying hens					XXXX
Dozen eggs sold	XXXX		XXXX	XXXX	XXXX
8. Broilers	XXXX			XXXX	XXXX
9.					
10.					
11.					

II. CROPS - 1960

Crop (on land owned and/or rented)	Acres 1960	Total Production	OR Yield per acre	Fertilizer and Lime Used: Analysis	Lbs. per A	OR Total
1. Corn - grain		bu	bu			
2. Corn - silage		T	T			
3. Soybeans - early		bu	bu			
4. Soybeans after small grain	( )	bu	bu			
5. Wheat - grain		bu	bu			
6. Other ________						
7. Barley - grain						
8. Other ________						
9. Oats - grain		bu	bu			
10. Other ________						
11. Rye - grain		bu	bu			
12. Other ________						
13. Alfalfa hay: 1st.		T	T			
14. 2nd.	( )	T	T	XXX	XXX	XXX
15. 3rd.	( )	T	T	XXX	XXX	XXX
16. 4th.	( )	T	T	XXX	XXX	XXX
17. pastured	( )	hd da	hd da	XXX	XXX	XXX
18. Lespedeza: 1st.		T	T			
19. Clover and timothy: 1st.		T	T			
20. 2nd.	( )	T	T	XXX	XXX	XXX
21. pastured	( )	hd da	hd da	XXX	XXX	XXX
22. Other hay: 1st.		T	T			
23. 2nd.	( )	T	T	XXX	XXX	XXX
24. pastured	( )	hd da	hd da	XXX	XXX	XXX
25. Veg. and truck crops (specify)						
26.						
27. Total cropland*		XXX	XXX	XXX	XXX	XXX

Note: Indicate double cropping with (). *Should equal above (I.1.b.) excluding ().

VI. 1960 CROP AND FEED DISPOSITION

Item		Corn grain bu.	Corn Silage Ton	Soybeans bu.	Wheat bu.	Barley bu.	Oats bu.	Rye bu.
1. Produced (see page 5)								
2. Purchases	quantity							
	value							
3. Begin. inventory (May 1, 1960)								
A. Total supply								
1. Sales	quantity							
	value							
2. Ending inventory (April 30, 1961)								
B. Total								
C. Avail. for feed A-B								
Feed used by: * Beef cows								
Feeder calves								
Fattening cattle								
Brood Sows and gilts								
Hogs								
Feeder pigs								
Dairy cows								
Other dairy								
Sheep								
Chickens								
Other (specify)								
D. Total								

* Use proportions if absolute amounts unobtainable.

VI. 1960 CROP AND FEED DISPOSITION

Item		( ) Hay (T)	Purchased bu. T. lbs.	bu. T. lbs.	bu. T. lbs.	bu. T. lbs.	bu. T. lbs.	bu. T. lbs.
1. Produced (see page 5)								
2. Purchases	quantity							
	value							
3. Begin. inventory (May 1, 1960)								
A. Total supply								
1. Sales	quantity							
	value							
2. Ending inventory (April 30, 1961)								
B. Total								
C. Avail. for feed A-B								
Feed used by: * Beef cows								
Feeder calves								
Fattening cattle								
Brood Sows and gilts								
Hogs								
Feeder pigs								
Dairy cows								
Other dairy								
Sheep								
Chickens								
Other (specify)								
D. Total								

* Use proportions if absolute amounts unobtainable.

VII. FARM LABOR FORCE

Member	Approx. Age	No. of mths. wrk'd on** farm in 1960	Average Number of hours per wk. that each member is willing and able to work on farm during: Dec. Jan	Feb. Mar. April	May June	July August	Sept. Oct. Nov.	No. of days worked off farm in 1960
1. Family workers a) Operator								
b) Wife	XXXX							
c) Sons (1)								
(2)								
(3)								
d) Daughters (1)								
(2)								
(3)								
e) Others (1)								
(2)								
2. Hired workers: f) Regular (1)								Wage
(2)								
g) Seasonal								
Total*	XXXX							XXXX

* For office use only ** 26 days equal one month

3. During the periods of the year when applicable, about how many hours per day of total labor are spent on each of the following livestock enterprises?

