WHEAT GRADING ACCURACY

AND POTENTIAL PROFIT

FROM SEGREGATION

AND CLEANING

BY

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Bachelor of Science

in Agricultural Economics

Oklahoma State University

Stillwater, Oklahoma

1996

Submitted to the Faculty of the
Graduate College of
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 1998

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Thesis Approved:

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ACKNOWLEDGMENTS

I want to express my sincere appreciation to my major advisor, Dr. Phil Kenkel for his tireless supervision, intelligent guidance, unending patience, and friendship. Dr. Kenkel is especially good at stimulating imagination and creativity. My appreciation also extends to my other committee members Dr. Brian Adam and Dr. Joe Schatzer. Their guidance, assistance, encouragement, and friendship are invaluable. Moreover, I sincerely thank Dr. Brian Adam for guiding me through not only the graduate, but also the undergraduate program at Oklahoma State University. Also, I would like to thank Dr. Phil Kenkel and the Department of Agricultural Economics for providing me with this research opportunity and their generous financial support.

Also, I would like to express my sincere gratitude to those who provided suggestions and assistance for this study: Dr. Conrad Lyford, Dr. Kim Anderson, Dr. Wade Brorsen, Mr. Wes Elliot, and Dr. Francis Epplin.

I would like to give special appreciation to my fiancée, Reneé Turnage, for her suggestions to my research, patience, love, and understanding through the entire process. My parents also receive my sincere gratitude for their continued support and encouragement.

Finally, I would like to thank the Department of Agricultural Economics for supporting me during the past year and a half of study.

TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

Table		Page

LIST OF APPENDIX TABLES

Table		Page

LIST OF FIGURES

CHAPTER I

SUMMARY OF WORK, INTRODUCTION, OBJECTIVES, AND OVERVIEW OF THESIS

Summary of Work

This research evaluated the quality related marketing activities of grain elevators in the Southern Plains. It determined if elevators inaccurately grade and price grain, and determined how these inaccuracies affect producer and elevator profitability. Also, the research determined the most profitable segregation, blending, and cleaning strategies available to elevators. The research then compared the grading accuracy of cooperative and investor-owned elevators.

This study is divided into three sections: (1) an analysis of the accuracy of elevator grading practices using a paired difference test, (2) a blending model that determines the most profitable segregation, blending, and cleaning strategies available to an elevator, and (3) a comparison of the grading and marketing practices between cooperative and investor-owned elevators. All of these sections used actual harvest wheat quality data collected during the 1995 and 1996 wheat harvests.

We used a paired difference analysis to determine the accuracy of elevator grading practices in Oklahoma. In the paired difference analysis, we compared elevator and official estimates of wheat quality to determine grading accuracy. We used data collected on over 3,000 tailgate truck samples at 24 elevators throughout Oklahoma wheat production areas. We selected the sampling sites to represent all major wheat producing areas, and to include elevators with trade territories that extended into Texas and Kansas. For each sample we obtained the complete scale ticket data, including net weight, and the elevator's estimate of moisture, dockage, test weight, grade and other grade factors such as shrunken and broken kernels, foreign material, and total defects. Each sample was also submitted to a licensed Federal Grain Inspection Service (FGIS) agency for an official measurement of grade and quality factors. Also, a corresponding price was assigned to each sample based upon a Farmland discount schedule.

The elevators tended to overestimate test weight and underestimate dockage and other undesirable grade factors such as shrunken and broken kernels, and damaged kernels. This inaccuracy resulted in a higher qualitative grade assigned to the sample of grain. This inaccuracy cost the typical elevator more than 9.32 cents per bushel in the 1995 harvest year and 3.75 cents per bushel in the 1996 harvest year. The major portion of the loss to elevators in both years resulted from underestimating dockage in wheat.

Underestimating dockage has significant impacts on country elevators. Terminal elevators remove dockage from weight and they impose price discounts for dockage levels above specified levels. Therefore, a country elevator that underestimates the level of dockage in a wheat sample pays wheat price for material that is removed from weight by the terminal elevator. The elevator ends up paying cleaning fees or may lose some of its margin that was in excess of the price discount it originally charged to the producer.

The analysis of grading accuracy also examined other issues related to grading equipment and the actual grading process. The purpose of this analysis was to determine technologies and specific aspects of the grading process which could improve grading accuracy. First, the grading accuracy of elevators using automated probes was compared to elevators using hand probes (sampling method). Similarly, the effect of mechanical dockage machines was compared to a hand pan sieve procedure (grading method). Finally, the importance of each grading step was determined. In both years, sampling method did not appear to have a significant impact on grading accuracy. In most cases, the use of mechanical dockage testers improved the accuracy of the dockage estimation for country elevators, because the dockage machines were less likely to underestimate dockage. Specifically, in the 1995 harvest, elevators using hand pan sieves were twice as likely to underestimate the true dockage level than those using mechanical dockage testers. The grading and sampling method results for 1996 were very similar to 1995. The three most important grading steps were the determination of dockage, shrunken and broken kernels, and test weight. Dockage determination was the most important step because it would have benefited an elevator 22 cents per bushel in 1995 and over 5 cents per bushel in 1996. Checking for test weight would have benefited an elevator 12 cents per bushel in 1995 and over 6 cents per bushel in 1996. Furthermore, checking for shrunken and broken kernels would have benefited an elevator .75 cents per bushel in 1995 and around .20 cents per bushel in 1996. By using mechanical dockage testers and checking for each grading step, an elevator manager can significantly increase an elevator's grading accuracy and increase its returns.

For the second aspect of this study we used a normative blending model. The model determined the most profitable blending, cleaning, and marketing strategies for an elevator. Also, this model facilitated a true measure of the economic impact of grading inaccuracy by modeling the actual value of each load of grain after blending and cleaning. The cleaning model optimizes elevator revenue, and is similar to the one proposed by Johnson and Wilson (1993). This model takes the form of a classic normative blending problem rather than a budget analysis (e.g., Adam and Anderson; Kiser). Normative models allow for variations in the intensity of cleaning operations and allow for alternative blending activities.

In 1995, the model indicated that the optimal strategy was for the elevator to clean approximately 30% of its wheat. This strategy would have generated additional revenue for the elevator, net of variable cleaning costs of approximately 3 cents per bushel. The cleaning results varied dramatically among elevators. Assuming that the dockage levels encountered during the sample period were typical of the overall grain received, some elevators should clean up to 70% of their grain for a net gain of over 8 cents per bushel, while other elevators would experience no gain from cleaning. The segregegation strategy that included dockage and moisture was the optimal segregation strategy in 1995.

In 1996, grain cleaning never entered the blending model due to the overall low dockage levels experienced at harvest. In 1996, segregation strategies that separated wheat based upon test weight and grade criteria were the optimal segregation strategies.

The final aspect of this study is the comparison of cooperative and investor owned elevators. The possible existence of differences in management practices between cooperative and investor owned firms has long been of interest to agricultural economists. In addition, grading inaccuracy in cooperative firms is of particular interest because the economic loss is borne by the farmer members. A paired difference analysis and a regression analysis were used to determine differences in grading accuracy between cooperative and private elevators.

In both 1995 and 1996 cooperative elevators on average graded less accurately than their investor-owned counterparts based upon the paired difference analysis. In general, the cooperative elevators' grading error in estimating foreign material (FM), damage, shrunken and broken kernels (SBK), and total damage was higher than that of the independent elevators. Cooperatives had a higher tendency to underestimate dockage, shrunken and broken kernels and to overestimate grade. In the regression analysis, cooperative elevators were 60% more likely to inaccurately measure dockage than their independent counterparts.

The results of this research are important to the entire wheat industry of the United States. The results indicate that country elevators in Oklahoma are not grading and pricing based on quality. Producers delivering high quality wheat are not being rewarded, and producers delivering lower quality wheat are being overcompensated. As a result, producers receive no incentive to invest in quality enhancing practices such as weed control and improved tillage methods.

Also, the results of this study are important because they address several issues that are related to grading accuracy. Analyzing these issues may provide methods to improve elevator grading practices and improve grain quality. For example, elevators can improve their dockage estimations by using dockage machines. Elevators which are skipping grading steps can test for dockage, test weight, and shrunken and broken kernels and significantly reduce its grading losses. By increasing the overall accuracy of country elevator grading practices, quality-adjusted prices could increase the quality of U.S. wheat.

Continued grading inaccuracy and failure to correct quality incentives could hurt the competitiveness of the U.S. wheat industry. This is due to the fact that other wheat exporters such as Canada and Australia continue to increase their market share at the expense of the United States. Since almost all of the wheat in the U.S. market must pass through a country elevator, the country elevator's estimates of quality provide important signals for the rest of the marketing channel. Therefore, increasing the accuracy of elevator grading practices should increase the usefulness of wheat quality information to the end user. Similarly, the increased accuracy of grading practices should provide incentives to producers to increase the overall quality of U.S. wheat.

Introduction

Country elevators are required by the Federal Grain Inspection Service (FGIS) to provide the first estimate of quality for grain as it enters the wheat marketing system. After grain quality is determined by the country elevator, it is then officially graded as it moves to the terminal elevator, food processor, or exporter. Due to the interdependence of the components of the wheat marketing system, the accuracy of grading personnel at country elevators and the time and costs of grading have a direct relationship with the net handling margin of the country elevator. Also, the accuracy of elevator grading affects elevator marketing activities such as segregation and blending which rely on estimates of grain quality. Therefore, if elevators inaccurately grade grain there will be an impact on both the net handling margin of the elevator and on any elevator decisions that are based on unreliable estimates of quality.

Grading inaccuracy also can affect producers in three important areas: price received by the producer, production incentives, and differential price impacts. Since the price received by the producer for grain delivered can be a function of an elevator's estimate of grain quality, grading inaccuracy can affect the price received for grain. Furthermore, inaccurate grading may decrease the efficiency of the marketing system by failing to provide producers with correct incentives to invest in weed control and other quality enhancing practices. Finally, inaccurate grading also may have differential impacts on producers delivering different qualities of grain. For example, often it is assumed that elevators tend to overestimate grain quality in an attempt to increase their market share. If systematic grading bias does occur and elevators adjust their bid prices to reflect their grading gains or losses, inaccurate grading may subsidize producers delivering lower quality grain at the expense of producers delivering higher quality grain.

Despite this direct influence on the marketing system, there has been little research on elevator grading accuracy. For this reason, the effect of grading inaccuracy on the marketing system needs to be assessed. Also, additional information on grading practices can improve an elevators blending, cleaning, and segregation strategies. Finally, producers need this information to determine the effect on production incentives.

Several factors emphasize the importance of studying elevator grading practices and marketing strategies, specifically the increasingly competitive wheat marketplace and the strong public policy interests in the area. The wheat marketplace is changing with substantial improvements in quality measurement technology, and there is heightened buyer attention to quality attributes (Barkema, Drabenscott, and Welch, 1991). Further emphasizing the need for the increased focus on wheat quality and interactions in the marketplace is the strong, long-term public policy interests in this area. Recently, the U.S. Congress, under the 1996 Farm Bill, enabled the Federal Grain Inspection Service (FGIS) to amend the grain grading system to match the quality standards of other exporting countries (Johnson and Wilson, 1995). One aspect of review for the FGIS is the mandatory cleaning of dockage before export. Other studies, such as, Mercier (1993) and Adam and Anderson (1992), indicate long term research and policy interests in this area.

Objectives

The general objective of this research is to examine the grading accuracy of country wheat elevators. In addition, the research will examine the quality of wheat delivered and the load by load variation in quality and its impact on elevator segregation strategies.

Specific Objectives:

1. Determine the grading factor and discount accuracy of Oklahoma wheat elevators compared to an official grading agency (Enid Grain Inspection Agency), and determine the economic impact of grading inaccuracy.

2. Determine the most profitable blending, cleaning, and marketing strategies for country elevators based upon the quality variation in the loads being delivered.

3. Determine the differences in grading practices between cooperative and investor owned elevators.

Overview of Thesis

To accomplish the first objective, actual elevator and official wheat harvest data will be used to determine differences between elevator and official estimates. Because elevators have the opportunity to blend and clean grains, a blending and cleaning model will be used to determine the true economic cost of grading inaccuracy. The blending and cleaning model also will be used to determine the most profitable segregation, blending, and cleaning strategies available for country elevators. Finally, the harvest data will be used to determine the differences in grading practices between cooperative and private elevators.

The assessment of elevator grading practices will indicate the costs of inaccurate grading to elevators and producers and help determine if improved grading practices are profitable alternatives for country elevators. The blending model will help improve marketing decisions by indicating the most profitable segregation, blending, and cleaning strategy available. Finally, information on differences between cooperative and investor owned elevators might help cooperative firms operate more efficiently.

The following is a brief overview of the subsequent chapters. Chapter 2, a review of the literature, shows the importance of grading accuracy historically, and demonstrates how improved grading accuracy can benefit U.S. wheat in the increasingly competitive world wheat market. The review also notes the importance of wheat quality, and how it can be improved through further conditioning (i.e. segregating, blending, and cleaning).

Chapter 3 describes the data used to determine the accuracy estimations, and the model simulations. Two years (1995 and 1996) of actual harvest time grain quality data that are based on over 3,000 tailgate truck samples at 24 cooperating elevators throughout Oklahoma wheat producing areas are used to determine elevator grading and pricing accuracy. This data includes elevator estimates of net weight, and elevator and official estimates of moisture, dockage, test weight, grade, shrunken and broken kernels, foreign material, damage, and total defects of the sample. The data are also used in the cleaning and blending model along with the required economic engineering estimates. The data, coupled with the economic engineering estimates, allow the cleaning and blending model to determine possible strategies that elevators can implement to respond to changing incentives and market conditions. Finally, data from the 1996 crop year is used to compare the differences in grading practices between cooperative and investor-owned elevators.

Chapter 4 describes the background, procedures, and results of the grading accuracy analysis. This study determines the grading factor and discount accuracy of Oklahoma wheat elevators compared to an official grading agency. Chapter 5 discusses the background, procedures, and results of the blending, cleaning, and marketing model. In this chapter the most profitable blending, cleaning, and marketing strategies are identified. Chapter 6 discusses the background, procedures, and results of the cooperative and investor-owned elevator grading accuracy comparison. This study determines the differences in grading practices between cooperative and investor-owned elevators.

Finally, chapter 7 presents a summary of the entire report, and emphasizes the need for further research on the grading and marketing practices of country elevators.

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of this chapter is to review the importance of grain grading accuracy and grain conditioning, and to determine how these affect country elevators, producers, and the quality of grain in the United States. In addition, it suggests that accurate grain grading and conditioning activities have the potential to improve the profitability of country elevators and strengthen the competitiveness of U.S. wheat. Finally, this chapter discusses the operating and marketing characteristics of grain elevators with comparisons between privates and cooperatives.

The review begins by discussing the role of quality in the grain market, emphasizing the need for improved quality in U.S. exports. It then discusses how uniform grades and standards can help improve the competitiveness of U.S. wheat. The review also describes price-quality relationships for grain, and addresses grading accuracy and other activities used to improve grain quality, beginning with segregating and blending, and then discussing the benefits and costs of cleaning wheat. Finally, the review addresses differences between the operating characteristics of cooperative and private elevators.

The Role of Quality

The role that quality plays in wheat markets is becoming an important issue as we move into the 21st century. In fact, Mercier (1993) states that unless the U.S. wheat sector continues to improve the cleanliness and quality of wheat, the United States may experience a decline in its share of the world wheat market. Wheat quality is becoming an increasingly important issue for importers, and many importing countries are increasing their quality requirements. When making decisions about wheat import sources, importers consider factors such as wheat quality, price, trade-service reliability, and political relationships. Specifically, Mercier states that the U.S. can stabilize or increase its market share by improving grain quality.

In her study of wheat quality, Mercier examined the market structure and import decision making process in 18 major wheat-importing countries. Of the 18 countries surveyed, quality was the most important decision making factor in Italy, South Korea, Venezuela, and Yemen. Quality was the second or third most important factor in 12 other countries.

Shultz (1996), in accordance with Mercier, states that 20% to 30% of the global grain market is purchasing imported wheat on the basis of intrinsic quality characteristics. Wheat contracts now incorporate into specifications characteristics such as protein, gluten quality, wheat hardness, sprout damage, and moisture content. A major factor affecting the increased concentration on quality is mechanization. Flour milling, once based on hand labor, is adding equipment to improve production efficiency. This equipment is less "forgiving" of variations in grain uniformity. This can pose a major problem when processors deal with lower quality grain.

These studies emphasize the need for improved quality in U.S. exports. A major problem that the U.S. faces is finding a way to measure and improve the quality of wheat produced. The primary way to communicate wheat quality through the marketing system is through a uniform and accurate grading system. The importance of a uniform grading system, along with the shortcomings of the current system, is discussed in the next section.

Importance of Uniform Grades and Standards

Farris (1960) states that uniform grades and standards serve several purposes, and have been credited for improving the operation of the grain marketing system. First, they exert their influence through increasing knowledge about the product. Usually, more knowledge increases price competition. Second, uniform grades and standards facilitate trading by making it easier to deal with quantities and qualities of a commodity more efficiently. Finally, they facilitate the performance of such marketing functions as financing, storage, and transportation.

Hill (1990), on the other hand, states that current grades and standards fail to perform any of these functions adequately. He cites the declining share of U.S. grain in the export market as evidence that the U.S. grading system needs improvement in its grading standards.

Hill also notes that in the past international grain markets were not as competitive, and the U.S. overlooked buyer complaints and obvious flaws in the grading system. In fact, in the early 1900s the grading system gave buyers little information about quality and did not provide incentives for producers and elevators to improve quality. However, the privatization of wheat markets, increases in process mechanization, buyer's increasingly stringent quality standards, and the decreased competitiveness of U.S. wheat have exposed the inability of the grading system to provide quality enhancing incentives to producers

Hill states that to remain competitive, the U.S. grain market must change. Hill provides several proposals that address this issue. Hill advocates that wheat grades must convey information about quality and should provide incentives to producers and others in the market to improve quality. Hill also suggests that the U.S. grain market should prohibit practices which are considered detrimental to quality, and change pricing policies so that participants are rewarded for improving quality and value. Hill concludes that grades should be based on economic values and relationships, and should provide incentives for improved quality.

Hill (1988) states that if grain grades were measured and recorded as accurately as measurement technology permits, the market would establish value, reward producers' efforts to improve quality, and eliminate incentives for diminishing value. Further, incentives to deliver the desired end product would render possible government intervention unnecessary, and would generate beneficial responses by those who control quality through their production decisions on the farm and through their marketing decisions at the elevator. Hill (1988) concludes that the price of grain through discounts and premiums would provide the primary incentives to producers to improve quality. The importance of this is emphasized in the next section on price-quality relationships for grain, especially in the discussion of the Hall and Rosenfield (1982) article.

Price-Quality Relationships for Grain

Hall and Rosenfield (1982) stated that specific price-quality characteristics of grain are a function of various economic elements. They formulated a theoretical model which stated that the economic relevance of grading schemes can be assessed by determining the relationship between the amount of an input characteristic in the grain (e.g. moisture, test weight) and a buyer's valuation of that input characteristic. They also developed an empirical model which determined that foreign material and damage were important economic factors that warranted discount pricing, while test weight was not a relevant economic factor in determining discount prices for grain.

While Hall and Rosenfield (1982) observed the economic relevance of grading schemes, Hill, Brophy, and Florkowski (1987) determined that producers actually respond to relevant schemes. They estimated a supply function to determine responses to price premiums for low temperature drying methods. They showed that producers are willing to invest in methods to improve corn quality even though it may take several years to recover the investment. The producer's age and the price premium were both significant factors in the producer's decision to purchase low-temperature dryers to generate higher quality corn. Hill, Brophy, and Florkowski (1987) concluded that not only must grading schemes be economically relevant, in addition they must also provide incentives to the producer.

Further, Hill, Brophy, Zhang, and Florkowski (1991) emphasized that producers not only respond to quality incentives, but also prefer a pricing system with quality based incentives. They conducted a survey of corn and soybean farmers in Illinois, Iowa, and Indiana to determine farmers' attitudes toward pricing strategies and discounts implemented by country elevators for different qualities of grain. The authors found that 61.4% of Illinois farmers, 68.3% of Iowa farmers, and 55.8% of Indiana farmers favor quality discounts and premiums for corn and soybeans.