a. Beef cow-calf herd_______________ c. Sows and litters_______________

b. Fattening cattle _______________ d. Fattening hogs _______________

e. Other livestock (specify)____

____

____

VIII. BUILDING INVENTORY

Kind	Size	Type of ** Construction	Year built	Years useful life remaining	Estimated present value
General stock barn (specify use)	ft x ft				
	ft x ft				
	ft x ft				
Stanchion barn	stanchions				
Loafing barn (dairy)	ft x ft				
	ft x ft				
Milking parlor	stalls				
Hog parlor	ft x ft				
Farrowing house	ft x ft				
	ft x ft				
Poultry house	ft x ft				
	ft x ft				
Machine shed	ft x ft				
Hay shed	tons				
Granary	bu				
Corn crib	bu				
Silo* U, B, T	ft x ft				
	ft x ft				
	ft x ft				
Other crop storage facilities (specify kind and size)					
Other buildings (excluding residences)					

* Specify: (U) upright; (B) bunker; (T) trench.

** Frame, masonry, steel, or specify other.

IX. MACHINERY AND EQUIPMENT INVENTORY

Item	Size and type	Annual use**	Year*** purchased	Purchase price	Estimated life Remaining
1. Truck hydraulic flat bed	ton	mi	N U		
2. hydraulic flat bed	ton	mi	N U		
3. Tractor gasoline diesel	plow	hrs	N U		
4. gasoline diesel	plow	hrs	N U		
5. gasoline diesel	plow	hrs	N U		
6. gasoline diesel	plow	hrs	N U		
7. Corn picker*	S.P.,T.M.,P.T.O., row AM	a	N U		
8. Picker-sheller*	S.P.,T.M.,P.T.O., row AM	a	N U		
9. Corn sheller		bu	N U		
10. Combine corn head*	S.P.,T.M,P.T.O. ft. AM	a	N U		
11. grain head*	S.P.,T.M.,P.T.O. ft. AM	a	N U		
12. Forage harvester	S.P.,T.M.,P.T.O. AM	a	N U		
13. Hay baler	P.T.O. AM	a	N U		
14. Hay dryer	G,E	hrs	N U		
15. Ensilage blower		hrs	N U		
16. Elevator	G,E	hrs	N U		
17. Auger	G,E	hrs	N U		
18. Crop dryer: (specify kind)		XXXX	N U		
19. Self unloading wagon		XXXX	N U		
20. Rotary mower		da a	N U		
21. Other: (specify kind)			N U		
22.			N U		
23.			N U		
24.			N U		

* Circle: S.P. (Self-propelled); T.M. (Tractor mounted); P.T.O. (Power take-off) A.M. (Auxilliary motor); and other where applicable.

** Include and note: (1) custom work done (C)
(2) custom work hired (H) and cost per unit under purchase price

*** Circle (N) new; (U) used

X CROP PRACTICES

1. What type of crop dryer do you have? (check appropriate ones)

/__/ a. (1) don't dry (high moisture)

/__/ b. (1) field dry

/__/ (2) natural air

/__/ (3) heated air

/__/ c. (1) batch

/__/ (2) wagon box

/__/ (3) in storage

/__/ (4) commercial dryer

/__/ (5) on farm custom drying

/__/ (6) other (specify)______________________________

2. What crops and how much of each do you dry with your crop dryer?

crop	amount
____________________	____________________ bu. T.
____________________	____________________ bu. T.
____________________	____________________ bu. T.
____________________	____________________ bu. T.

3. Describe your land preparation (plowing, discing, etc.) procedures (in terms of size and type of equipment, number of times and combinations, etc.):

Plow width ________ in. Number of plows ___________

Disc no. of times_________ width _________ft. Number of discs ___________

Harrow no. of times ______ width _________ft. Number of harrows _________

Comments:____

4. How do you control weeds and insects in your crops?

/__/ a. spray (1) airplane /__/ or (2) tractor /__/ No. of times ______

/__/ b. cultivate - No. of times___________

/__/ c. dust (1) airplane /__/ or (2) tractor /__/ No. of times________

Comments:____

____

5. How many rows are handled by most of your planting and cultivating equipment?

   __________ rows.

6. About when do you expect to begin harvesting this year's corn crop?

   ____

7. On what basis do you decide when to begin corn harvest? (check appropriate)

   ☐ a. moisture _____%

   ☐ b. price

   ☐ c. hurricane (storm risk)