These studies have emphasized the need for a relevant grading scheme for wheat that provides producers with incentives for improving grain quality. A relevant grading scheme is particularly important because recently the U.S. has come under criticism for exporting wheat of lower quality than other competitors such as Canada and Australia. One reason for this may be the grading system. For example, in the U.S. marketing system dockage is a non-grade determining factor. Because dockage is not a grade-determining factor in the U.S. wheat market, international competition serves as a regulatory mechanism (Wilson, Scherping, Johnson, and Cobia, 1992). However, international competitors such as Canada and Australia provide incentives to producers and guarantee minimum dockage levels in exports, therefore they have increased their market share in the world wheat market. Wheat buyers are paying Canada and Australia higher prices for higher quality wheat, and they are purchasing this wheat in higher quantities than ever before.

Wilson (1989) notes that this trend may continue. He states that price differentiation in the world wheat market has increased in the last 10-15 years, causing importers of wheat to provide implicit incentives for higher quality wheat. Therefore, as demand for improved quality in wheat rises, the importance of price differentials in wheat will rise. This implies that grading accuracy at country elevators will become an increasingly important issue in the future. The importance of grading accuracy is emphasized in the next section, beginning with the Farris (1958) article.

Grading Accuracy

Farris (1958) states that the wheat market is generally viewed as one of the best examples of a pricing system under perfect competition. This applies not only to the futures market but also to other stages of the marketing channel. To evaluate the performance of the wheat marketing system, Farris analyzed the pricing process for soft red winter wheat at the country elevator level in Indiana, focusing on elevator paying prices in two areas in Indiana. Farris determined the grade and price discount difference between an elevator and an official laboratory estimate for the same sample. Farris observed that there are substantial departures from perfect competition, and several imperfections are serious. Farris (1958) determined that due to an elevator's inability to grade wheat accurately, producers do not receive incentives to improve quality, producers who deliver lower quality grain are subsidized at the expense of other producers, and an elevator's net handling margin will decrease. As a result, this reduces the effectiveness of the pricing system for wheat at the country elevator level. Finally, the author concludes that there is considerable room for increasing the effectiveness of the pricing system for wheat at the country elevator level through more accuracy in grading and price discounting.

Further, Kiser and Frey (1990) suggested that elevators try to grade accurately, but use improper procedures when grading. The authors conducted a survey to determine how many Kansas elevators measure for dockage, what methods were being used to measure dockage, and the percentage level of dockage being used to adjust the quantity of wheat purchased. The authors indicated that most Kansas elevators measure for dockage, but few used a Carter-Dockage Tester. Most elevators used a simple inadequate method to simulate the official measurement of dockage. Finally, few elevator operators adjusted the quantity of wheat purchased based on the level of dockage in the sample. This procedure often resulted in elevators inaccurately estimating the amount of dockage in the wheat.

Gunn and Wilson (1986) confirmed the conclusion of previous studies that elevators generally grade wheat inaccurately. The authors studied the grading and pricing practices of North Dakota country elevators for durum and hard red spring wheat. They interviewed 77 country elevators to compare their grading practices with an official agency (FGIS). The authors found that elevator managers skipped several grading steps to save time and money, and the only factor that was priced on a consistent basis was wheat protein.

These previous studies (Farris (1958); Kiser and Frey (1990); and Gunn and Wilson (1986)) show that many elevators may grade inaccurately. There is obviously considerable room for improved grading practices, thereby increasing the effectiveness of the wheat grading system. Increasing grading accuracy also will improve an elevator's determination of grain quality which will affect other marketing activities such as segregation, blending, and cleaning. Segregation and blending are discussed in the next section.

Segregating and Blending Benefits

Elevators usually segregate wheat received to facilitate their stored grain management and to increase their wheat sales revenue through improving their cleaning and blending operations. Grain segregation can increase the efficiency of grain cleaning operations by limiting the number of bushels which must be run through the cleaner. Segregation and blending strategies also are interrelated since the advantages of blending can only be obtained if bins of grain with the desired quality differences exist.

Blending wheat is another marketing alternative that elevators use to meet buyers' minimum contract specifications, thereby improving quality. Since the wheat grading system is based on a threshold approach, not all grade factors bind wheat to a lower quality grade. Blending wheat can be used to raise the numerical grade of a bin of wheat. For example, assume that an elevator segregates grade #3 wheat into two bins, where bin 1 has a low test weight level that binds it to a #3 grade. Assuming bin 2 has a higher test weight level, blending the two bins could raise the test weight level in bin 1 and raise bin 1's numerical grade to #2. This example shows segregating and blending can be used to make lower quality wheat meet a buyer's contract specification and receive a higher contract price.

Emphasizing the importance of blending activities, Hill (1988) likewise observed that blending may provide elevators with increased revenue and may increase wheat quality. He notes that grain will earn a higher quality grade, therefore earning a higher price, if grain characterized by high moisture, damage, and foreign material is blended with higher quality grain.

Another important quality enhancing activity that can be coupled with segregating and blending wheat is cleaning. Cleaning benefits and costs are described in the next section.

Cleaning Benefits and Costs

Grain cleaning also can be a quality related marketing strategy employed by country elevators. Grain cleaning is generally used to lower the percentage of dockage in the wheat. However, small amounts of good wheat are also lost during the cleaning and handling process. Benefits to the elevator from cleaning wheat include the reduction in the cost of transporting dockage, reducing or eliminating price discounts for dockage, and the feed value of the screenings which are separated during the cleaning process. In addition to the fixed investment costs of cleaning equipment, variable cleaning costs include electricity, and the value of marketable material (good wheat, SBK and FM) which is removed during the cleaning process.

The type of cleaner used depends upon the composition of the dockage. Materials that are substantially larger or smaller than wheat can be easily separated from wheat by screen type cleaners or combination screen aspirators. Materials which are similar in size to wheat, but have different aerodynamic properties can be separated with an aspirator cleaner or by combination screen aspirator cleaners.

Several studies have emphasized the importance of using cleaning activities to reduce dockage levels and improve grain quality. Johnson and Wilson (1995) determined that dockage is one of many quality attributes that have affected the competitiveness of U.S. wheat in international trade. While Canada and Australia monitor the amount of dockage in their wheat exports, the U.S. does not. As mentioned previously, dockage is a non-grade determining factor in the U.S. grading system. The result of this policy is that many importing countries find that the dockage level of U.S. wheat is higher than that of other exporters. This dockage decreases the amount of U.S. wheat bought by the importer.

To find ways to increase the competitiveness of U.S. wheat, Adam and Anderson (1992) looked at the marginal benefits and costs of cleaning wheat before export. The authors used an economic engineering approach to develop the costs of cleaning wheat. This study was also the first study to include the good wheat lost during the cleaning process as a cost of cleaning. The authors concluded, that in the absence of price discounts, tranportation and handling savings were insufficient to warrant cleaning before export.

Another cleaning study by Johnson and Wilson (1995) developed a method to determine and assess the impacts of critical variables on the demand for cleaner wheat exported from the United States. The results determined the "optimal" dockage level in U.S. shipments to various importers. Data were used from two countries for purposes of illustrating the trade-offs and differences in optimal solutions. The authors concluded that intensive cleaning before export must be competitive with the marginal cleaning costs and sale of screenings at the importing country. Since these factors vary across importing countries, the authors concluded that it is impossible to determine how trade volumes would react to regulated reductions in wheat dockage.

Kiser (1992), on the other hand, looked at cleaning costs at individual elevators rather than using Johnson and Wilson's (1995) country level approach. Kiser sampled wheat at 12 different Kansas elevators that utilized an aspirator cleaner. He sampled wheat just before entering the cleaning process and again upon exiting the cleaner. The author compared these before and after samples to determine the marginal benefit from cleaning wheat compared to the marginal costs of cleaning.

Kiser (1992) concluded that smaller elevator operations usually are not able to clean wheat to improve profitability. Only in years when the wheat crop contained higher levels of nonwheat material was it profitable to clean wheat.

Expanding the focus of Kiser's (1992) study, Scherping, Cobia, Johnson, and Wilson (1992) documented dockage levels at various stages in the marketing system, described merchandising practices that influence dockage levels, derived economic-engineering cleaning cost estimates, and presented cleaning costs at country and export elevators for durum, hard red spring, and white wheat. They concluded that dockage levels are higher for durum and hard red spring wheat. Also, if dockage is above 1%, country elevators generally will clean wheat at costs ranging from \$.39/bu to \$.081/bu. The benefits that these elevators receive from cleaning are transportation savings of \$.024/bu (transportation cost of \$.60/bu) and revenues from the sales of screenings of \$.048/bu (screening values of \$40/ton). Based on these estimates, the authors conclude that cleaning wheat is feasible in areas with high dockage levels.

Contrary to the Scherping, Cobia, Johnson, and Wilson (1992) article, Hyberg et al. (1993), citing previous studies, concluded that cleaning wheat is not feasible for the wheat industry. They examined the economics of cleaning wheat, and concluded that the costs of cleaning wheat exceed the domestic benefits resulting in a net cost that must be borne by the industry. The authors state that mandatory cleaning would cost the industry $23 million that would be distributed between farmers, millers, elevator operators, and importers.

Cooperative and Investor Owned Elevator Comparisons

Because cooperatives market approximately 55 percent of the wheat in the Southern Plains, the impact of an organizational type on grading and quality related strategies is of interest. In fact, the differences in the marketing, operating, and governance structure between investor owned and cooperative elevators have long been recognized. The first comparison that most authors make is the difference in the marketing environment that cooperative elevators face.

Reed (1984) conducted a survey of grain handling firms in the Cornbelt and Southeast to determine the environmental and intrafirm differences between cooperative and private elevators. Reed determined that, on average, cooperative elevators had a larger storage capacity and had a lower turnover rate than investor owned elevators. Reed also states that private elevators are more likely to allow managers to set bid prices, while cooperates are less likely to allow their managers that discretion due to the democratic nature of a cooperative's decisions.

Vercammen, Fulton, and Hyde (1996) state that due to the democratic nature of a cooperative's decisions, pricing and grading decisions can become controversial in a cooperative. Casual conversations with growers suggest that most growers expect their cooperative to accept delivery of their wheat regardless of quality or condition. Cooperative managers are often reluctant to stringently apply discounts to their farmer members. Because grading and quality practices affect the returns of the cooperative's farmer members either directly (as in the case of discounts and premiums) or indirectly (as in the case of the costs of cleaning, segregating and blending) they can become politically important issues among the cooperative's membership (Vercammen, Fulton, and Hyde, 1996).

Fulton and Vercammen (1995) addressed the political nature of cooperative decision making in the context of profit distribution. The authors stated that since each member has a vote in a cooperative, the majority rule is often used. Therefore, the authors used the median voter theory to predict how members as a whole will vote on pricing strategies and production contracts. The authors concluded that equity and fairness will influence cooperative behavior if members consider these items important.

Many authors also state that cooperatives may develop pricing strategies with respect to equity and fairness issues. In fact, the impact of pricing strategies with respect to cooperative business volume, profitability and membership reaction has long been recognized. Vercammen, Fulton, and Hyde (1996) examined the impact of differential pricing (volume discounts) on cooperative profitability. The authors concluded that differential pricing would improve cooperative profitability but is often difficult to implement due to the democratic governance of the cooperative. Nubern and Kilmer examined cooperative differential pricing systems based on spatial differences (transportation costs). They determined that nondiscriminatory pricing strategies reduce a cooperative's cost, but may have detrimental impacts on individual producers. Cobia and Coon (1986) examined the use of differential prices in durum wheat cooperatives. The authors concluded that differential pricing helped these grain cooperatives maintain volume and reduce costs, while cooperatives that did not use differential pricing may lose some of their highest volume patrons to higher paying competitors.

However, the impact of grading practices and quality discounts of grain cooperatives and their members has not been researched extensively. A 1993 national survey of grain elevators concluded that cooperatives were less likely than independent elevators to refuse to accept inferior (insect infested) grain. Twenty percent of cooperative elevators indicated that their policy was to refuse to accept insect infested farm stored grain as opposed to thirty-three percent of independent elevators (Kenkel, 1993).

Summary

This review has shown that academic observers and the grain industry have documented the importance of grain quality. The importance of grain quality has become more pronounced as the U.S. share of the global wheat market has declined. One reason for this decline is the increasing quality requirements of importing countries.

The review mentioned several ways to improve grain quality. One method to improve grain quality is to increase the accuracy of an elevator's grading practices. Grading accuracy is important because an elevator's estimate of quality and price provides an important signal to the rest of the marketing channel. Likewise, an elevator's estimate communicates important quality enhancing incentives from the world wheat market to producers. Therefore, the accuracy of an elevator's grading practices holds important implications for the quality of grain produced in the U.S.

Segregating, blending and cleaning wheat are methods to improve grain quality. However, the benefits of these activities must be weighed against the costs to determine if these are feasible methods to improve quality. Also, the benefits and costs of these activities may change depending on the quality of wheat produced in a harvest year (Kiser, 1992).

This research attempts to increase the pricing efficiency in wheat markets by determining the accuracy of elevator grading practices compared to an official agency (FGIS). Several studies have suggested that elevators may grade some quality characteristics inaccurately. However, no previous research has estimated the effect that inaccurate grading has on the net handling margin of the elevator and on quality incentives to the producer. Also, the results of this study will help to identify ways to improve grading accuracy, thereby increasing the efficiency of the grain marketing system.

Since segregation, blending, and cleaning can be used to increase the quality of wheat, this research will also attempt to determine the most profitable conditioning strategies for an elevator. This research explicitly examines the tradeoff between the costs and benefits of cleaning wheat at a country elevator. If the benefits of cleaning exceed the costs, these strategies will provide elevators with methods to improve the cleanliness and quality of U.S. wheat.

CHAPTER III

WHEAT QUALITY FACTORS, WHEAT GRADING SYSTEM, AND DATA

Introduction

The purpose of this chapter is to describe the wheat quality factors, wheat grading system, and the data used to determine the accuracy estimations. The economic engineering estimates used in the blending, cleaning, and marketing model are also discussed.

This chapter begins by discussing the three major dimensions of wheat quality (physical condition, intrinsic characteristics, and uniformity). It then discusses the wheat grading system, and specifically discusses the grade and non-grade factors that measure wheat quality. The chapter then describes the wheat harvest quality data used for the grading accuracy estimations and model simulations, and discusses the overall quality of each harvest year based upon the wheat quality data collected. Finally, the chapter describes the economic engineering estimates used in the cleaning and blending model.

Wheat Quality Factors

There are three dimensions of wheat quality: 1) physical condition, including purity and soundness, 2) intrinsic characteristics, and 3) uniformity. These characteristics affect the performance of wheat in terms of its processing and end-use properties (Hill, 1988).

Purity measures the amount of dockage, foreign material and other aspects of wheat's wholesomeness, including pesticide residue, live insects, and toxic weed seeds. Soundness measures defects, including damaged kernels and shrunken and broken kernels. Test weight and moisture content are also included as measures of soundness because test weight provides an indication of likely milling yields and the moisture content affects wheat's storability. Damaged kernels are also correlated with lower milling yields (Hill, 1988).

Intrinsic characteristics are the biochemical and structural properties inherent in the wheat. Important intrinsic characteristics for wheat include protein content, gluten quality, hardness, color, fat acidity, crude fiber and ash. Measuring these intrinsic characteristics of wheat can be difficult and time consuming. Requirements for intrinsic attributes differ by end-use. For example, baking properties of flour could be affected by gluten qualities even when the protein content is the same (Hill, 1988). U.S. grade standards do not measure intrinsic properties directly, but kernel soundness measures are weakly correlated with intrinsic properties. Protein measurement can be included on official grading certificates at the request of the buyer or seller.

Uniformity refers to the degree of variation in wheat quality within a shipment and between shipments. Fine materials in bulk grain naturally segregate during shipment by moving to the bottom-middle of the grain vessel. When discharged, the cargo is rarely re-blended into separate sub-lots for each buyer. Lack of uniformity frequently is a source of disputes because different buyers can own wheat in one shipment. Variation in wheat quality between shipments can cause disruption to buyers' milling operations. Blending or mixing wheat varieties also affects uniformity. In general, the larger the number of wheat varieties, the less uniform the quality (Hill, 1988). Uniformity is not directly measured in the U.S. grading system. However, buyers can increase the uniformity of their wheat purchases by imposing tight specifications and discounts for each soundness measure included in the U.S. grading system.

Wheat Grading System

Hard red winter wheat (HRW) in the United States is graded based on the physical quality characteristics outlined in the Official U.S. Standards for Grain (FGIS 1997). Grades are based on test weight (a measure of density), and the percentages of shrunken and broken kernels (SBK), foreign material (FM), damaged kernels (DM), total defects (the sum of SBK, FM and DM) and the percentage of wheat of contrasting classes. Nongrade determining factors include dockage and moisture. There are five numerical grades of HRW, with grade #1 representing the highest quality. To obtain a particular grade, wheat must exceed the minimum standards for each grade factor. Wheat which does not meet the minimum grade standards for #5 HRW is designated U.S. Sample Grade and must be channeled to non-food usage.

Physical separations and measurements are used to determine test weight and the percentage of shrunken and broken kernels. Grade quality factors made on the basis of visual inspection include the determination of the percentage of foreign material, damaged kernels, and wheat of contrasting classes. Dockage and moisture measurements are mandatory non-grade factors which are reported on the official grain certificate but do not impact the grade. Dockage is determined by mechanical separation while moisture determination is determined with an approved electronic moisture tester. The percentage of protein also can be included on the grade certificate as an optional non-grade quality factor.

In the U.S. grain marketing system, wheat is typically graded at the country elevator by a licensed grader employed by the elevator. Official grades are generally obtained on lots of grain sold by the country elevator to the sub-terminal elevators, terminal elevators, exporters, or food processors. The country elevator grader has the discretion to consider a sub-set of the grade factors but must list the grade and factors used to determine the grade on the producer's scale ticket. Because grain must meet the minimum standards for each grade factor, bypassing one or more grading steps can lead to over-estimating the actual grade. Elevators, which overestimate the quality of the grain either by inaccurate grading, must absorb the loss when the grain is subsequently marketed based on official grade inspection. Inaccurate grading also can lead to inequitable compensation for producers, and can interfere with the market's role in providing incentives to the producer for quality related production and harvesting decisions.

Wheat Quality Data

The data that were used in the study were based on over 3,000 tail-gate truck samples at 24 cooperating elevators throughout the Oklahoma wheat producing areas. The sampling sites were carefully selected to represent all of the major wheat producing areas and to include elevators with trade territories that extended into Texas and Kansas. The information obtained on grain quality and elevator grading, management and marketing practices represented the Southern Plains wheat producing region (Texas, Oklahoma, and Kansas).

Samples were collected at each of the participating elevators at or near the peak of the 1995 and 1996 wheat harvests. The samples were obtained using the truck (tailgate) sampling procedures recommended by the Federal Grain Inspection Service (FGIS). Four to six sub-samples (cuts across the flowing grain stream) were obtained from each truck. The sampling procedure was to pull the truck sampling container through the entire falling grain stream in a continuous motion. The sub-samples were taken at random intervals throughout the dumping process. They were then combined to provide a 1,200 to 1,500 gram sample for each truck. Each sample was identified by scale ticket number and stored in a sealed container. Complete scale ticket data were obtained for each sample. This data included elevator estimates of net weight, moisture, dockage, test weight, grade, shrunken and broken kernels, foreign material, damage, and total defects of the sample. A producer identification code was also included in each sample that preserved the confidentiality of the grade data and identified which samples had been provided by the same producer. After the samples were taken from each location, the samples were taken to the official grain inspection station in Enid, Oklahoma. Tickets were put in each sample so that we would be able to match the scale tickets with the official grades.