   ☐ d. fall plowing for winter crop

   ☐ e. other____

8. When did you sell last year's corn crop?

   a. ☐ at harvest

   b. ☐ after storage : Month(s)__________________

   ____

   ____

   c. ☐ none sold

9. On what basis do you decide when to sell your corn? (check appropriate)

   ☐ a. price

   ☐ b. storage costs

   ☐ c. need money

   ☐ d. storability

   ☐ e. other____

10. If 8 b or c (above), how was corn stored?

   a. on farm:

   ☐ (1) ear

   ☐ (2) shelled

   ☐ b. commercial storage

   ☐ c. in "grain bank"

   ☐ d. gov't storage

11. Please describe the type of corn storage structure: (If 10 a (above) omit)

   ____

   ____

   ____

XI. CAPITAL AND FUTURE ADJUSTMENTS

1. a. We would like to get an estimate of the total investment in this farm operation (present "fair" market value)

$________________

b. Of this total, how much do you:

1) Own (equity) $______________

2) Owe (borrowed capital) $______________ long-term
$______________ operating

2. Would you be willing and able to borrow additional capital (long-term and short-term) to expand or adjust your present farming operation? (land, buildings, equipment, livestock) /___/Yes /___/No

a. If YES: How much?______________

For what purpose?____

____

____

b. If NO: Why not?____

____

____

3. a. Which additional crops and classes of livestock (dairy, beef, sheep, etc) would you consider producing on your farm?

____

____

b. Why are you not producing them at present?______________________________

____

____

c. Which classes of livestock would you not consider producing?______________

____

____

Why not?____

____

____

4. a. Are you eligible for participation in the "Feed Grain Program"?
/__/Yes /__/No

b. If YES: Are you participating in this program? /__/Yes /__/No

c. If YES: How much acreage have you diverted from grain production?

_______________ acres.

d. What percent of your allotment does this represent? _______________%

e. Why are you or why are you not participating? _______________

____

____

5. a. Do you have a wheat allotment (more than 15 acres)? /__/Yes /__/No

If YES, _______________ acres

b. Have you complied with your wheat allotment? /__/Yes /__/No

c. Why or why not? _______________

____

____

6. Do you have a tobacco allotment? /__/Yes /__/No

If YES, _______________ acres.

Comments: _______________

____

____

Survey of

HARVESTING AND DRYING

In Northeastern Virginia, 1961

Farm Code No.___________________________
Date____________________________________
Enumerator______________________________

Operator________________________________ Address________________________________

County__________________________________

1. How many tillable acres did you farm in 1961?______________________________

2. How many acres and bushels of the following crops did you harvest in 1961?

Corn:	Soybeans:	Oats:	Wheat:	Barley:
Acres______	Acres______	Acres______	Acres______	Acres______
Bu.______	Bu.______	Bu.______	Bu.______	Bu.______

3. Describe harvesting and drying equipment now on your farm.

	Size and Type	Year Purchased	Original Cost if Purchased New
Picker	Rows		$
Field Sheller			$
Augers	Ft.______ H.P.		$
Elevators	Ft.______ H.P.		$
Driers	Fan Diameter______ H.P.		$
Aeration System	Fan Diameter______ H.P.		$
Moisture Tester			$
Trucks			$
Trucks			$
Wagons			$
Wagons			$

4. Describe any new corn storage erected in 1961

Number of Structures	Make and Type	Capacity (Bushels)	Cost

5. Record of Harvesting and Drying for 1961.

	Harvesting Ear Corn		Harvesting Shelled Corn		Bushels Dried	Estimated Field Losses Bu./Acre
	Acres	Bushels	Acres	Bushels		
Sept. 1-15						
Sept. 16-30						
Oct. 1-15						
Oct. 16-31						
Nov. 1-15						
Nov. 16-30						
Dec. 1-15						
Dec. 16-31						
Totals						XXXXXXXXXXXXXXXX

6. What was the date and moisture content of corn in the field?

a. at beginning of harvest?____________ date____________%

b. at end of harvest?____________ date____________%

7. To what moisture content did you dry your corn in 1961?

a. Direct marketing____________% Bushels____________

b. Farm storage for future marketing ____________% Bushels____________

c. Farm storage for feed ____________% Bushels____________

8. List bushels of other crops dried ________ ________ ________ ________

9. Were there any delays in the harvesting operations after harvest had begun? Yes ________ No__________. If yes, indicate reasons in order of importance, such as weather __________, machinery breakdowns__________, competition with other crops____________, competition with livestock work____________, speed of drying operation__________, other________.

10. Were there any delays in the drying operations after harvest had begun? Yes________ No__________. If yes, indicate reasons in order of importance, such as weather________, machinery breakdowns____________, competition with other crops______________, competition with livestock work____________, speed of harvesting operation__________, other______.

11. Indicate order of importance and effect of the following factors on the condition of corn harvested and field losses.

    (___) Weather____

    (___) Time of day (early morning, midday, or late afternoon)____________

    ____

    (___) Rate of travel____

    ____

    (___) Adjustment of (picker) or (field sheller)____________________

    ____

    (___) Other____

12. Are your storage structures equipped with aeration equipment? yes________ No__________. If yes, describe______________________

____

How many hours was aeration equipment used for 1960 crops? ________________

____

How many bushels were aerated? ____

Have you had difficulties in storing corn? Yes ____________ No ____________

If yes, explain ____

____

____

13. Drying--General Information

What was the cost of the electrical wiring and fixtures necessary to operate the drier and electric motors used on elevators and augers? ________________

____

If you have a moisture tester, are you satisfied with the tester?

Yes ________ No __________. If no, why not? ____________________________

____

How is drying equipment stored? ____

Does the use of heated air drying equipment affect the premium on your fire insurance? Yes ________ No __________. If yes, explain ________________

____

____

14. Batch Drying Only - Man hours per batch dried and moved to storage ____________ hours. Average bushels per batch __________________, and total number of batches _______________.

15. Total cost of electricity for operation of drier and conveyors:

$__________________; Bushels __________________.

16. Fuel used for total operation: (or if for average daily operation, specify number of bushels involved) ________________bushels.

	Type of Fuel	Gallons	Total Cost or Cost per Unit
a. Tractor for picker	______	______	______
b. Field Sheller	______	______	______
c. Tractors or Trucks (Hauling)	______	______	______
d. Drier	______	______	______
e. Engines or tractors on Fans	______	______	______
f. Engines on conveyors	______	______	______

17. Man hours of farm labor and costs for major repairs:

a. Harvesting Equipment

1. Preseason overhaul hours________________________Cost____________

2. During season hours ________________________Cost____________

3. Total Hours________________________Cost____________

b. Drier

1. Preseason overhaul hours________________________Cost____________

2. During season hours________________________Cost____________

3. Total Hours________________________Cost____________

18. What was the size of crew (number of people) normally used for the complete job of harvesting, drying, and storage of corn?________________________

19. What are advantages of your grain harvesting, handling and drying system?

____

____

20. What are disadvantages?________________________________

21. What changes would you make?________________________________

22. If drying corn, why are you drying?________________________________

23. If not drying corn, why not?________________________________

24. Any additional comments________________________________

DRB:mrp

INSTRUCTION FOR FILLING IN DAILY RECORD

A. 1. Include time spent greasing, adjusting, making repairs, etc.

2. Include time field shelling or picking, trouble stops, unloading combine or changing wagons.

3. Include driving time, preparing to unload, unloading, trouble stops (other than breakdowns), loading or changing wagons.

4. Omit if no drying operation.

5. Include time spent checking moisture and supervising operation.

6. Delay includes time caused by waiting on some job.

7. Omit if no drying operation.

8. Total hours spent on grain operation.

9. Time used in performing livestock or other crop work.

10. Total man-hours worked.

B. Omit if corn is not mechanically dried.

C. Omit if corn is not mechanically dried.

D. 1. Acres and bushels harvested during day.

2. Field losses may be estimated in the following manner:

In field-shelled corn, make a check at four points on each of the two rows. Pick up and count all the shelled kernels found in a 40-inch square. (One hill in 40 x 40 checked corn) Average all these losses and divide by 20. The result is your shelled-corn loss in bushels per acre.