The previously described sampling procedure (continuous tailgate samples) was selected because it was the most representative of the total quality of the load and because it did not interfere with or influence the elevators sampling and grading procedures. The design was also palatable to the producers delivering wheat since their price had already been determined prior to the research samples. Because the grades used in the study were based on separate samples, the study design simultaneously tested the relevancy of the elevators sampling procedure and its grading accuracy. This makes it impossible to determine if the elevator's tendency to underestimate undesirable factors resulted from sampling procedures or from grading procedures. To partially address this issue, the 1996 study included a parallel set of probe samples which were also officially graded on approximately 10 loads at each elevator. The purpose of these supplementary samples was to determine if the type of sampling method (tailgate versus probe) affected the dockage and grade quality estimates.

Overall Wheat Quality

The average quality of the loads sampled during the 1995 and 1996 studies is provided in Table 3.1. The 1995 wheat crop experienced fairly wet conditions that resulted in fairly high levels of dockage (3.85%), shrunken and broken kernels (1.64%), foreign material (0.38%), and damage (0.44%). The 1996 harvest followed an extremely dry production situation which resulted in low yields, low levels of dockage and foreign material and abnormally high levels of protein. Test weights in both years were below average.

The dockage and grade factor distributions for each year are provided in Figure 3.1 through Figure 3.5. Examining grade quality factors is potentially important for several reasons:

(1) In the case of undesirable grade factors, the distributions provide some instances when the minority of the loads delivered account for the majority of the undesirable grain.

(2) The distributions may provide an understanding of the variation of quality in the loads being delivered, and an understanding of the effectiveness of segregation strategies.

(3) The shift in the distributions between crop years provides insight as to the extent that grading and segregation strategies may need to be re-examined with each crop year.

Figure 3.1 shows the grade distribution of the loads in both years. The distribution of grades was skewed right (right tail is longer than left tail, and mean is greater than the median and mode) in both years. This figure reflects the instance when relatively small changes in a grade quality factor may have a large impact on the grade distribution. For example, in both years the average test weight was close to the 58 lb./bu. threshold for #2 wheat. Due to this, most of the loads delivered were U.S. grade #2 or #3. The test weight distribution is shown in Figure 3.2. As this figure indicates, the observed test weights were more normally distributed around an average of 57.75 lb/bu. and 58.34 lb/bu. in 1995 and 1996, respectively. Figure 3.3 provides the distribution of dockage of the loads which was skewed right in both years. While most of the loads delivered had below one percent dockage levels, the subset of loads with high dockage levels significantly raised the average dockage levels.

The protein distribution, which showed the most interesting distributions, is shown in Figure 3.4. As this figure indicates, the distribution in 1995 was more normally distributed around a mean of 12.42%, while the distribution in 1996 was skewed left around a mean of 14.04%. The reason for the disparity in distribution between 1995 and 1996 can be explained by the difference in growing conditions in these years. Protein is usually higher in years characterized by dry growing conditions (i.e. 1996), and is inversely related to yield. These year to year changes in both the average protein level and the distribution of loads around the average may be important to elevator operators who are designing strategies to segregate and market grain based on protein. As Figure 3.5 indicates, the shrunken and broken distribution in both years was skewed right around a mean of 1.64% and 1.91% in 1995 and 1996, respectively.

Grain Cleaning Economic Engineering Estimates

The economic engineering estimates used in the model were taken from several studies. Estimates from Kiser (1992) and Adam and Anderson (1992) were used as a basis for the cleaning and blending model parameters. Parameters from Scherping et al. (1992) also were considered.

Kiser developed economic engineering estimates by sampling aspirator and screen/aspirator cleaners at 12 Kansas country elevators. These estimates of the change in characteristics (dockage, FM, SBK) from the cleaning process are located in Table 3.2. Also, Adam and Anderson calculated economic engineering estimates for 13 types of common cleaning machines. Their estimates focused on the reduction in dockage and generated similar estimates (approximately 60% reduction in dockage). Scherping et. al surveyed cleaner manufacturers and generated engineering estimates for 14 types of cleaners. He obtained estimates of the operating capacity that could be obtained at various levels of beginning and ending dockage. The manufacturers indicated that aspirator type cleaners could operate at 80%-100% of maximum capacity when reducing dockage from 3% to 1% (67% reduction).

Another important factor of cleaning efficiency is the amount of good wheat lost during cleaning and handling. Adam and Anderson developed scientific estimates of wheat lost during the cleaning process by sampling wheat screenings at commercial elevators. They estimated that approximately .4% of good wheat is lost in cleaning to a 1% final dockage level. Scherping et. al surveyed elevator managers and cleaner manufacturers and obtained similar estimates. The composite estimate of good wheat lost ranged from .1 at 1% final dockage to 1% at .1% final dockage.

The economic engineering estimates used in the cleaning model include Kiser's estimation of an aspirator's cleaning efficiency (Table 1), and a wheat loss estimate of .4% as calculated by Adam and Anderson. Other estimates from Adam and Anderson include transportation costs of 4.8 cents/bushel/mile assuming 100 miles of transportation on average, labor and electricity costs of .4 cents per bushel, and the value of cleanings sold of 2 cents per pound.

Table 3.1 Wheat Quality of Sampled Loads (1995-1996)

Year	Test Weight	Dockage	SBK	Foreign Material	Damage	Total Defects	Protein
1995	57.75 lb/bu.	3.85%	1.64%	.38%	.44%	2.44%	12.42%
1996	58.34 lb/bu.	.97%	1.91%	.08%	.05%	2.04%	14.04%

Table 3.2 Estimates of Cleaning Efficiency: Percentage Model

Characteristic	Percentage Change in the Characteristic	R-Squared
Dockage	-66.8%	0.91
Foreign Material	-39.7%	0.41
Shrunken & Broken Kernels	-19.2%	0.21
Factors significant at the 1% level		

* Taken from Kiser's "Removing Nonwheat Material From Kansas Wheat" p. 22

Figure 3.1
Grade Distribution
For 1995 and 1996 Wheat Harvests

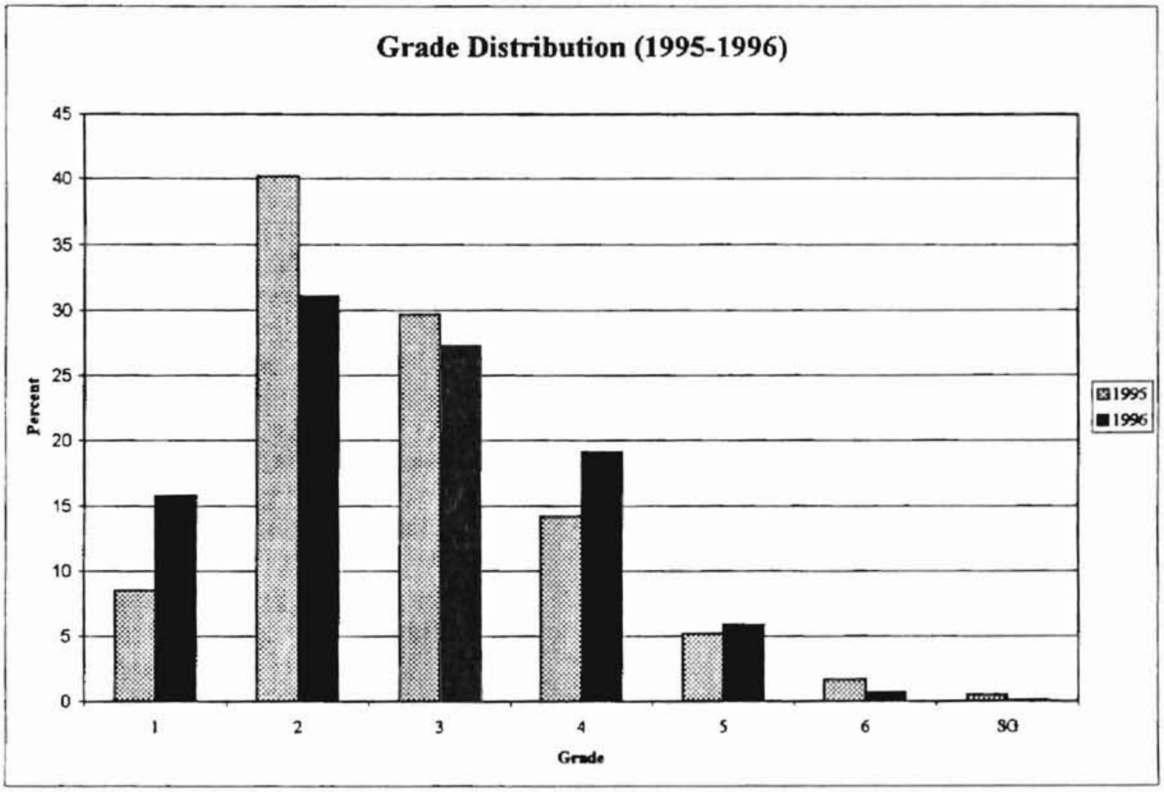


Figure 3.2
Test Weight Distribution
For 1995 and 1996 Wheat Harvests

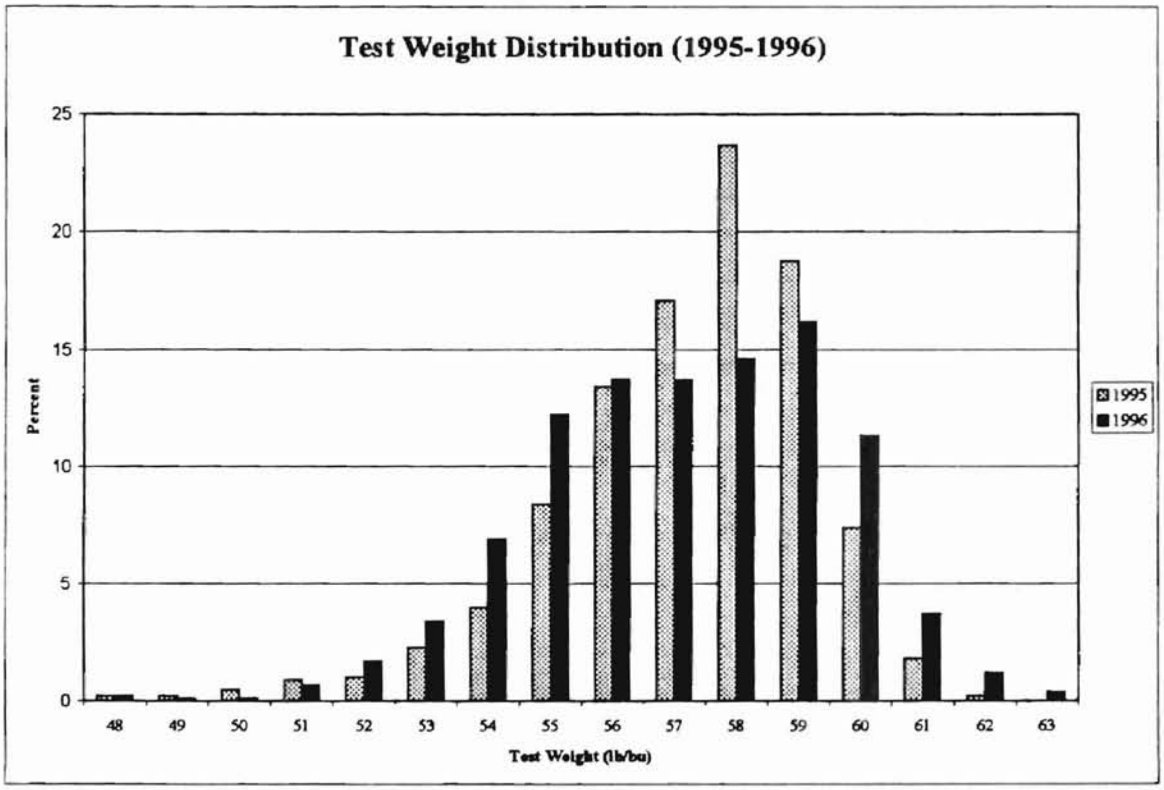


Figure 3.3
Dockage Distribution
For 1995 and 1996 Wheat Harvests

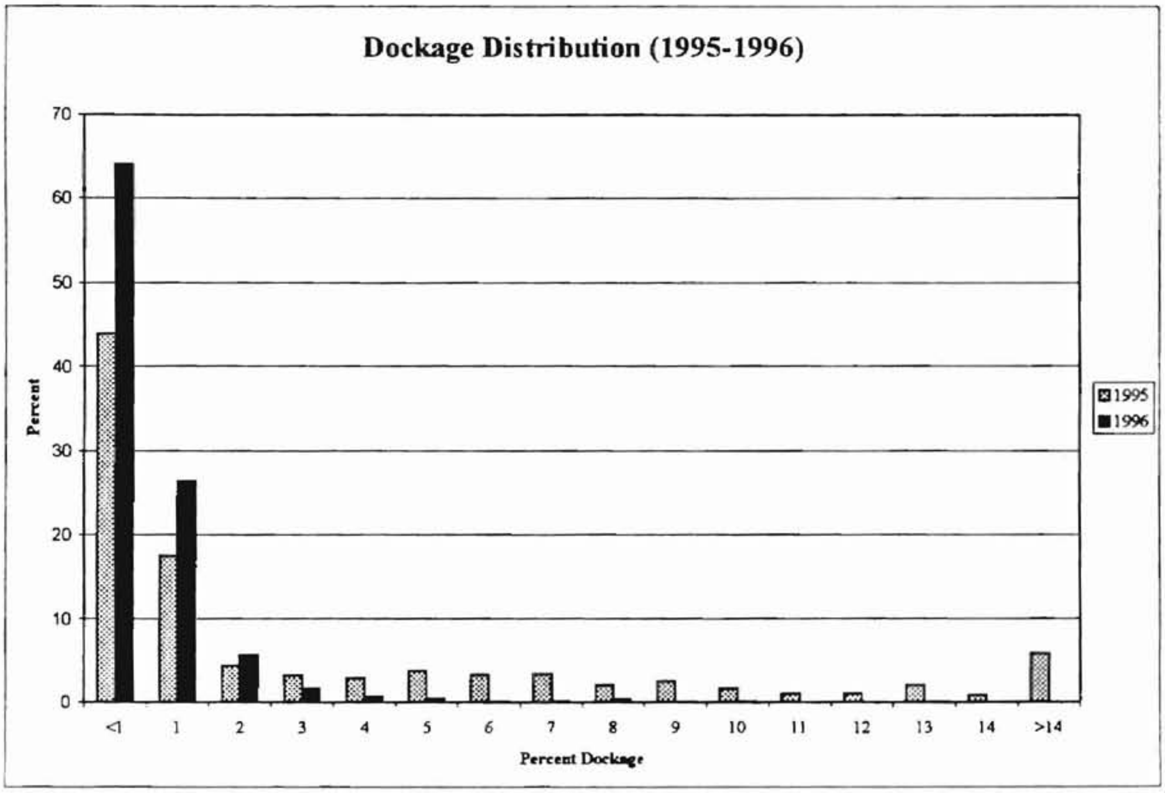


Figure 3.4
Protein Distribution
For 1995 and 1996 Wheat Harvests

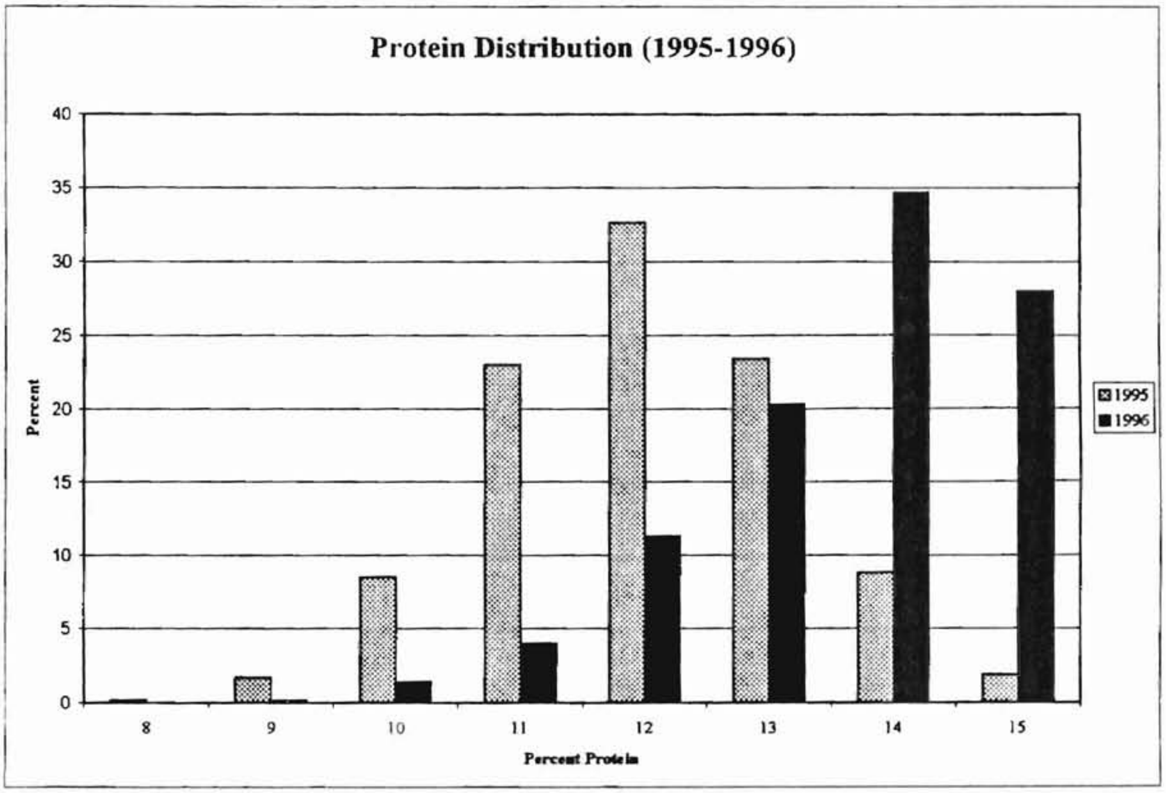
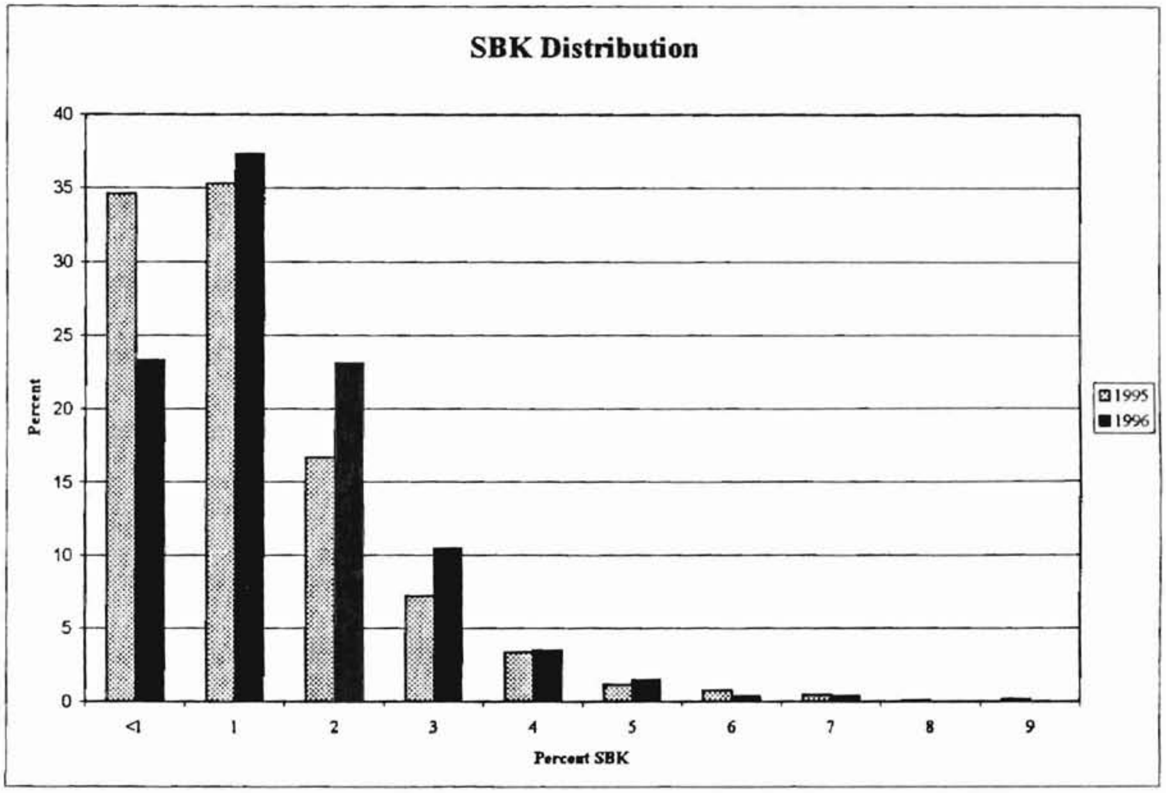


Figure 3.5
Shrunken and Broken Distribution
For 1995 and 1996 Wheat Harvests



CHAPTER IV

GRAIN QUALITY MEASUREMENT AND GRADING ACCURACY AT COUNTRY WHEAT ELEVATORS

Introduction

Each year close to $10 billion of wheat rolls off the combines throughout the U.S. and a substantial portion is marketed through country elevators. The performance and functioning of these country elevators is a vital intermediary between the producer and end-user. One area of particular importance in recent years is the area of grain quality. Wheat quality varies considerably due to variety selection, management decisions and the production environment. There is also extensive diversity in end uses for wheat and a wide range of preferred quality characteristics.