To determine ear-corn loss, step off 43 paces at four places in the field and pick up all missed ears. Each good-sized ear in this length represents a loss of one bushel per acre.

E. Record the following from sale tickets for corn sold:

Date	No. of bushels	Moisture	Price

DAILY RECORD GRAIN HANDLING(Bin Dryer)

DATE______________________________ FARM CODE NO.____________________

A. Labor and Machine Use (indicate hours for each man)

Man Number	1	2	3	4	5
1. Maintenance of Equipment for Field Shelling or Picking	____	____	____	____	____
2. Operation of (Combine) or (Picker)	____	____	____	____	____
3. Haul and Unload	____	____	____	____	____
4. Fill Drier	____	____	____	____	____
5. Check and Supervise	____	____	____	____	____
6. Delay	____	____	____	____	____
7. Store Dry Corn	____	____	____	____	____
Total	____	____	____	____	____
8. Free Time for Other Duties	____	____	____	____	____
Total Man-Hours	____	____	____	____	____

B. Supplemental Heat and Natural Air Drying

1. No. of Bushels Placed on Drier____________________
2. Depth of Grain______________________________inches
3. Hours of Operation for Fan ____________________
4. Hours of Operation for Heater____________________
5. Fuel Used_________________________Gallons.

C. Moisture Content

1. Moisture Percentage in Field____________________.
2. After Drying Moisture Content at Top________________.
3. After Drying Moisture Content at Bottom__________________.
4. After Drying Average Moisture Content for Bin_____________________.
5. Drying Temperature__________ ^{o}F.

D. Harvesting

1. Acres Harvested____________________ No. of Bushels____________________
2. Estimated Field Losses_________________________Bu./A.

E. Record Sales on Attached Sheet.

DAILY RECORD GRAIN HANDLING (Batch Dryer)

DATE____________________ FARM CODE NO.________________

A. Labor and Machine Use (indicate hours for each man)

Man Number	1	2	3	4	5
1. Maintenance of Equipment for Field Shelling or Picking					
2. Operation of (Combine) or (Picker)					
3. Haul and Unload					
4. Fill Drier					
5. Check and Supervise					
6. Delay					
7. Store Dry Corn					
Total					
8. Free Time for Other Duties					
Total Man-Hours					

B. Machine-Hours, Drier

Batch No.	1	2	3	4	5
1. Fill Drier					
2. Heating					
3. Cooling					
4. Store Dry Corn					
5. Delay					
Total Machine-Hours					

C. Moisture Content

Batch	1	2	3	4	5
1. Beginning Percentage					
2. Final Percentage					
3. No. of Bushels Final					
4. Drying Temperature °F.					

D. Harvesting

1. Acres Harvested________________ No. of Bushels________________
2. Estimated Field Losses________________Bu./A.

E. Record Sales on Attached Sheet.

RECORD OF CORN SALES

DATE	NO. OF BUSHELS	MOISTURE %	PRICE/BU.

ABSTRACT

Typical grain and combination grain and livestock farms in Northeastern Virginia were selected for study of the available resources and their restrictions for harvesting, handling, drying and storing corn.

The costs involved in various combinations of machinery and equipment for performing the above operations were analyzed and the proper combinations of resources under alternative resource and price conditions determined.

A model for approximating the seasonal movement of prices was developed and used to predict the variability in the historical average price in the area.

An enterprise budget was prepared as an example for preparing budgets and estimates for specific farm situations with conditions similar to those existing in the area of this study.

Significant differences were found among the farms in the returns from the corn enterprise due to the time of sale, seasonal fluctuations in price, the quality and quantity of corn disposed, and the methods and resources used to harvest, dry, and store corn. It was found that the size of the operation, the resources available, risk and uncertainty, and timeliness must be considered in order to select a profit maximizing grain handling system.