In the wheat marketing system, elevators play an important role in communication, physical sorting and blending by serving as a key link between the producer and the desired quality needs of the end-user. The wheat marketing system is based on a system of grades and standards which traces back to the United States Grain Standards Act of 1916. The grading system is designed to (1) facilitate an efficient marketing system and (2) ensure fairness and equity in the marketplace. In the U.S. wheat marketing system, the initial grading process is undertaken by the agribusinesses (country elevators) first receiving the grain. Transactions at subsequent stages of the marketing system are generally based on official grades from the federal grain inspection service (FGIS) or licensed official agencies.

Recent issues and long term trends in the domestic and foreign wheat markets further emphasize the importance of grading accuracy. The U.S. has experienced significant losses in its world wheat market share over the last 10-15 years (Mercier, 1993). A study by the Office of Technology Assessment (U.S. Congress, 1989) attributed this decline to increased competition in world wheat markets and the increased focus on wheat quality by many importing countries. Wheat importing countries such as Japan, the Philippines, and Taiwan are beginning to apply strict penalties for certain quality factors that are below a specified level. Specifications on kernel size, protein, wet gluten, extraction, falling number, and farinograph stability have been added to most export wheat contracts during the last ten years (Kenkel, 1997). Market privatization, increased technical sophistication of the buyers, and improved testing technologies have all contributed to this increased focus on wheat quality (Shultz, 1996). Processing mechanization is also a factor. Both domestic and foreign flour millers are now adding equipment to improve production efficiency. This equipment is less forgiving of variations in grain uniformity (Shultz, 1996).

The objective of this research is to analyze the accuracy of grading practices at country wheat elevators and the resulting economic impacts on the producers and elevators. Other aspects of this study examine: (1) the results from supplemental probe samples, (2) the differential impacts of current grading practices on producers delivering different qualities of grain, (3) the effect of automatic sampling and grading equipment on grading accuracy, and (4) the economic impact of skipping grading steps. The results provide important implications on the pricing efficiency of the wheat marketing system and on the degree to which quality related incentives are being communicated to the producer.

Methods and Procedures

Elevator grading accuracy was determined by compiling all of the elevator grade data from the scale tickets and comparing the dockage and grade factor estimates with the results from the official grade analysis on the same samples. A paired difference test was used to determine elevator grading accuracy, and to determine if the elevator estimates of the dockage and grade factors were significantly different from the official estimates. The paired difference test involved subtracting the elevator grade and discount estimates from the official estimate for each observation (truckload).

To estimate the economic impact of the elevator grading inaccuracy, discount schedules were obtained from Oklahoma and regional terminal elevators for the 1995 and 1996 crop years. Quality factor discounts were computed for each load of wheat based on both the elevator grader estimates and the official grade analysis. The difference in discounts indicated an elevator's loss or gain caused by grading inaccurately. This economic impact assumed country elevators transferred discount gains and losses directly to producers.

To determine the extent to which grading inaccuracies were the result of elevator grading procedures rather than sampling method, supplemental probe samples were collected at each elevator in addition to the continuous tailgate samples. These samples were officially graded and compared to the elevator grades using a paired difference test.

Determining the equity of current elevator grading practices required sorting the 1995 and 1996 wheat harvest data by dockage levels, and placing each load into one of four dockage categories. These categories related to the percentage of dockage that was recorded for each producer truckload. Then an elevator and official quartile estimate of the dockage discount was determined using the scale ticket data. The difference between the official and elevator discount was determined for each quartile, and a gain or loss was computed for each quartile. This indicated how much Oklahoma elevator grading practices distorted market incentives by subsidizing producers delivering high dockage wheat at the expense of low dockage producers.

To determine the impact of automated grading technologies, information on how each elevator probed a truckload of wheat and separated dockage from that same truckload were compiled. For example, each elevator sampled during the 1995 and 1996 wheat harvests either used manual or automated probing and separating procedures. During the sampling process, each elevator was given an identification code that indicated the type of procedures used by that elevator. To determine if the adoption of automated grading technologies appear to be cost effective alternatives for country elevators, the scale ticket data was sorted by type of practice used. Then a paired difference test was used to compare the grading practice and official wheat characteristic and discount averages. The paired difference test determined if the means of each grading practice were significantly different from the others, and indicated which practice was more accurate for each wheat characteristic. The resulting measure of the costs of grading inaccuracy for each category reflected the benefit of technology in reducing grading inaccuracy

Finally, determining the economic impact of each grade factor required the summation of the average factor discount and the grade effect if an elevator grader overlooked the factor step. The grade effect represented the cost associated with skipping a grading step that would have bound the wheat to a lower numerical grade. This information is important to elevator managers who must weigh the value of each grading step in reducing grading inaccuracy with the labor costs involved.

Results

Grading Results

In each year, elevators tended to underestimate both the amount of dockage and the undesirable grade factors such as the percentage of damaged kernels, shrunken and broken kernels, and foreign material (Tables 4.1 and 4.2). Also, the elevators tended to overestimate test weight. All of the differences between the elevator and official quality factors were statistically significant at the 95% significance level except for the moisture measurements.

Cheat seeds (also called chess) were the largest cause of dockage in the 1995 samples. Separating cheat from a wheat sample was a time consuming practice, particularly when hand-panning methods were used. The elevators that used mechanical dockage machines were less likely to underestimate dockage, suggesting that the difficulty of removing dockage with hand pans was partially responsible for the elevator's underestimation. Observation of the elevator grading techniques suggested that the tendency to underestimate shrunken and broken kernels, damage and foreign material was due to the elevator graders skipping these grading steps on some or all of the samples. Most of the elevators appeared to hand-pick samples for foreign material and damaged kernels only when problems were evident in the overall sample.

Grading Distribution

In general, participating elevators assigned a higher quality (lower numerical) grade to the grain relative to the official results. Mis-estimating the individual grade factors did not always result in a discrepancy between the official and elevator grades, because the particular factor may not have been the limiting grade factor. In 1995, the elevators assigned a higher quality grade than the official agency for 39% of the samples. The same pattern is also evident in 1996. Because the test weight of many of the loads delivered during 1996 was close to the 60 lb./bu. minimum for U.S. #1 wheat, the elevator's tendency to slightly over-estimate test weight often resulted in the elevator assigning a U.S. #1 grade designation for wheat which officially graded U.S. #2. The elevator graders' tendency to by-pass examination for damage and foreign material also led them to underestimate the percentage of samples in the lower grades.

Frequency of Over-Estimation and Under-Estimation

An analysis of the number of times the elevators over or under estimated each grade quality factor for each year is presented in Tables 4.3 and 4.4. The elevator and official graders reached the same grade determination on slightly less than half of the samples. However, the elevator and official estimates of the individual grade and quality factors agreed (were within + or - 10%) on less than 10% of the samples. In 1995, the elevator graders on average under-estimated the undesirable quality factors in over 1,000 of the 1,300 samples. In 1996, the graders under-estimated the undesirable factors in over 580 of the 1370 samples.

High Dockage Implications

The 1995 Oklahoma wheat crop had average dockage levels (4%) that were above the typical dockage level of .5 to 1%. Higher levels of dockage can cause a greater level of grading error when hand-panning techniques are used due to the difficulty of separating all of the dockage from the wheat sample.

Supplemental Probe Samples

As noted earlier, the grading accuracy samples were based on continuous tailgate sampling as the trucks unloaded. A comparison of the official grades from the official probe sample, elevator probe sample, and tailgate truck sample is provided in Table 4.5. The results indicated the same basic pattern as those obtained from the tailgate samples. The elevator grades indicated statistically significantly lower levels of dockage, shrunken and broken kernels, foreign material, and damage relative to the official grades. The elevator grades also slightly overestimated test weight, however, the test weight differences were not statistically significant (due in part to the smaller sample size). These results suggested that much of the difference between the elevator and official grade results was due to elevator grading procedures rather than their sampling procedures.

Economic Impact of Grading Difference

The dollar value that a producer received for a load of wheat is determined by the net weight, elevator's estimate of dockage (which is removed from weight), the market price and the price discounts for overall grade and the individual grade factors including dockage. When the country elevator sells grain to a terminal elevator or export buyer an official grade is obtained. The dollar value that the country elevator receives is determined by the official measurement of dockage and grade factors and the terminal's discount schedule. A country elevator that overestimates grain quality factors pays the terminal elevator higher price discounts than the producer paid.

Underestimating dockage has two impacts on the country elevator. Because the terminal elevator removes dockage from weight, a country elevator that underestimates dockage pays wheat price for material that will be removed from weight by the terminal elevator. Terminal elevators also impose price discounts (often called cleaning fees) for dockage levels above specified levels. A country elevator that underestimates dockage pays cleaning fees that are in excess of the price discounts it originally charged the producer.

Economic Impact: 1995

The estimation of dockage had the largest economic impact on revenue. On average, elevator's underestimation of dockage resulted in the elevator absorbing price discounts of 2.74 cents per bushel. Underestimating dockage also implied that the elevators were not subtracting the appropriate amount of dockage from the net weight of wheat delivered, which had an additional impact of 6 cents per bushel. The elevators' tendency to overestimate test weight and underestimate the other grade factors also resulted in difference in the final grade assigned and/or triggered different grade factor discounts. The total economic loss to the country elevator from inaccurate grading procedures was 9.32 cents per bushel (Table 4.6).

Economic Impact: 1996

The participating elevators' underestimation of undesirable grade factors and overestimation of desirable ones resulted in the elevators continuing to absorb price discounts from the terminal elevators in 1996 (Table 4.7). Underestimating dockage continued to have the greatest overall effect. On average, elevators' tendency to underestimate dockage caused them to absorb .31 cents per bushel in price discounts and to absorb 2 cents per bushel by not deducting an adequate amount of dockage from net weight. The total impact of dockage determination was 2.31 cents per bushel. Higher wheat prices during 1996 contributed to the economic impact of dockage determination, because of the higher penalties from improper weight adjustments. The estimation of test weight had the next largest economic impact on the elevators in this study. On average, elevator's overestimation of test weight resulted in the elevator absorbing price discounts of 1.23 cents per bushel. The total economic loss to the country elevator from inaccurate grading procedures was 3.75 cents per bushel. In 1996, the economic impact varied substantially across regions due to differences in grain quality and dockage content.

Equity of Current Grading Practices

In 1995, the one quarter of the sample (325 loads) having the highest dockage averaged 11.9 percent dockage (Table 4.8). On average, the elevators estimated the dockage in these loads to be 6.7 percent. Overestimating the net weight of grain delivered (by underestimating dockage by 5.2 percent) cost the elevators 15 cents per bushel. Based on their grades and dockage estimates, the elevators discounted the price paid to the producers by 15.7 cents per bushel. When the elevators shipped the wheat to a terminal elevator or exporter, they received a 34 cents per bushel price discount which was based on the official estimate of dockage and grade factors. The total price discount absorbed by the elevator for these 325 loads was 18.3 cents per bushel. Combined with the loss from overestimated dockage free net weight this resulted in a total loss to the elevator of 33.3 cents per bushel. Relative to the average, the producers delivering these loads received 24.1 cents per bushel more for their wheat.

In contrast, the 325 loads with the lowest dockage sampled in 1995 averaged .36% dockage. On average, the elevators estimated the dockage of these loads to be 1 percent. Overestimating dockage by .64 percent cost the producer 1.5 cents per bushel. The elevators discounted the price paid to these producers by .8 cents per bushel. Based on the official grades, the elevators were able to ship this wheat without receiving a price discount.

Overestimating the dockage and underestimating the grade quality factors resulted in the elevators paying this category of producers 2.3 cents per bushel less than the true market value of the wheat. This represented 11.6 cents per bushel less than the overall average.

The same basic pattern was evident in 1996 (Table 4.9), although the lower overall dockage levels made the inequities less dramatic. Elevator graders under-estimated the dockage content by more than one percentage point for the quarter of the loads with the highest dockage. This implied that the producers delivering these loads were receiving over 3 cents per bushel more than the value that would have been estimated using the official dockage levels. The elevator dockage estimates for the cleanest quarter of the loads trailed the official estimates by only .15 percentage points which implied that this group of producers was receiving .71 cents per bushel more than would have been calculated using the official dockage levels. This is in contrast to the previous year in which clean wheat producers were receiving less per bushel from the country elevator than they would from an official agency. However, most of the benefit from an elevator's inaccurate grading went to high dockage producers. A summary of the loss or gain of producers in each dockage category to the overall average (Table 4.10) indicates that in both years, producers delivering the highest dockage wheat benefit at the expense of producers delivering the cleanest wheat.

Other Aspects of Grading

Elevator managers weigh the time and cost of improved grading procedures with the benefits from improved grading accuracy. Possible alternatives for improving grading accuracy include mechanized probing devices and dockage testers and the expansion of grading procedures to full factor grading.

Mechanized Dockage Testers and Sampling Probes

Elevators that used dockage machines were less likely to underestimate dockage. In 1995, elevators using hand sieves underestimated the true dockage level by twice as much as those using mechanical dockage testers (Table 4.11). Also, elevators using hand sieves had more than twice as much error in estimating dockage in 1996 (Table 4.12). Furthermore, the difference in dockage measurement error between mechanical dockage machines and hand sieves is significant at the .05 level for both years (Table 4.13). The analysis of elevator sampling method (hand probes versus those using automatic samplers) found no significant difference in dockage estimation in 1995 (Table 4.13). In 1996, the elevators using power probes had a slightly higher but statistically significant increase in dockage measurement inaccuracy. Observation of the sampling procedures indicated that regardless of the sampling technology, none of the elevators in study routinely took as many samples from each load as recommended by FGIS.

Relative Importance of Each Grading Step

The official measurements of grade and quality factors were also analyzed to determine the economic importance of each grading step (Table 4.14). The three most important steps were the determination of dockage, test weight, and shrunken and broken kernels. All of these steps involve simple, mechanical procedures. Checking test weights was worth almost 12.7 cents per bushel to elevators in 1995 and over 6 cents per bushel in 1996. The results also indicated that determining dockage is clearly worth the time and effort to the elevator since ignoring this step would have cost the elevator almost 22.34 cents per bushel in 1995 and over 5 cents per bushel during the relatively clean 1996 harvest. The value of sieving the wheat for foreign material and broken kernels (SBK) was, not surprisingly, related to the level of SBK in the loads. The SBK was worth .75 cents per bushel in 1995 and .2 cents per bushel in 1996.

Hand picking samples for damage and foreign material had a relative low value both years. Because these factors were rarely the determining grade factors, ignoring either step would have cost the elevators less than a third of a cent per bushel. These conclusions would obviously change in a year in which growing conditions led to sprouting or other damage or generated the presence of unusual weeds.

Conclusions

Country elevators in the high plains tend to underestimate the amount of dockage in wheat and overestimate the grain quality. Despite the increased focus on wheat quality in the international market place, the conclusions of earlier studies (elevator graders often skip grading steps and grade more leniently than official grade agencies) appear to still be relevant. The results indicate that inaccurate grading procedures cost elevators several cents per bushel, even during years with relatively good grain quality. If it were assumed that competitive pressure would force elevator managers to pass on the savings from more accurate grading in the form of higher board prices, producers delivering the cleanest wheat have the most to gain from more accurate grading. The study's results also indicate that the adoption of technologies which automate the sampling and grading process increases grading accuracy.

The results of this study assume that grading more accurately would not cause producers to shift their sales to other elevators that were not grading accurately. To the extent that an elevator may lose business because of grading more accurately, these amounts overestimate the actual loss incurred by elevators not grading accurately. Some evidence suggests that one of the reasons elevators do not grade accurately is fear of losing customers to competing elevators (e.g. Kiser, 1990). Other evidence indicates that local competitive conditions may influence an elevator decision of whether to grade accurately (e.g. Elliot, 1997). Further research is needed to verify this hypothesis.

Table 4.1 Comparison of Elevator and Official Grades (1995)

	Average Elevator Grade	Average Official Grade	Difference (Official minus Elevator)
Moisture	12.43%	12.07%	-.36%
Dockage	2.13%	3.85%	1.72%*
Test Weight	57.84 LBS.	57.75 LBS.	-.09 LBS.*
Grade	#1: 19.1% #2: 36.8% #3: 27.9% Avg: 2.42	#1: 8.5% #2: 40.2% #3: 29.7% Avg: 2.70	
Foreign Material	.07%	.38%	.30%*
Damage	.08%	.44%	.36%*
Shrunken & Broken	.42%	1.64%	1.22%*
Total Defects	.69%	2.44%	1.74%*
Protein [a]		12.42%	12.42%

Sample Size = 1,314 loads, 16 elevators
a. Not analyzed by any of the cooperating elevators
*Elevator and Official means are significantly different at the .05 level.

Table 4.2 Comparison of Elevator and Official Grades (1996)

	Average Elevator Grade	Average Official Grade	Difference (Official minus Elevator)
Moisture	12.69%	12.63%	-0.05%
Dockage	0.55%	0.97%	0.42%*
Test Weight	58.34 LBS.	58.00 LBS.	-0.34 LBS.*
Grade	#1 28.2% #2 29.6% #3 26.4% #4 11.8% #5 3.6% #6 0.1% SG 0.2%	#1 15.7% #2 31.1% #3 27.3% #4 19.1% #5 5.9% #6 0.7% SG 0.1%	
Foreign Material	0.00%	0.08%	0.08%*
Damage	0.00%	0.05%	0.05%*
Shrunken & Broken	0.59%	1.91%	1.32%*
Total Defects	0.59%	2.04%	1.45%*
Protein		14.04%	14.04%

Sample Size = 1,370, 13 elevators
*Elevator and Official means significantly different at the .05 level.

Table 4.3 Grading Accuracy Summary (1995)

	Elevator Over Estimated[a]	Elevator Under Estimated	Elevator and Official Agree[b]
Grade	218	508	588
Moisture	785	467	62
Dockage	272	1033	9
Test weight	767	505	42
Foreign Material	16	1140	158
Damage	19	914	381
Shrunken and Broken	133	1174	7
Total Defects	117	1186	11

N=1,314

a. Overestimation of grade refers to the elevator assigning a better quality (lower numerical grade to the sample, relative to the official grade.

b. Grade factors within + or - 10% of the official results were considered to be in agreement.

Table 4.4. Grading Accuracy Summary (1996)

	Elevator Over Estimated[a]	Elevator Under Estimated	Elevator and Official Agree[b]
Grade	401	391	578
Moisture	880	423	67
Dockage	274	1071	25
Test weight	922	379	69
Foreign Material	18	634	718
Damage	18	267	1085
Shrunken and Broken	270	1096	4
Total Defects	1370	0	0

N=1,370

a. Overestimation of grade refers to the elevator assigning a better quality (lower numerical grade to the sample, relative to the official grade.

b. Grade factors within + or - 10% of the official results were considered to be in agreement.

Table 4.5. Comparison of Supplementary Probe Samples with Elevator Grades (1996)

	Elevator Probe Sample and Grade	OSU Probe Sample and Official Grade	OSU Tailgate Sample and Official Grade
Moisture	13.05%	13.12%	13.24%
Dockage	.36%	.85%	1.29%
Test Weight	57.5 lb/bu.	57.17 lb/bu.	57.02 lb/bu
S&B	.82%	1.96%	1.88%
Foreign Material	0.0%	0.6%	0.7%
Damage	0.0%	.03%	.06%
Total Defects	0.0%	2.06%	2.02%
Average Grade	2.63%	2.93%	2.92%

Table 4.6 Economic Impact of Grading Inaccuracy (1995)

	Average Elevator Grade (Discount)	Average Official Grade (Discount)	Difference (Official minus Elevator)
Moisture	12.43% (-.12¢)	12.07% (-.30¢)	-.36% (-.19¢)
Dockage	2.13% (-1.43¢)	3.85% (-4.17¢)	1.72% (-2.74¢)
Test Weight	57.84 LBS. (-1.11¢)	57.75 LBS. (-1.32¢)	-.09 LBS. (-.21¢)
Grade	#1: 19.1% #2: 36.8% #3: 27.9% (-.87¢)	#1: 8.5% #2: 40.2% #3: 29.7% (-1.03¢)	.28 (-.16¢)
Foreign Material	.07% (.00¢)	.38% (.00¢)	.30% (.00¢)
Damage	.08%	.44%	.36%
Shrunken & Broken	.42% (-.17¢)	1.64% (-.34¢)	1.22% (-.17¢)
Total Defects	.69% (-.00¢)	2.44% (-.05¢)	1.74% (-.05¢)
Protein		12.42%	12.42%
Factor Discount	-3.52¢	-6.82¢	-3.30¢
Value of Dockage Forgiven			-6.02¢
Total Economic Impact			-9.32¢
Sample Size = 1,314			

Table 4.7 Economic Impact of Grading Inaccuracy (1996)

	Average Elevator Grade (Discount)	Average Official Grade (Discount)	Difference (Official minus Elevator)
Moisture	12.69% (-0.97¢)	12.63% (-1.00¢)	-0.05% (-0.03¢)
Dockage	0.55% (-0.71¢)	0.97% (-1.02¢)	0.42% (-0.31¢)
Test Weight	58.34 LBS. (-3.36¢)	58.00 LBS. (-4.59¢)	-0.34 LBS. (-1.23¢)
Grade	#1 28.2% #2 29.6% #3 26.4% #4 11.8% #5 3.6% #6 0.1% SG 0.2% (-1.18¢)	#1 15.7% #2 31.1% #3 27.3% #4 19.1% #5 5.9% #6 0.7% SG 0.1% (-2.06¢)	(-0.88¢)
Foreign Material	0.00% (0.00¢)	0.08% (-0.07¢)	0.08% (-0.07¢)
Damage	0.00% (0.00¢)	0.05% (0.00¢)	0.05% (0.00¢)
Shrunken & Broken	0.59% (-0.15¢)	1.91% (-0.18¢)	1.32% (-0.02¢)
Total Defects	0.59% (-0.13¢)	2.04% (-0.21¢)	1.45% (-0.08¢)
Protein		14.04%	14.04%
Factor Discount	-5.32¢	-7.07¢	-1.75¢
Value of Dockage Forgiven			-2.00¢
Total Economic Impact			-3.75¢

Sample Size = 1370

Table 4.8 Accuracy of Dockage Estimates (by dockage category) 1995

	High Dockage (highest 325 loads)	Moderate-High Dockage (next 325 loads)	Moderate-Low Dockage (next 325 loads)	Low Dockage (lowest 325 loads)
Elevator Estimate	6.7%	1.6%	1.1%	1.0%
Official Estimate	11.9%	2.7%	.81%	.36%
Difference	5.2%	1.1%	-.3%	.64%
Value of dockage forgiven	15¢	3¢	-.9¢	-1.5¢
Price discount Elevator estimate	15.7¢	1.6¢	.8¢	.8¢
Price Discount Official Estimate	34.0¢	2.5¢	0¢	0¢
Price discount absorbed	18.3¢	.87¢	-.8¢	-.8¢
Total Impact	33.3¢	3.87¢	-1.1¢	-2.3¢
Total Impact relative to Average	24.1¢	-5.45¢	-10.4¢	-11.6¢

Table 4.9 Accuracy of Dockage Estimates (by dockage category) 1996

	High Dockage (highest 341 loads)	Moderate-High Dockage (next 341 loads)	Moderate-Low Dockage (next 341 loads)	Low Dockage (lowest 341 loads)
Elevator Estimate	1.0.%	.56%	.52%	.12%
Official Estimate	2.1%	.94%	.55%	.27%
Difference	1.1%	.38%	.03%	.15%
Value of dockage forgiven	1.31¢	1.35¢	1.34¢	.83¢
Price discount Elevator estimate	1.5¢	.7¢	.59¢*	.12¢*
Price Discount Official Estimate	3.28¢	.85¢	0¢	0¢
Price discount absorbed	1.78¢	.15¢	-.59¢	-.12¢
Total Impact	3.09¢	1.50¢	.75¢	.71¢
Total Impact relative to Average	.78¢	-.81¢	-1.56¢	-1.6¢

*Individual dockage estimates led to price discounts even though the average dockage level of the group was below the price discount threshold

Table 4.10 Summary of Gain or Loss by Dockage Category

	High Dockage	Moderate-High Dockage	Moderate-Low Dockage	Low Dockage
1995				
Total Impact	33.3¢	3.9¢	-1.1¢	-2.3¢
Relative to Average	24.1¢	-5.5¢	-10.4¢	-11.6¢
1996				
Total Impact	3.09¢	1.50¢	.75¢	.71¢
Relative to Average	.78¢	-.81¢	-1.56¢	-1.6¢

Table 4.11 Grading Accuracy: Hand Grade versus Dockage Machine 1995

	Hand Grade (grading error)	Dockage Machine (grading error)
Grade	.255	-.015
Moisture	-.039	-.332
Dockage	2.03	1.30
Test weight	.151	-.262
Foreign Material	.308	.295
Damage	.192	.459
Shrunken and Broken	1.51	1.26
Total Defects	1.83	1.83
Factor Discounts	4.83¢	4.50¢
Value of Dockage Forgiven	7.12¢	4.57¢
Total Economic Impact	11.95¢	9.08¢
	n=401	n=913

Table 4.12 Grading Accuracy: Hand Grade versus Dockage Machine (1996)

	Hand Grade (grading error)	Dockage Machine (grading error)
Grade	0.192	0.373
Moisture	-0.685	0.123
Dockage	0.822	0.312
Test weight	-0.159	-0.396
Foreign Material	0.119	0.072
Damage	0.066	0.044
Shrunken and Broken	1.483	1.273
Total Defects	1.671	1.387
Factor Discounts	-1.762¢	-1.742¢
Value of Dockage Forgiven	-3.905¢	-1.482¢
Total Economic Impact	-5.667¢	-3.224¢
	n=324	n=1,046

Table 4.13 Comparison of Dockage Measurement Accuracy*

Automatic Probes and Dockage Testers		
1995		
	Accuracy	Prob>|t|
Dockage Machine	1.607	0.0209
Hand Grade	2.143	
Hand Probe	1.711	.3281
Power Probe	1.977	
1996		
Dockage Machine	0.819	0.001
Hand Grade	0.525	
Hand Probe	0.712	0.001
Power Probe	0.953	

*Official Measurement – Elevator Estimate

Table 4.14 Value of Each Grading Step

	Value of Each Grading Step (1995)	Value of Each Grading Step (1996)
Dockage	-22.34¢	-5.63¢
Test Weight	-12.70¢	-6.46¢
Shrunken & Broken	-0.75¢	-0.20¢
Foreign Material	-.32¢	-.09¢
Damage	-0.14¢	-0.01¢
Sample Size (1995)=1,314 Sample Size (1996)=1,370		

CHAPTER V

EXAMINING WHEAT BLENDING, CLEANING, AND MARKETING STRATEGIES FOR COUNTRY ELEVATORS

Introduction

Each year millions of bushels of wheat are produced in the United States, providing substantial producer income while meeting customers' quantity and quality needs. Much of this wheat is first handled and marketed through country elevators. The country elevators' roles are to take producers' wheat with various levels of desired quality attributes and sort, blend, clean and store the wheat to maximize returns through meeting buyer specifications. The wheat marketplace is changing with substantial improvements in quality measurement technology, and there is heightened buyer attention to quality attributes (Barkema, Drabenscott, and Welch, 1991). This suggests that there may be substantial benefit to studying effective country elevator quality strategies in this dynamic market environment.

In response to these market changes, terminal elevators are beginning to implement increasingly stringent quality standards. For example, maximum dockage levels without a discount have dropped from 3% in 1995 to 1% in 1996. However, U.S. terminal elevator restrictions pale in comparison to the quality restrictions of foreign buyers. Major wheat importing countries such as Japan have decreased the maximum allowable dockage from 0.8% in 1992 to 0.5% in 1997 (U.S. Wheat Associates, 1997). These changes in quality restrictions have driven country elevators to implement more effective marketing strategies such as blending and cleaning wheat.

In addition to implementing increased quality restrictions, importers expressed their need for higher quality wheat in a survey conducted at the USW Marketing Plan Conferences (1996). Quality issues were ranked in order of importance as limitations to the competitiveness of U.S. wheat in world markets. The most important issue was cleanliness. This issue dealt with the need for the U.S. to provide cleanliness in wheat comparable to that of Canada and Australia for customers willing to pay for it. The second most important issue was grain uniformity. This issue dealt with the need for more consistent wheat quality, both within and among cargoes (USW Marketing Plan Conference, 1996). These issues expressed a definitive for the improvement of U.S. wheat quality in the marketplace.

Another important reason to study wheat quality and interactions in the marketplace is the strong, long-term public policy interests in this area. Recently, the U.S. Congress, under the 1996 Farm Bill, enabled the Federal Grain Inspection Service (FGIS) to amend the grain grading system to match the quality standards of other exporting countries (Johnson and Wilson, 1995). One aspect of review for the FGIS is the mandatory cleaning of dockage before export. Other studies, such as, Mercier *et al* (1989) and Adam, Kenkel, and Anderson (1994), indicate long term research and policy interests in this area.

To address these issues, a decision model of a representative country elevator is developed to evaluate several alternative blending, cleaning, and marketing strategies. These alternatives represent some of the possible strategies that firms could use in responding to changing market incentives and policy regulations. In evaluating specific strategies, actual truckload level quality data for several years is used to evaluate the economic impact on the first handler. This data provides a rich source of information through which a more realistic evaluation of country elevator decisionmaking can be developed than was possible in earlier studies on this topic (e.g. Johnson et al., 1992).

The research is presented in the following fashion. The elevator decisionmaking model is developed in the next section, while the third section presents the results of the analysis and key implications for elevators. A concluding section highlights key issues identified in the paper and provides some implications for the marketing system.

A Grain Elevator Blending, Cleaning, and Marketing Model

The blending, cleaning and marketing model optimizes elevator revenue, and is similar to the one proposed by Johnson and Wilson (1993). This model takes the form of a classic normative blending problem which has been applied to the wheat cleaning decision framework rather than a budget analysis (e.g., Adam and Anderson; Kiser). The budget analysis approach examines the costs and benefits of cleaning a given quantity and quality of wheat. Normative models attempt to recreate the decision framework of the country elevator manager and allow for variations in the intensity of cleaning operations and allow for alternative blending activities. The model was used to determine the most profitable blending, cleaning, and marketing strategies for an elevator. In the model, each elevator had a number of grain bins. A segregation strategy and the quality of the wheat received determined the quality and quantity of wheat in each bin. The model selected blending, cleaning, and marketing activities to achieve the highest net revenue for the grain received.

Cleaning, a key elevator decision, was incorporated in the model. The dockage in a bin, independent of the blending activities, was assessed to evaluate if it should be reduced. In this decision, a number of facets were incorporated to enable the model to accurately reflect relevant benefits and costs of cleaning wheat. Two benefits of cleaning or removing dockage are (a) the higher price received from cleaner wheat, and (b) transportation savings. In addition, the dockage removed by cleaning can be sold as livestock feed. These benefits must be balanced against the cost of cleaning bins of wheat. To maximize net revenue the model cleaned wheat to the point where the marginal cost equals the marginal benefit of cleaning. This model contains two sections: (1) the objective function, and (2) segregation and blending strategies.

Objective Function

Each elevator seeks to maximize net revenue (π):

$$\pi = WHTREV - TCC - TRAN, \qquad (5.1)$$

where *WHTREV* denotes the wheat sales revenue received from the terminal elevator, *TCC* denotes the total cost of cleaning, *TRAN* denotes gross weight transportation costs. The choice variables for this model are the choice of segregation strategies which are affected by an elevator's estimate of the benefits that can be received through using different segregation activities.

Segregation and Blending Strategies

Elevators usually segregate wheat received to increase their wheat sales revenue through improving their cleaning and blending operations. Blending also is used to increase an elevator's wheat sales revenue by improving the quality of the grain sold to the terminal elevator. Grain segregation can increase the efficiency of grain cleaning operations by limiting the number of bushels that must be run through the cleaner. Segregation and blending strategies are also interrelated since the advantages of blending can only be obtained if lots of grain with the desired quality differences exist.

In the model, wheat was segregated by a predetermined strategy and placed into storage bins. Four base segregation strategies commonly used by commercial elevators were examined. In an independent procedure, a protein requirement was also added to each of the four base strategies to determine the affect of protein segregation on net revenue. The base segregation strategies (Table 5.1) were based on interviews with Oklahoma elevator managers representing commonly effective practices. These sorting strategies used the scale ticket quality data to segregate individual truckloads into three bins indexed by $i (i = 1,2,3)$. The average bin quality level was then entered into the blending, cleaning, and marketing model (Tables 5.2 and 5.3). The model allowed the elevator to market up to two blended lots of grain indexed by $j (j = 1, 2)$. The model could market each blend directly or select one or two stages of cleaning prior to marketing. The revenue from the marketed grain was based on the average annual wheat price and the published terminal elevator discount schedules for the 1995 and 1996 crop years.

The goal of this model was to determine the optimal blending, cleaning, and marketing alternative by maximizing the objective function. In the model, each bin contained wheat with different beginning percentages of dockage ($BDKG_{ij}$), shrunken and broken kernels ($BSBK_{ij}$), foreign material (BFM_{ij}), damage (DMG_{ij}), total defects (BTD_{ij}), and moisture ($MOIST_{ij}$), and beginning levels of test weight ($TEST_{ij}$), and protein ($PROT_{ij}$).

Elevators had several marketing options. As mentioned above, wheat could satisfy up to two contract specifications by going into one of two blends. Also, wheat could either skip the cleaning process or undergo cleaning by an aspirator cleaner as described by Adam and Anderson (1992). The decision to clean was based on whether cleaning would improve returns. Cleaning costs for an elevator were a function of the aspirator electricity costs ($ELEC_{ij}$), and the loss of saleable wheat due to the cleaning process (WL_{ij}), minus the transportation savings due to the cleaning process ($TRANSAV_{ij}$) and the value of cleanings sold ($CLNVAL_{ij}$):

$$CC_{ij} = (ELEC_{ij} + WL_{ij}) - (TRANSAV_{ij} + CLNVAL_{ij}) \tag{5.2}$$

$$TCC = \sum_{i} \sum_{j} CC_{ij}. \tag{5.3}$$

The beginning percentages of dockage $BDKG_{ij}$, foreign material BFM_{ij}, and shrunken and broken kernels $BSBK_{ij}$ were functions of the segregation strategy used, and the quantity and quality of wheat being segregated.

As wheat is cleaned undesirable factors such as dockage, shrunken and broken kernels, and foreign material are reduced by a percentage as referenced from Kiser's estimates of an aspirator's cleaning efficiency. Therefore, the ending percentages of dockage $EDKG_{ij}$, foreign material EFM_{ij}, and shrunken and broken kernels $ESBK_{ij}$ were direct functions of the beginning percentages:

$$EDKG_{ij} = b_0 \cdot BDKG_{ij} \tag{5.4}$$

(5.5) $$ESBK_{ij} = b_1 \cdot BSBK_{ij}$$

(5.6) $$EFM_{ij} = b_2 \cdot BFM_{ij}$$

where $0 < b_0, b_1, b_2 < 1$. Examples of the impact of grain cleaning on dockage levels and the cleaning costs calculated by the model are provided in Table 5.4. Ending total defects ETD_{ij} is a function of foreign material EFM_{ij}, shrunken and broken kernels $ESBK_{ij}$, and DMG_{ij}:

(5.7) $$ETD_{ij} = EFM_{ij} + ESBK_{ij} + DMG_{ij}.$$

Let BP_{ij} denote the base price received from the terminal elevator for strategy i, bin j, where $DISC_{ij}$ is a function of $EDKG_{ij}$, $ESBK_{ij}$, EFM_{ij}, $TEST_{ij}$, DMG_{ij}, ETD_{ij}, and $MOIST_{ij}$. Therefore, revenue from the sale of wheat ($WHTREV_{ij}$) in one bin is given by:

(5.8) $$WHTREV_{ij} = (BP_{ij} - DISC_{ij}) \cdot NBDKG_{ij},$$

where $NBDKG_{ij}$ is the bushels net of dockage in each bin.

Each elevator's revenue was maximized with respect to the ending quality and quantity of wheat in each bin. Since this is a result of how the wheat was segregated, blended, and cleaned, the resulting objective function indicated which segregation, blending and cleaning strategies were the most profitable for an elevator. This entire process can be shown in Figure 5.1, which is a simplex tableau of the blending, cleaning, and marketing model.

The maximization procedure took place using MUSAH, a general linear optimizer. Since all constraints are linear, the "feasible region" for the problem is convex. This means that, similar to other blending models, there was mathematical assurance that a "local" maximum was actually "global".

Results

The results of the blending, cleaning, and marketing model had several important implications for country elevators. The model determined that cleaning a portion of the wheat received could be an economically efficient activity for country elevators. However, the results indicated that the economic efficiency of cleaning is affected by the quality of the crop year. The model also determined that segregation strategies have a significant impact on the revenue of a country elevator.

In 1995, the model indicated that the optimal strategy was for the elevator to clean approximately 35.59% of its wheat, while in 1996 cleaning did not enter the model. In 1995, cleaning would have generated additional revenue for the elevator, net of variable cleaning costs of approximately 2¢/bu. The cleaning results varied dramatically among elevators. Assuming that the dockage levels encountered during the sample period were typical of the overall grain received, some elevators should clean up to 70% of their grain for a net gain of over 8¢/bu., while other elevators would experience no gain from cleaning.

Since the fixed ownership costs of grain cleaning equipment have been estimated to be approximately .5¢/bu. (Adam and Anderson, 1992), ownership of grain cleaners would have been advantageous during 1995. The overall profitability of investing in grain cleaning equipment obviously depends on the frequency of high dockage years at a particular elevator. However, the relatively high value of cleaning equipment for the 1995 crop year suggests that cleaning equipment is likely to be a positive net present value investment for many elevators.

Optimal Segregation Strategies

The model determined that segregation had a significant impact on wheat quality and on country elevator revenue. Each strategy increased elevator revenue, but the most important strategies were not the same from year to year. Each strategy also increased the efficiency of the cleaning and blending activities of the model.

In the model, segregation strategies determined the aggregate quality levels of elevator separations. Even though each strategy separated wheat unevenly in the bins, the strategies were practical for country elevators. The quantity and quality of wheat which would be stored in each bin for the four segregation strategies is summarized in Tables 5.2 & 5.3. The segregation strategy based on grade (strategy 4) resulted in the most even distribution while the strategy based on both test weight and dockage resulted in the most disparity between bins. While the overall wheat quality was the same for all strategies, the quality characteristics of each bin varied dramatically depending on the segregation criteria. Within a given segregation strategy, the quality characteristics of each bin also varied fairly widely between 1995 and 1996. Since elevator managers have little or no knowledge of crop quality prior to the start of harvest, the success of a given strategy in a particular year will obviously depend on the quality characteristics of the harvest.

In both 1995 and 1996, all of the segregation strategies tested increased the elevator's net revenue relative to the naive strategy of commingling all grain at harvest and the composite strategy of selling each individual load. The segregation strategies examined yielded elevators with cleaning equipment an increase of about .49¢ to .63¢/bu. The total impact of segregation to a typical elevator is depicted in Tables 5.5 and 5.6.

The value of segregating grain was slightly higher for elevators without grain cleaning equipment (around 4¢/bu). While elevators with cleaning equipment received a higher net price, the relative impact of segregation was slightly higher for elevators without cleaners since the segregation and blending process was the only method available to impact the dockage levels of blends marketed. Strategy 1, which included dockage and moisture criteria, was the optimal segregation strategy in 1995, while Strategies 2 through 4 yielded slightly less net revenues. In 1996, there was little impact of segregation on the average net price received by the elevator for their final blends. Strategies 3 and 4, which focused on test weight and grade, generated slightly higher net revenue. Segregation had no impact on grain cleaning since the grain cleaning activities did not enter the model when the 1996 quality data was used. The lack of importance of grain cleaning in 1996 contributed to the fairly low impact of segregation on net revenues. The major differences among the segregation strategies were the percentage of the wheat which was cleaned. Because strategy 1 was more successful in separating the high dockage wheat it reduced the percentage of wheat which needed to be cleaned. This benefit of segregation could be important to elevators with limited cleaning capacity.

Protein Segregation

Segregating wheat based on protein had several important implications for country elevators. The results from the model indicated that in some years it may be profitable to segregate wheat based on the protein content of the grain. However, the profitability of protein based marketing is very uncertain and depends on the quality of the crop year. Also, the technology required for measuring protein may not be readily available to country elevators at the present time.

During 1995, over 20% of the wheat sampled would have met the flour millers requirement for protein, test weight, dockage, and shrunken and broken kernels. Segregating a portion of the wheat received (20%) for specialty marketing to flour millers had the potential to raise elevator profits by $9,887 to $11,298 (Table 5.9), assuming a 15 cent per bushel premium for high protein wheat. These results are net of the decline in revenue from marketing the remainder of the wheat at a lower price due to the slight decline in quality. Also, some of the strategies experienced an increase in cleaning costs. In years such as 1995 when a protein premium exists, segregating high protein wheat at the time of harvest can clearly be a profitable quality related marketing strategy for the country elevator.

Unfortunately, the analysis of the 1996 sample revealed the uncertain nature of protein based marketing strategy. In 1996, dry growing conditions led to a crop with a high average protein content. The protein content of the sampled loads was over 14%. Because they were able to meet protein requirements from regular commodity market sources, flour millers did not offer a premium for high protein wheat in 1996. The feasibility of protein segregation for a particular elevator depends both on the average protein content of the state harvest and the range of protein in the loads delivered. The average level of protein for the 1995 crop (when protein segregation was indicated to be profitable) was typical for the Southern Plains of Oklahoma and Kansas. This result suggests that segregation on the basis of protein should be profitable for elevators in most years.

Summary and Conclusions

With international wheat quality standards on the rise, elevators need strategies to remain profitable. As the results of the blending model show, segregating and blending wheat can increase elevator revenue, and improve the quality of U.S. wheat. However, the effectiveness of cleaning depends upon the cleanliness of wheat in a particular year and the initial segregation strategy used. In years characterized by high dockage levels (i.e. 1995), elevators can increase revenue by cleaning a portion of their wheat before shipment. This study states that the optimal strategy for elevators in 1995 was to clean approximately 35.59% of their wheat resulting in an increase in net revenue of 3 cents per bushel. However, the cleaning results varied dramatically between individual elevators depending on the quality of wheat received. In 1996, a year characterized by low dockage levels, cleaning activities were not profitable.

The segregation strategy used also had an impact on the effectiveness of an elevator's cleaning activities. In 1995, segregating wheat before cleaning yielded an increase in net revenue of .49 to .63 cents per bushel. While segregating wheat was profitable for elevators with cleaners, it held an even greater impact on elevators without cleaners since segregation and blending were the only methods available to improve quality. In 1996, there was little impact of segregation on the net revenue of an elevator.

Also, segregating based on the protein level of the wheat had a positive impact on the net revenue of the country elevator. However, the effectiveness of this marketing strategy depended upon the quality of the crop year, and the potential for elevators to measure this intrinsic characteristic.

This research focused on evaluating effective blending, cleaning, and marketing alternatives that elevator managers can use to respond to an increasingly competitive world. Not surprisingly, these strategies had the most impact in years of low wheat quality. Country elevators can use these results to make more effective marketing decisions. This may improve elevator decision making and profitability.

Table 5.1 Segregation Strategies*

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Focus:	Separate hard to store wheat	Separate high quality, clean wheat	Separate by test weight	Separate by grade
Bin 1	Dockage > 10% or Moisture > 14%	Test Weight > 56#	Test Weight > 56# & Test Weight < 60#	Grade 1
Bin 2	Test Weight > 60#	Test Weight > 60# & Dockage < 5%	Test Weight > 60#	Grade 2
Bin 3	Remainder	Remainder	Remainder	Remainder

*In an independent prodedure, a protein requirement was also added to each strategy. This requirement separated the wheat into a fourth bin. The protein requirement was protein > 12%, test weight > 58 lb/bu., dockage < 1.5%, and shrunken and broken kernels < 3.5%.

Table 5.2 Initial Simulation Parameters (High Dockage Year-1995)

Strategy 1

Parameter	Bin 1	Bin 2	Bin 3
Bushels	62,109.87 bu	34,394.83 bu	389,853.75 bu
Dockage	8.35%	2.66%	3.61%
SBK	0.07%	0.74%	0.35%
Moisture	14.21%	11.96%	12.05%
Test Weight	57.20 lbs/bu	60.90 lbs/bu	57.65 lbs/bu
Protein	12.12%	11.86%	12.51%

Strategy 2

Parameter	Bin 1	Bin 2	Bin 3
Bushels	316,500.48 bu	122,217.30 bu	47,640.67 bu
Dockage	5.09%	3.80%	6.27%
SBK	0.40%	0.26%	0.10%
Moisture	11.82%	13.81%	11.92%
Test Weight	58.41 lbs/bu	58.27 lbs/bu	52.78 lbs/bu
Protein	12.54 %	12.10%	12.41%

Strategy 3

Parameter	Bin 1	Bin 2	Bin 3
Bushels	317,141.83 bu	111,687.17 bu	57,529.45 bu
Dockage	4.99%	2.79%	6.83%
SBK	0.369%	0.40%	0.08%
Moisture	12.42%	11.97%	12.45%
Test Weight	57.85 lbs/bu	60.28 lbs/bu	52.92 lbs/bu
Protein	12.47%	12.29%	12.41%

Table 5.2 (continued)

Strategy 4

Parameter	Bin 1	Bin 2	Bin 3
Bushels	105,739.50 bu	188,473.92 bu	19,2145.03 bu
Dockage	2.85%	4.23%	6.01%
SBK	0.27%	0.36%	0.35%
Moisture	11.95%	12.25%	12.59%
Test Weight	60.26 lbs/bu	58.60 lbs/bu	55.71 lbs/bu
Protein	12.32%	12.48%	12.41%

Table 5.3 Initial Simulation Parameters (Low Dockage Year-1996)

Strategy 1

Parameter	Bin 1	Bin 2	Bin 3
Bushels	87,980.21 bu	116,992.32 bu	424,521.3 bu
Dockage	0.96%	0.57%	0.45%
SBK	0.38%	0.17%	0.74%
Moisture	14.97%	12.38%	12.29%
Test Weight	57.61 lbs/bu	60.97 lbs/bu	57.77 lbs/bu
Protein	13.50%	13.31%	14.36%

Strategy 2

Parameter	Bin 1	Bin 2	Bin 3
Bushels	278,557.01 bu	298,925.08 bu	52,011.14 bu
Dockage	0.49%	0.59%	0.56%
SBK	0.903%	0.219%	1.01%
Moisture	12.17%	13.18%	12.58%
Test Weight	57.77 lbs/bu	59.57 lbs/bu	54.38 lbs/bu
Protein	14.39%	13.52%	15.20%

Strategy 3

Parameter	Bin 1	Bin 2	Bin 3
Bushels	347,897.39 bu	212,821.62 bu	68,774.83 bu
Dockage	0.53%	0.47%	0.83%
SBK	0.82%	0.10%	0.87%
Moisture	12.71%	12.49%	13.16%
Test Weight	57.81 lbs/bu	60.53 lbs/bu	54.27 lbs/bu
Protein	14.18%	13.51%	15.00%

Table 5.3 (continued)

Strategy 4

Parameter	Bin 1	Bin 2	Bin 3
Bushels	181,736.62 bu	150,971.24 bu	30,513.45 bu
Dockage	0.55%	0.57%	296785.97%
SBK	0.0%	0.26%	0.53%
Moisture	12.29%	12.18%	1.11%
Test Weight	60.57 lbs/bu	57.74 lbs/bu	56.78 lbs/bu
Protein	13.45%	14.18%	14.34%

Table 5.4 Estimated Ending Dockage Levels and Calculated Cleaning Costs ($/bu.) at Various Dockage Levels

Beginning Dockage	Ending Dockage	Wheat Loss	Labor & Elec.	Trans. Savings	Value of Screenings	Total Cost
1.00%	.33%	-0.0247	-0.0038	0.0051	0.0154	-0.008
5.00%	1.67%	-0.0858	-0.0038	0.0219	0.0658	0.0981
10.00%	3.33%	-0.1621	-0.0038	0.0429	0.1287	0.2857
15.00%	5.00%	-0.2385	-0.0038	0.1916	0.1916	0.4332
20.00%	6.67%	-0.3148	-0.0038	0.2545	0.2545	0.5608
25.00%	8.33%	-0.3912	-0.0038	0.1058	0.3175	0.7083
30.00%	9.99%	-0.4675	-0.0038	0.1268	0.3804	0.8759
35.00%	11.66%	-0.5439	-0.0038	0.1478	0.4433	1.0034
40.00%	13.32%	-0.6202	-0.0038	0.1687	0.5062	1.1310

Table 5.5 Comparison of Segregation Strategy on Net Price $/bu. (1995)

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Net Price/Bu. (% Cleaned)	$3.9040 (24%)	$3.9027 (31%)	$3.9029 (26%)	$3.9026 (25%)
Without Cleaning	$3.8660	$3.8660	$3.8663	$3.8663
No Segregation:				
With Cleaning	$3.8977 (35.59%)			
Without Cleaning	$3.8264 (0%)			
Composite load value	$3.78 (0%)			

Table 5.6 Comparison of Segregation Strategy on Net Price $/bu (1996)

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Net Price/Bu. (% Cleaned)	$4.722718 (0%)	$4.722712 (0%)	$4.722732 (0%)	$4.72301 (0%)
No Segregation:				
With Cleaning	$4.722612 (0%)			
Without Cleaning	$4.722612 (0%)			
Composite Load Value	$4.68 (0%)			

Table 5.7 Discount Schedule Used in the Cleaning Model (cents/bu.)-1995

Test Weight Discount	Dockage Discount	Foreign Material Disco
>64# = 0	<2.9 = 0	<1.4 = 0
63#-63.9 = .5	3.0-3.5 = 2	1.5-1.9 = 1
62#-62.9 = 1.5	3.6-3.9 = 4	2.0-2.4 = 2
61#-61.9 = 3.5	4.0-4.5 = 6	2.5-2.9 = 3
60#-60.9 = 5.5	4.6-4.9 = 8	3.0-3.4 = 4
59#-59.9 = 7.5	5.0-5.5 = 10	3.5-3.9 = 5
58#-58.9 = 9.5	5.6-5.9 = 12	4.0-4.4 = 6
57#-57.9 = 11.5	6.0-6.5 = 14	4.5-4.9 = 7
56#-56.9 = 13.5	6.6-6.9 = 16	5.0-5.9 = 8
55#-55.9 = 15.5	7.0-7.5 = 18	6.0-7.0 = 10
54#-54.9 = 17.5	7.6-7.9 = 20	
53#-53.9 = 20.5	8.0-8.9 = 22	
52#-52.9 = 26.5	9.0-9.9 = 26	
51#-51.9 = 32.5	10.0-10.9 = 30	
50#-50.9 = 38.5	11.0-11.9 = 34	
<50# = 44.5	12.0-13.0 = 38	

Total Defects Discount	SBK Discount	Moisture Discount
<7 = 0	<1.4 = 0	<14 = 0
7.1-8.0 = 1	1.5-1.9 = 0.5	14.0-14.5 = 3
8.1-9.0 = 2	2.0-2.4 = 1.0	14.6-15.0 = 6
9.1-10.0 = 3	2.5-2.9 = 1.5	15.0-15.5 = 9
10.1-11.0 = 4	3.0-3.4 = 2.0	15.6-16.0 = 12
11.1-12.0 = 5	3.5-3.9 = 2.5	16.0-16.5 = 15
12.1-13.0 = 6	4.0-4.4 = 3.0	16.6-17.0 = 18
13.1-14.0 = 7	4.5-4.9 = 3.5	>17.0 = 21
14.1-15.0 = 8	5.0-5.9 = 4.5	
>15 = 10	6.0-6.9 = 5.5	
	7.0-7.9 = 6.5	
	8.0-8.9 = 7.5	
	9.0-9.9 = 8.5	
	>10.0 = 9.5	

Table 5.8 Discount Schedule Used in the Cleaning Model (cents/bu.)-1996

Test Weight Discount	Dockage Discount	Foreign Material Discount
>60# = 0	<0.9 = 0	<0.5 = 0
59.0#-59.9 = 0.5	1.0-2.0 = 2	0.5-0.7 = 0.5
58.0#-58.9 = 1.0	2.1-3.0 = 4	0.8-1.0 = 3
57.5#-57.9 = 2.0	3.1-4.0 = 6	1.1-1.3 = 5
57.0#-57.4 = 4.0	4.1-5.0 = 8	1.4-2.0 = 6
56.5#-56.9 = 6.0	5.1-6.0 = 12	2.1-2.5 = 7
56.0#-56.4 = 8.0	6.1-7.0 = 16	2.6-3.0 = 8
55.5#-55.9 = 10.0	7.1-8.0 = 20	3.1-3.5 = 9
55.0#-55.4 = 12.0	8.1-9.0 = 24	3.6-4.0 = 10
54.5#-54.9 = 15.0	9.1-10.0 = 28	4.1-4.5 = 11
54.0#-54.4 = 18.0	>10.1 = 32	>4.6 = 12
<54# = 24.0		

Total Defects Discount	SBK Discount	Moisture Discount
<3 = 0	<3.0 = 0	<14 = 0
3.1-4.0 = 0.5	3.0-3.9 = 0.5	14.0-14.5 = 3
4.1-5.0 = 1.0	4.0-4.9 = 1.0	14.6-15.0 = 6
5.1-6.0 = 3.0	5.0-5.9 = 3.0	15.0-15.5 = 9
6.1-7.0 = 5.0	6.0-6.9 = 5.0	15.6-16.0 = 12
7.1-8.0 = 7.0	7.0-7.9 = 7.0	16.0-16.5 = 15
8.1-9.0 = 9.0	8.0-8.9 = 9.0	16.6-17.0 = 18
9.1-10.0 = 11.0	9.0-9.9 = 10.0	>17.0 = 21
10.1-11.0 = 14.0	10.0-10.9 = 11.0	
11.1-12.0 = 17.0	11.0-11.9 = 13.0	
12.1-13.0 = 20.0	>12.0 = 15.0	
13.1-14.0 = 23.0		
>14=26.0		

Table 5.9 Analysis of a Protein Segregation Strategy (1995)*

	Without Protein Segregation		With Protein Segregation				
	Net Return	Total Return**	% Flr. Wheat	Net Return	Flour Premium (15¢/bu.)	Total Return w/ protein seg.**	Net gain from protein segregation
Overall	$3.8977		21.22%				
Strat. 1	$3.9040	$1,894,561	21.22%	$3.8954	$15481	$1,910,041	$11,298.11
Strat. 2	$3.9027	$1,894,415	21.22%	$3.8951	$15481	$1,909,896	$11,784.47
Strat. 3	$3.9029	$1,892,615	21.22%	$3.8914	$15481	$1,908,096	$9,887.67
Strat. 4	$3.9026	$1,892,858	21.22%	$3.8919	$15481	$1,908,339	$10,276.75

*Protein segregation was not profitable in 1996.
**486,358.5 bushels

Figure 5.1 Simplex Tableau

						Quality Traits			Marketing Activ.			Cleaning Stage 1			Cleaning Stage 2		
	Rows	Activities	maximize	RHS	Bushel	Quality Trait 1	. . .	Quality Trait 11	Selling Activ. 1	. . . .	Selling Activ. 212	Cleaning Bin 1	Cleaning Bin 2	Cleaning Bin 3	Cleaning Bin 1	Cleaning Bin 2	Cleaning Bin 3
	Objective		E		p				-s11,..-s1n, -s21..-s2n, -sn1..-snn			-c	-c	-c	-c	-c	-c
	Capacity		E	-Al	1												
	Qual. Val 1		L	.								b1	c1	d1	b21	c21	d21
	.		L	.								b2	c2	d2	b22	c22	d22
	.		L	.								.	.	.	.	.	.
	.		L	.								.	.	.	.	.	.
	Qual. Val 9		L	-A10								b9	c9	d9	b29	c29	d29
Blend 1	Trans. Bu		L	0	-1				1	. . . .	1						
	Qual. Trans. 1		L	0		-1			1,2,..,n1								
	.		L	0		-1				1,2,..,n2							
	.		L	0		-1				1,2,..,nn							
	.		L	0		-1											
	Qual. Trans. 8		L	0													
	Acctg. Act 1		E	0		-1			1...1								
	.		E	0		-1				1...1							
	.		E	0		-1				1...1							
	.		E	0		-1				1...1							
	Acctg. Act 8		E	0		-1											
	Cleaning-Bin 1		L	0	-1							1+a			1+a2		
	Cleaning-Bin 2		L	0	-1								1+a			1+a2	
	Cleaning-Bin 3		L	0	-1									1+a			1+a2
Bin1	Clean1-Clean2		L	0								-1			1		
Bin 2	Clean1-Clean2		L	0									-1			1	
Bin 3	Clean1-Clean2		L	0										-1			1
Blend 2	Trans. Bu		L	0	-1				1	. . . .	1						
	Qual. Trans. 1		L	0		-1			1,2,..,n1								
	.		L	0		-1				1,2,..,n2							
	.		L	0		-1				1,2,..,nn							
	.		L	0		-1											
	Qual. Trans. 8		L	0													
	Acctg. Act 1		E	0		-1			1...1								
	.		E	0		-1				1...1							
	.		E	0		-1				1...1							
	.		E	0		-1				1...1							
	Acctg. Act 8		E	0		-1											
	Cleaning-Bin 1		L	0	-1							1+a			1+a2		
	Cleaning-Bin 2		L	0	-1								1+a			1+a2	
	Cleaning-Bin 3		L	0	-1									1+a			1+a2
Bin1	Clean1-Clean2		L	0								-1			1		
Bin 2	Clean1-Clean2		L	0									-1			1	
Bin 3	Clean1-Clean2		L	0										-1			1

End Note: Description of Simplex Tableau

1. Objective:

   To maximize net revenue per bushel.

2. Constraints:

   Capacity = total number of bushels in the bins

   Quality Value n = average quality in the bins

3. Transfer rows:

   Trans. Bu. = bushel transfer row. The transfer unit is one bushel.

   Quality Trans. n = transfers quality to the marketing activities.

   Acctg. Act. n = ensures only one price is assigned to each quality level.

   Cleaning-Bin n = transfers bushels from bins to the cleaning activity.

   Clean1-Clean2 = transfers bushels from cleaning activity one to two.

4. Activities:

   Bushel = sells bushels at a base price (p).

   Quality Traits = tracked the transformation of bushel quality from bins to marketing activities.

   Selling Activity n = quality factors that correspond to each level of a terminal discount schedule. Discounts subtracted from base price ($s_{11},..s_{nn}$).

   Cleaning Stage n = cleaning activity which can clean the bushels. The improvement of each quality factor (b1,..,d29), and the cost of cleaning (c) came from the *SAS* segregation model. The good wheat lost from the cleaning process (a, a2) also came from the *SAS* segregation model.

CHAPTER VI

COMPARISON OF GRAIN GRADING ACCURACY BETWEEN COOPERATIVE AND PRIVATE ELEVATORS

Introduction

Cooperatives market close to $20 billion worth of grains and oilseeds each year, holding an aggregate market share of roughly 36% measured at the farm gate (Sexton, 1990). The performance and functioning of cooperative grain elevators, like other first handlers, is a vital intermediary between the producer and end user. In addition to performing quality appraisal, sorting, blending, conditioning, and storage, these firms serve as a key link in communicating the desired quality needs of the end-user to producers.

Unfortunately, grain handling cooperatives are not taking a leading role in wheat quality. According to a 1993 national survey of grain elevators conducted by OSU, only 20% of cooperative elevators indicated that their policy was to refuse insect infested grain as opposed to 33% of independent elevators. On average, cooperative elevators also took fewer samples per load, were less likely to use traps to monitor insect populations, and fumigated more times each year. Casual conversations with growers suggest that most growers expect their cooperative to accept delivery of their wheat regardless of quality or condition. Cooperative managers are often reluctant to stringently apply discounts to their farmer members.

Even when a cooperative recognizes the potential marketing advantages in supplying higher than average quality grain, improving the quality of wheat and other grains is a complex endeavor. In the short run, the quality of wheat delivered to the country elevator is fixed. Most elevators can enhance quality only through segregation and blending. (The elevator's stored grain management practices also impact quality by preventing losses and deterioration). In the longer run, the elevator can affect wheat quality by establishing a discount and premium schedule which encourages producers to change management practices (such as weed control and combine settings) to deliver cleaner wheat. Elevator's can also install and use wheat cleaners to reduce the amount of dockage and foreign material.

A cooperative manager also faces unique challenges in developing and implementing grain quality related policies. Due to the democratic nature of a cooperative's decisions, quality related policies could become controversial in a cooperative. These same policies can be implemented at the discretion of the manager in an investor owned firm. One quality related policy that is especially controversial in a cooperative is improving grading accuracy.

Inaccurate grain grading impacts the profitability of a cooperative, and unlike investor owned firms, the costs of inaccurate grading are entirely borne by the farmer members. Grading accuracy directly affects the cooperative's ability to equitably distribute marketplace incentives to its members. Because grain margins must cover grading losses, inaccurate grading may subsidize members delivering lower quality grain at the expense of members delivering higher quality grain. In the long run, inaccurate grading also fails to provide members with incentives to invest in weed control, variety selection, and other quality enhancing practices.

Grading accuracy is also an important equity and fairness issue in a cooperative. Unlike investor owned firms, cooperatives distribute the surplus from operations to the patrons based on patronage rather than on the basis of stock ownership (USDA, 1982). Therefore, the accuracy of revenue and cost estimates (including grading costs) from a cooperative elevator must be assessed in order to provide a fair distribution to each patron.

Despite the important implications of accurate grading on cooperative profitability, and the potential that member reaction may limit the managers flexibility in enforcing accurate grading, no previous research has addressed the accuracy of a cooperative's pricing strategies.

Objectives

The objectives are to determine the grading and pricing accuracy of cooperative wheat elevators and to investigate the differences between cooperatives and investor-owned wheat elevators in grading wheat delivered by producers. The economic impact of grading inaccuracy on the cooperative as a whole, and on members delivering various qualities of grain is also examined.

The objectives are divided into two research questions:

(1) Do significant grading differences exist between cooperatives and independent elevators? Specifically, do cooperatives grade less accurately than independent elevators?

(2) What are the implications of cooperative elevator grading practices on members delivering various qualities of grain?

Methods and Procedures

To address research question 1, "Do significant grading differences exist between cooperative and independent elevators," three unique methods were used. First, a split sample statistical test (t-test of differences between means) was used to determine if statistically significant differences in grading accuracy were present with respect to firm type (cooperative or independent).

Also, to address research question 1, a paired difference test determined the economic impact of cooperative grading inaccuracy. In the paired difference test, discount schedules were obtained from Oklahoma and regional terminal elevators for the 1996 crop year. Quality factor discounts were computed for each load of wheat based on both the elevator grader estimates and the official grade analysis. The difference in discounts indicated an elevator's loss or gain caused by grading inaccurately.

The third method used was an ordinary least squares (OLS) regression. This method more formally tested the impact of firm type on grading accuracy. The OLS model determined the effect that firm type, grade method, and region had on percentage dockage. The corresponding OLS function is

(6.1) *Percentage Dockage Error = f(Firm Type, Grade Method, Region).*

Each independent variable in the OLS model is an indicator variable included to control for the impact of region, firm type, and grade method. The firm type variable was included to determine the impact of a cooperative controlled firm compared to an investor owned firm on percentage dockage error. A cooperative elevator was expected to grade less accurately than investor owned firms, thereby increasing the percentage dockage error. The grade method variable was included to determine the differences between using a dockage machine compared to the hand pan sieve method for measuring dockage. An elevator using a dockage machine is hypothesized to grade more accurately than one using the hand grade method, thereby decreasing the percentage dockage error. Finally, the region variable was included to determine the affect of the elevator's region on percentage dockage error. The affect of region on percentage dockage error depends upon the quality of the wheat crop in a particular region. Due to the diversity of the growing conditions by region, the affect of region on percentage dockage error was not hypothesized.

Research question 2, the implications of cooperative elevator grading practices on members delivering various qualities of grain, was determined by sorting the load data into four dockage categories (quartiles) based on the official dockage levels. These categories related to the percentage of dockage that was recorded for each producer truckload. Categories were compiled by segregating producer truckloads sequentially into dockage quartiles relative to other truckloads. Then an elevator and official quartile estimate of the dockage discount was determined using the scale ticket data. The difference between the official and elevator discount was determined for each quartile, and a gain or loss was computed for each quartile. This will indicate how much cooperative elevator grading practices distort market incentives by subsidizing producers delivering high dockage wheat at the expense of low dockage producers.

Results

Research Question 1

The split sample statistical test compared the grading accuracy of cooperative and independent elevators. The test uncovered some differences with respect to firm type (Table 6.1). In general, the cooperative elevator's grading error in estimating grade, dockage, shrunken and broken kernels, and total defects were higher than the independent elevators. Cooperatives had a higher tendency to under-estimate dockage, shrunken and broken kernels and total defects, and to over-estimate grade.

In the paired difference test, the estimation of dockage had the largest economic impact on cooperatives. On average, a cooperative elevator's underestimation of dockage resulted in the cooperative absorbing price discounts of .69 cents per bushel. Underestimating dockage also implied that the cooperative elevators were not subtracting the appropriate amount of dockage from the net weight of wheat delivered, which had an additional impact of 3.19 cents per bushel. The cooperative elevators' tendency to overestimate test weight and underestimate the other grade factors also resulted in difference in the final grade assigned and/or triggered different grade factor discounts. The total economic loss to the cooperative elevator from inaccurate grading procedures was 5.33 cents per bushel (Table 6.2). Independent elevators also had the tendency to underestimate dockage and other undesirable quality factors while slightly over-estimating test weight (Table 6.3). However, the lenient grading practices cost the cooperative elevators over 3.81 cents per bushel more than the independent elevators included in the sample.

The OLS model determined the effect of firm type, grading method, and region on the percentage error in dockage estimation. The coefficient on the firm type (cooperative versus independent) variable had a positive sign and was significant at the .0001 level indicating that the percentage error in dockage measurement by the cooperative sub-sample was approximately 60% higher than the independent firms (Table 6.4). The negative coefficient on grade method indicated that the use of automatic dockage testers resulted in a statistically significant reduction in dockage measurement error. The coefficients on the regional variables were positive and also significant at the .001 levels. The positive coefficients indicated that the location of an elevator in a region with higher average dockage levels relative to the base region increased the percentage of measurement error.

Research Question 2

In 1996, one quarter of the sample (207 loads) having the highest dockage averaged 2 percent dockage (Table 6.5 and 6.6). On average, the cooperative elevator estimated the dockage in these loads to be .60 percent. Overestimating the net weight of grain delivered (by underestimating dockage by 1.4 percent) cost the elevators 6.65 cents per bushel. Based on their grades and dockage estimates, the cooperative discounted the price paid to the producers by .75 cents per bushel. When the cooperative shipped the wheat to a terminal elevator or exporter, they received a 3.15 cent per bushel price discount that was based on the official estimate of dockage and grade factors. The total price discount absorbed by the cooperative for these 207 loads was 2.4 cents per bushel. Combined with the loss from overestimating dockage free of net weight, cooperative elevators lost 9.05 cents per bushel. Relative to the average, the producers delivering these loads received 5.08 cents per bushel more for their wheat. In contrast, the 208 loads with the lowest dockage sampled in 1996 averaged .26% dockage. On average, the elevators estimated the dockage of these loads to be .04 percent. Underestimating dockage by .22 percent cost the cooperative only .01 cents per bushel. Underestimating the dockage resulted in the elevators paying this category of producers 1.03 cents per bushel more than the true market value of the wheat. However, this represented 2.94 cents per bushel less than the overall average. Therefore, cooperatives paid producers delivering higher dockage wheat more relative to producers delivering lower dockage wheat.

Conclusions

The results of this study support the assertion that cooperatives often grade less accurately than independent elevators. The results of research question 1 show that there are significant grading differences between cooperative and independent elevators. Specifically, cooperatives were shown to grade less accurately and experience more grading losses than independent elevators. In fact, the percentage error in dockage measurement by the cooperative elevators was approximately 60% higher than the independent firms. Finally, the results of research question 2 show that cooperative elevators may subsidize high dockage producers at the expense of lower dockage producers.

A cooperative elevator's grading inaccuracy occurs for a variety of reasons ranging from adverse member reaction (some members may serve on the board of directors) to lack of investment in automated technologies such as dockage machines (board of directors must approve all capital outlays). Also, some cooperative managers believe that the cooperative has a responsibility to accept lower quality wheat due to member ownership. This perception is coupled with a lack of previous research on the affects of grading inaccuracy on the equity distribution to members delivering different qualities of grain. Therefore, since the losses from grading inaccuracy are borne by the farmer members, grading accuracy is an important issue for a cooperative and should be addressed by a cooperative's management.

The primary focus of this research was not to investigate the exact magnitude of the grading difference between cooperatives and investor owned firms. However, the results of the research suggest that there are some differences in grading accuracy with respect to firm type. The sample size and regional distribution of the elevator observations limited the control that variables other than firm type had on the assessment of grading accuracy. Therefore, further research is needed to more accurately address the magnitude of grading differences between cooperatives and investor owned firms.

Table 6.1 Analysis of Independent vs. Cooperative Elevator Grading Accuracy (1996)

Percentage Error ((official-elevator)/official)	Independent	Cooperative
Dockage*	0.088	0.780
Moisture*	-0.011	-0.011
Test Weight*	-0.007	-0.006
Foreign Material*	1.000	0.999
Damage*	1.000	1.000
S&B*	0.509	0.719
Total Defects*	0.559	0.732
Grade*	0.091	0.119

*Means significantly different at the .05 level.

Table 6.2 Economic Impact of Grading Accuracy on Cooperative Elevators (1996)

	Average Elevator Grade (Discount)	Average Official Grade (Discount)	Difference (Official minus Elevator)
Dockage	0.27% (-0.29¢)	0.94% (-0.98¢)	0.67% (-0.69¢)
Test Weight	58.71 LBS. (-2.30¢)	58.36 LBS. (-3.45¢)	-0.35 LBS. (-1.16¢)
Grade	#1 38.3% #2 34.5% #3 20.4% #4 6.6% #5 0.0% #6 0.2% SG 0.0% (-0.65¢)	#1 19.2% #2 35.8% #3 27.4% #4 12.7% #5 3.9% #6 0.7% SG 0.2% (-1.75¢)	(-1.10¢)
Foreign Material	0.00% (0.00¢)	0.08% (-0.09¢)	0.08% (-0.09¢)
Damage	0.00% (0.00¢)	0.04% (0.00¢)	0.04% (0.00¢)
Shrunken & Broken	0.60% (-0.15¢)	1.76% (-0.16¢)	1.16% (-0.01¢)
Total Defects	0.60% (-0.11¢)	1.89% (-0.19)¢	1.29% (-0.07¢)
Protein		14.07%	14.07%
Factor Discount	-3.73¢	-5.87¢	-2.14¢
Value of Dockage Forgiven			-3.19¢
Total Economic Impact			-5.33¢
Sample Size = 829			

Table 6.3 Economic Impact of Grading Accuracy on Independent Elevators (1996)

	Average Elevator Grade (Discount)	Average Official Grade (Discount)	Difference (Official minus Elevator)
Dockage	0.93% (-1.31¢)	1.00% (-1.07¢)	0.07% (0.23¢)
Test Weight	57.84 LBS. (-4.87¢)	57.50 LBS. (-6.19¢)	-0.34 LBS. (-1.32¢)
Grade	#1 18.6% #2 25.1% #3 32.0% #4 16.9% #5 7.1% #6 0.0% SG 0.4% (-1.91¢)	#1 10.3% #2 23.5% #3 27.1% #4 29.4% #5 9.2% #6 0.6% SG 0.0% (-2.51¢)	(-0.59¢)
Foreign Material	0.00% (0.00¢)	0.07% (-0.04¢)	0.07% (-0.04¢)
Damage	0.00% (0.00¢)	0.06% (0.00¢)	0.06% (0.00¢)
Shrunken & Broken	0.57% (-0.16¢)	2.12% (-0.20¢)	1.54% (-0.04¢)
Total Defects	0.57% (-0.14¢)	2.25% (-0.24¢)	1.68% (-0.09¢)
Protein		14.02%	14.02%
Factor Discount	-7.57¢	-8.76¢	-1.19¢
Value of Dockage Forgiven			-0.33¢
Total Economic Impact			-1.52¢

Sample Size = 524

Table 6.4 Statistical Effects of Cooperatives, Grade Methods, and Production Regions (1996[a]), OLS Regression - Dependent Variable: % Error in dockage estimated

Variable	Parameter Estimate	Standard Error	T Statistic	Prob > |T|
Intercept	-0.156	0.087	-1.781	0.0752
Cooperative*	0.604	0.060	10.124	0.0001
Grade Method**	-0.385	0.066	-5.864	0.0001
Region 2	0.799	0.082	9.740	0.0001
Region 4	0.337	0.062	5.392	0.0001
Region 5	1.166	0.063	18.505	0.0001

F Value = 131.754, Prob > F 0.0001
Adjusted R square = 0.3264

* Cooperative Elevators = 1 & Independent Elevators = 0
** Dockage Machine = 1 & Hand Grade = 0
a. The statistical effects of cooperatives, grade methods, and production regions were not computed in 1995 due to an unbalanced number of cooperative and investor owned firms.

Table 6.5 Accuracy of Dockage Estimates by Cooperative Elevators (by dockage category)

	High Dockage (n=207)	Moderately High Dockage (n=207)	Moderately Low Dockage (n=207)	Low Dockage (n=208)
Elevator Estimate	0.60%	0.30%	0.13%	0.04%
Official Estimate	2.00%	0.88%	0.53%	0.26%
Difference	1.40%	0.58%	0.40%	0.22%
Value of Dockage Forgiven	6.65¢	2.76¢	1.9¢	1.04¢
Price Discount Elevator Estimate	0.75¢	0.30¢	0.08¢	0.01¢
Price Discount Official Estimate	3.15¢	0.60¢	0.00¢	0.00¢
Price Discount Absorbed	2.4¢	0.30¢	-0.08¢	-0.01¢
Total Impact	9.05¢	3.06¢	1.82¢	1.03¢
Total Impact Relative to Average	5.08¢	-0.91¢	-2.14¢	-2.94¢

Table 6.6 Accuracy of Dockage Estimates by Cooperative Elevators (by dockage category)

	High Dockage (highest n=207)	Moderately High Dockage (n=207)	Moderately Low Dockage (n=207)	Low Dockage (n=208)
Elevator Estimate	0.60%	0.30%	0.13%	0.04%
Official Estimate	2.00%	0.88%	0.53%	0.26%
Producer's Gain or Loss	9.05¢	3.06¢	1.82¢	1.03¢
Producer's Gain or Loss Relative to Average	5.08¢	-0.91¢	-2.14¢	-2.94¢

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The research accomplished three specific objectives. It examined the grading accuracy of country wheat elevators, and the load-by-load variation in quality received by elevators. In addition, it also evaluated effective blending, cleaning, and marketing alternatives for country elevators. Finally, it compared the grading accuracy of cooperative and investor-owned elevators. All three objectives used actual harvest wheat quality data from the 1995 and 1996 wheat harvests.

The methods that accomplished each objective are: (1) a paired difference test determined if elevators inaccurately grade and price grain, (2) a normative blending, cleaning, and marketing model determined the most profitable segregation and cleaning strategies, and (3) a second paired difference test compared the grading accuracy of cooperative and investor-owned elevators.

The results of the first paired difference test found that country elevators tend to underestimate undesirable factors such as dockage, and overestimate grain quality. These results were consistent with earlier studies that determined that elevator graders often skip grading steps and grade more leniently than official grade agencies. This grading inaccuracy cost elevators several cents per bushel depending on the wheat quality of the harvest year. An elevator's grading inaccuracy also hurt producers delivering high quality grain. The results found that when elevators inaccurately grade grain they often subsidize low quality wheat producers at the expense of high quality wheat producers. Therefore, assuming that elevators pass on the savings from more accurate grading in the form of higher wheat prices, producers delivering the cleanest wheat have the most to gain.

The results of the blending, cleaning, and marketing model found that segregating and cleaning wheat could increase elevator revenues, and improve the quality of U.S. wheat. In years characterized by high dockage levels, elevators can clean a portion of their wheat before shipment, increasing net revenue by roughly 3 cents per bushel. In high dockage years, the segregation strategy used had an impact on the effectiveness of an elevator's cleaning activities. For elevators with cleaning equipment, segregation increased net revenue by .49 to .63 cents per bushel. Segregation had an even greater impact on elevators without cleaning equipment increasing net revenue by almost 4 cents per bushel. However, in low dockage years neither segregating nor cleaning had an impact on the net revenues of an elevator.

The results of the second paired difference test supported the assertion that cooperatives often grade less accurately than investor-owned elevators. Specifically, cooperatives were found to grade less accurately and experience more grading losses than their independent counterparts.

Importance of Study

The results of this research are important to the entire wheat industry of the United States. The results indicate that country elevators are not grading and pricing based on quality. Producers delivering higher quality wheat are not being rewarded. As a result producers have no incentive to invest in quality enhancing practices.

The competitiveness of the U.S. wheat industry will suffer if elevators continue to grade inaccurately and fail to provide correct quality incentives. Since cleanliness and uniformity are becoming more important to wheat importers, countries such as Canada and Australia which export extremely clean wheat continue to increase their market share at the expense of the United States.

Most of the grain in the U.S. market must pass through a country elevator. Therefore, signals from importers and buyers across the world must be communicated to domestic producers through the prices that country elevators set for various qualities of wheat (Johnson and King, 1988). Increasing the accuracy of elevator grading practices will increase the usefulness of wheat quality information to the end user. Similarly, when country elevators grade wheat more accurately they can provide better incentives to producers to increase the overall quality of U.S. wheat.

Need for Further Research

In Chapter 4, grade and dockage determination had significant revenue implications for country elevators. While these measures were addressed, new measures such as kernel size, protein, wet gluten, extraction, falling number, and farinograph stability are also becoming important to end users. New testing technologies are beginning to allow quick and accurate testing of some of these quality needs. As the availability of these technologies increase, further research is needed to test the feasibility of these technologies for country elevators.

In chapter 5, the potential profit from segregating, blending, and cleaning was addressed. Due to the quality needs of the end user and the increasingly competitive wheat marketplace, cleaning a portion of an elevator's wheat was shown to be profitable in high dockage years. However, due to the year-to-year variation in wheat quality, a longer time series is needed to fully examine the feasibility of purchasing cleaning equipment.

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APPENDIX A

SUPPORTING DATA

Table A.1 Dockage Specifications of the World's Leading HRW Importers

Rank	Country	Level at Which Discounts are Initialized	Maximum Level Allowed
1	Japan	All deductible	0.5%
2	Egypt	All deductible	0.8%
3	Philippines	All deductible	No limit
4	Korea	All deductible	0.7%
5	Mexico	0.5%	1.0%

* Survey by Wheat Associates 8/1/97.

Table A.2 Oklahoma Wheat Quality (1990-1994)

Year	Test Weight	Dockage	Shrunken and Broken Kernels	Foreign Material	Damage	Total Defects	Protein
1990	59.7	.7	2.14	.18	.39	2.14	11.4
1991	60.8	.7	1.56	.25	.56	1.56	12.5
1992	59.0	1.1	1.90	.26	2.46	4.62	11.4
1993	60.1	1.1	1.95	.24	.38	2.52	11.2
1994	59.5	1.2	1.77	.37	.50	2.68	13.3

*Source: Oklahoma Agricultural Statistics and Oklahoma Wheat Commission
**Reporting discontinued in 1995.

Table A.3 Kansas Wheat Quality (1984-1993, 1994 & 1995)

Year	Test Weight	Dockage	Shrunken and Broken Kernels	Foreign Material	Damage	Total Defects	Protein
Average 1984-1993	60.1	.7	2.0	.1	.2	2.3	12.1
1994	58.7	.6	2.5	0	.1	2.6	12.2
1995	60.8	.9	2.4	0	0	2.4	12.0

*Source: Kansas Wheat Quality 1995, Kansas Agricultural Statistics, Sept 9, 1995.

Table A.4 Kansas City Protein Premiums (8 Year Average, October 1988 to March 1996 (¢/bu.))

Protein	January 15	March 1	August 15	Nov. 15
11.00	.25	0.13	0.88	0.25
11.20	.50	0.25	1.38	0.63
11.40	1.00	0.50	2.00	1.75
11.60	1.56	1.25	2.50	2.38
11.80	2.56	1.63	3.25	3.19
12.00	2.94	1.88	4.25	5.00
12.20	3.56	2.75	4.69	6.19
12.40	4.44	3.94	6.19	7.50
12.60	5.50	6.13	8.44	8.19
12.80	6.25	9.00	9.69	10.69
13.00	10.31	11.19	11.50	14.19
13.20	12.19	12.94	13.13	15.81
13.40	14.13	14.94	14.63	17.69
13.60	16.13	17.31	16.25	20.19
13.80	17.13	18.69	18.25	22.06
14.00	21.50	21.44	19.06	28.19

*Source: Kansas City Board of Trade Review

APPENDIX B

TABLES NOT REFERENCED

Table B.1 Optimal Percentage of Wheat to Clean and Impact on Price Received Net of Cleaning Costs (1995*)

	Percentage Cleaned	Net Price with Cleaning	Net Price without Cleaning	Non-cleaning Net Price as Percentage of Cleaning Net Price
Overall	35.59%	\$3.8977	\$3.8264	98.17%
Elevator 1	79.13%	\$3.8423	\$3.7631	97.94%
Elevator 2	13.89%	\$4.0255	\$3.9907	99.14%
Elevator 3	28.92%	\$3.9387	\$3.8903	98.77%
Elevator 4	26.14%	\$3.9145	\$3.8408	98.12%
Elevator 5	6.74%	\$3.9119	\$3.8998	99.69%
Elevator 6	0.00%	\$3.8947	\$3.8947	100.00%
Elevator 7	0.00%	\$3.9169	\$3.9169	100.00%
Elevator 8	0.00%	\$3.9199	\$3.9199	100.00%
Elevator 9	14.9%	\$3.8591	\$3.8054	98.61%
Elevator 10	79.47%	\$3.8391	\$3.6361	94.71%
Elevator 11	18.81%	\$3.901	\$3.8390	98.41%
Elevator 12	44.16%	\$3.9147	\$3.7714	96.34%
Elevator 13	0.00%	\$3.8688	\$3.8057	98.37%
Elevator 14	0.00%	\$3.9183	\$3.9183	100.00%
Elevator 15	0.00%	\$3.9218	\$3.9218	100.00%
Elevator 16	0.00%	\$3.9032	\$3.9032	100.00%

*Cleaning was not indicated to be optimal for any elevator in 1996.

Table B.2 Quality Factor Mean, Variance, and Skewness (1995)

FACTOR	Mean	Variance	Skewness	Kurtosis	Prob<W	W Stat.
Protein	12.42%	1.463	-0.001	-0.088	0.253	0.986
Dockage	3.85%	34.226	2.556	8.770	0.000	0.676
Test Weight	57.75 lb/bu	4.139	-0.959	1.620	0.000	0.944
Grade	2.70	1.264	0.880	0.915	0.000	0.868

Table B.3 Quality Factor Mean, Variance, and Skewness (1996)

FACTOR	Mean	Variance	Skewness	Kurtosis	Prob<W	W Stat.
Protein	14.04%	1.6392	-0.3992	0.4114	0.0001	0.977
Dockage	0.97%	1.1822	4.6036	33.1574	0.0000	0.632
Test Weight	58.00 lb/bu	5.5102	-0.3589	-0.0263	0.0001	0.975
Grade	2.71	1.3694	0.3655	-0.4007	0.0000	0.901

Table B.4 Analysis of Segregating by Protein for Each Elevator (1995*)

	Without Flour	With Flour			
Elevator	Net Return/Bu.	% Flour Wheat	Net Return/Bu. Commodity Wheat	Total Flour Wheat Premiums	Total Value of Protein Segregation
Elevator 1	$3.8423	0.00%	$3.8408	$0.00	$11898.80
Elevator 2	$4.0255	18.06%	$3.9098	$27090	$21681.96
Elevator 3	$3.9387	12.47%	$3.9359	$18705	$12928.02
Elevator 4	$3.9145	18.25%	$3.9126	$23375	$17979.50
Elevator 5	$3.9119	27.65%	$3.9119	$41475	$36699.9
Elevator 6	$3.8947	23.21%	$3.8856	$34815	$29746.86
Elevator 7	$3.9169	49.70%	$3.9164	$74550	$71230.20
Elevator 8	$3.9199	28.02%	$3.9147	$42030	$37279.32
Elevator 9	$3.8591	13.57%	$3.8566	$20355	$14650.62
Elevator 10	$3.8391	7.34%	$3.8349	$11010	$4894.44
Elevator 11	$3.9010	24.50%	$3.8966	$36750	$31767.00
Elevator 12	$3.9147	14.17%	$3.9045	$21255	$15590.22
Elevator 13	$3.8688	4.02%	$3.9041	$6030	-$304.68
Elevator 14	$3.9183	18.02%	$3.9182	$27030	$21619.32
Elevator 15	$3.9218	32.45%	$3.9218	$48675	$44216.70
Elevator 16	$3.9032	21.06%	$3.9017	$31590	$26379.96

*Protein segregation was not profitable in 1996.

Table B.5 Grading Accuracy of Elevator 1 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	13.28% (.00¢)	14.84% (-6.00¢)	1.55% (-6.00¢)
DOCKAGE	1.5% (.00¢)	3.29% (-3.00¢)	1.79% (-3.00¢)
TEST WEIGHT	56.88 LBS. (-3.00¢)	57.66 LBS. (-2.00¢)	.79 LBS. (1.00¢)
GRADE	#1 #2 12.5% #3 75.0% #4 12.5% #5 #6 SG (-3.00¢)	#1 12.5% #2 37.5% #3 25.0% #4 12.5% #5 12.5% #6 SG (-.50¢)	(2.5¢)
FOREIGN MATERIAL	0% (.00¢)	.21% (.00¢)	.21% (.00¢)
DAMAGE	0%	2.43%	2.43%
SHRUNKEN & BROKEN	0% (.00¢)	.96% (.00¢)	.96% (.00¢)
TOTAL DEFECTS	0% (.00¢)	3.60% (.00¢)	3.60% (.00¢)
PROTEIN		11.84%	11.84%
FACTOR DISCOUNT	-6.00¢	-11.50¢	-5.5¢
VALUE OF DOCKAGE FORGIVEN			-6.26¢
TOTAL ECONOMIC IMPACT			-11.76¢

SAMPLE SIZE = 8

Table B.6 Grading Accuracy of Elevator 2 (1995) – West Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	11.03% (.00¢)	11.71% (.00¢)	.69% (.00¢)
DOCKAGE	3.29% (-3.00¢)	3.62% (-3.00¢)	.33% (.00¢)
TEST WEIGHT	59.03 LBS. (.00¢)	57.99 LBS. (.00¢)	-1.04 LBS. (.00¢)
GRADE	#1 45.0% #2 42.0% #3 10.0% #4 3.0% #5 #6 SG (.00¢)	#1 6.0% #2 55.0% #3 24.0% #4 12.0% #5 3.0% #6 SG (-.50¢)	(-.50¢)
FOREIGN MATERIAL	0% (.00¢)	.26% (.00¢)	.26% (.00¢)
DAMAGE	0%	.20%	.20%
SHRUNKEN & BROKEN	1.31% (.00¢)	1.86% (-.50¢)	.55% (-.50¢)
TOTAL DEFECTS	2.12% (.00¢)	2.33% (.00¢)	.21% (.00¢)
PROTEIN		12.28%	12.28%
FACTOR DISCOUNT	-3.00¢	-3.50¢	-.50¢
VALUE OF DOCKAGE FORGIVEN			-1.15¢
TOTAL ECONOMIC IMPACT			-1.66¢
SAMPLE SIZE = 100			

Table B.7 Grading Accuracy of Elevator 3 (1995) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	12.08% (.00¢)	11.88% (.00¢)	-.20% (.00¢)
DOCKAGE	.49% (.00¢)	4.49% (-7.00¢)	4.01% (-7.00¢)
TEST WEIGHT	58.54 LBS. (.00¢)	58.95 LBS. (.00¢)	.41 LBS. (.00¢)
GRADE	#1 41.0% #2 43.0% #3 10.0% #4 5.0% #5 1.0% #6 SG (.00¢)	#1 23.8% #2 51.5% #3 18.8% #4 5.0% #5 1.0% #6 SG (-.50¢)	(-.50¢)
FOREIGN MATERIAL	0% (.00¢)	.31% (.00¢)	.31% (.00¢)
DAMAGE	0%	.18%	.18%
SHRUNKEN & BROKEN	0% (.00¢)	1.78% (-.50¢)	1.78% (-.50¢)
TOTAL DEFECTS	0% (.00¢)	2.26% (.00¢)	2.26% (.00¢)
PROTEIN		11.93%	11.93%
FACTOR DISCOUNT	.00¢	-7.50¢	-7.50¢
VALUE OF DOCKAGE FORGIVEN			-14.03¢
TOTAL ECONOMIC IMPACT			-21.53¢
SAMPLE SIZE = 101			

Table B.8 Grading Accuracy of Elevator 4 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	12.51% (.00¢)	12.00% (.00¢)	-.51% (.00¢)
DOCKAGE	3.06% (-3.00¢)	4.88% (-7.00¢)	1.82% (-4.00¢)
TEST WEIGHT	58.24 LBS. (.00¢)	58.31 LBS. (.00¢)	.07 LBS. (.00¢)
GRADE	#1 5.3% #2 59.6% #3 34.0% #4 1.1% #5 #6 SG (-.50¢)	#1 8.2% #2 53.6% #3 25.8% #4 8.2% #5 1.0% #6 1.0% SG 2.1% (-.50¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.40% (.00¢)	.40% (.00¢)
DAMAGE	0%	.78%	.78%
SHRUNKEN & BROKEN	0% (.00¢)	1.11% (.00¢)	1.11% (.00¢)
TOTAL DEFECTS	0% (.00¢)	2.27% (.00¢)	2.27% (.00¢)
PROTEIN		12.05%	12.05%
FACTOR DISCOUNT	-3.50¢	-7.50¢	-4.00¢
VALUE OF DOCKAGE FORGIVEN			-6.37¢
TOTAL ECONOMIC IMPACT			-10.37¢

SAMPLE SIZE = 97

Table B.9 Grading Accuracy of Elevator 5 (1995) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	11.97% (.00¢)	11.71% (.00¢)	-.27% (.00¢)
DOCKAGE	.63% (.00¢)	2.99% (.00¢)	2.36% (.00¢)
TEST WEIGHT	56.14 LBS. (-3.00¢)	58.07 LBS. (.00¢)	1.93 LBS. (3.00¢)
GRADE	#1 4.0% #2 26.0% #3 34.0% #4 21.0% #5 15.0% #6 SG (-3.00¢)	#1 12.0% #2 46.0% #3 22.0% #4 17.0% #5 2.0% #6 1.0% SG (-.50¢)	(2.50¢)
FOREIGN MATERIAL	0% (.00¢)	.38% (.00¢)	.38% (.00¢)
DAMAGE	0%	.18%	.18%
SHRUNKEN & BROKEN	0% (.00¢)	1.60% (-.50¢)	1.60% (-.50¢)
TOTAL DEFECTS	0% (.00¢)	2.17% (.00¢)	2.17% (.00¢)
PROTEIN		12.56%	12.56%
FACTOR DISCOUNT	-6.00¢	-.50¢	5.50¢
VALUE OF DOCKAGE FORGIVEN			-8.25¢
TOTAL ECONOMIC IMPACT			-2.75¢
SAMPLE SIZE = 100			

Table B.10 Grading Accuracy of Elevator 6 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	14.57% (.00¢)	14.42% (-3.00¢)	-.15% (-3.00¢)
DOCKAGE	2.62% (.00¢)	1.28% (.00¢)	-1.34% (.00¢)
TEST WEIGHT	58.23 LBS. (.00¢)	57.53 LBS. (-2.00¢)	-.71 LBS. (-2.00¢)
GRADE	#1 35.5% #2 25.8% #3 29.0% #4 3.2% #5 1.6% #6 4.8% SG (-.50¢)	#1 1.6% #2 53.1% #3 18.8% #4 18.8% #5 6.3% #6 1.6% SG (-.50¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.14% (.00¢)	.14% (.00¢)
DAMAGE	0%	1.50%	1.5%
SHRUNKEN & BROKEN	1.16% (.00¢)	.79% (.00¢)	-.37% (.00¢)
TOTAL DEFECTS	2.58% (.00¢)	2.44% (.00¢)	-.14% (.00¢)
PROTEIN		11.41%	11.41%
FACTOR DISCOUNT	-.50¢	-5.50¢	-5.00¢
VALUE OF DOCKAGE FORGIVEN			4.68¢
TOTAL ECONOMIC IMPACT			-.32¢
SAMPLE SIZE = 64			

Table B.11 Grading Accuracy of Elevator 7 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	11.37% (.00¢)	12.07% (.30¢)	.70% (.00¢)
DOCKAGE	1.67% (.00¢)	1.72% (.00¢)	.05% (.00¢)
TEST WEIGHT	58.77 LBS. (.00¢)	58.06 LBS. (.00¢)	-.71 LBS. (.00¢)
GRADE	#1 30.3% #2 52.5% #3 15.2% #4 2.0% #5 #6 SG (.00¢)	#1 7.1% #2 58.6% #3 21.2% #4 11.1% #5 1.0% #6 1.0% SG (-.50¢)	(-.50¢)
FOREIGN MATERIAL	0% (.00¢)	.13% (.00¢)	.13% (.00¢)
DAMAGE	0%	.56%	.56%
SHRUNKEN & BROKEN	0% (.00¢)	1.33% (.00¢)	1.33% (.00¢)
TOTAL DEFECTS	0% (.00¢)	2.02% (.00¢)	2.02% (.00¢)
PROTEIN		12.84%	12.84%
FACTOR DISCOUNT	.00¢	-.50¢	-.50¢
VALUE OF DOCKAGE FORGIVEN			-.17¢
TOTAL ECONOMIC IMPACT			-.67¢
SAMPLE SIZE = 99			

Table B.12 Grading Accuracy of Elevator 8 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	14.34% (-3.00¢)	14.25% (-3.00¢)	-.09% (.00¢)
DOCKAGE	.90% (.00¢)	1.01% (.00¢)	.10% (.00¢)
TEST WEIGHT	58.00 LBS. (.00¢)	58.55 LBS. (.00¢)	.55 LBS. (.00¢)
GRADE	#1 7.4% #2 59.3% #3 33.3% #4 #5 #6 SG (-.50¢)	#1 11.1% #2 51.9% #3 33.3% #4 #5 #6 3.7% SG (-.50¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.16% (.00¢)	.16% (.00¢)
DAMAGE	0%	1.00%	1.00%
SHRUNKEN & BROKEN	0% (.00¢)	.94% (.00¢)	.94% (.00¢)
TOTAL DEFECTS	0% (.00¢)	2.06% (.00¢)	2.06% (.00¢)
PROTEIN		12.09%	12.09%
FACTOR DISCOUNT	-3.50¢	-3.50¢	.00¢
VALUE OF DOCKAGE FORGIVEN			-.36¢
TOTAL ECONOMIC IMPACT			-.36¢
SAMPLE SIZE = 27			

Table B.13 Grading Accuracy of Elevator 9 (1995) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	12.07% (.00¢)	11.38% (.00¢)	-.69% (.00¢)
DOCKAGE	1.54% (.00¢)	4.12% (-7.00¢)	2.58% (-7.00¢)
TEST WEIGHT	55.76 LBS. (-5.00¢)	56.33 LBS. (-4.00¢)	.57 LBS. (1.00¢)
GRADE	#1 #2 21.95 #3 38.5% #4 25.0% #5 11.5% #6 3.1% SG (-3.00¢)	#1 #2 25.0% #3 34.4% #4 22.9% #5 16.7% #6 1.0% SG (-3.00¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.51% (.00¢)	.51% (.00¢)
DAMAGE	0%	.61%	.61%
SHRUNKEN & BROKEN	0% (.00¢)	1.88% (-.50¢)	1.88% (-.50¢)
TOTAL DEFECTS	0% (.00¢)	3.04% (.00¢)	3.04% (.00¢)
PROTEIN		12.38%	12.38%
FACTOR DISCOUNT	-8.00¢	-14.00¢	-6.00¢
VALUE OF DOCKAGE FORGIVEN			-9.03¢
TOTAL ECONOMIC IMPACT			-15.03¢
SAMPLE SIZE = 96			

Table B.14 Grading Accuracy of Elevator 10 (1995) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	12.57% (.00¢)	12.24% (.00¢)	-.33% (.00¢)
DOCKAGE	4.84% (-7.00¢)	8.93% (.00¢)	4.09% (7.00¢)
TEST WEIGHT	55.71 LBS. (-5.00¢)	55.82 LBS. (-6.00¢)	.11 LBS. (-1.00¢)
GRADE	#1 3.0% #2 10.0% #3 48.0% #4 24.0% #5 13.0% #6 2.0% SG (-3.00¢)	#1 2.0% #2 8.0% #3 46.0% #4 24.0% #5 16.0% #6 4.0% SG (-3.00¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.31% (.00¢)	.31% (.00¢)
DAMAGE	0%	.19%	.19%
SHRUNKEN & BROKEN	0% (.00¢)	1.99% (.00¢)	1.99% (.00¢)
TOTAL DEFECTS	0% (.00¢)	2.46% (.00¢)	2.46% (.00¢)
PROTEIN		13.01%	13.01%
FACTOR DISCOUNT	-15.00¢	-9.00¢	6.00¢
VALUE OF DOCKAGE FORGIVEN			-14.31¢
TOTAL ECONOMIC IMPACT			-8.31¢
SAMPLE SIZE = 100			

Table B.15 Grading Accuracy of Elevator 11 (1995) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	11.67% (.00¢)	11.36% (.00¢)	-.31% (.00¢)
DOCKAGE	2.47% (.00¢)	4.33% (-7.00¢)	1.86% (-7.00¢)
TEST WEIGHT	58.25 LBS. (.00¢)	57.74 LBS. (-2.00¢)	-.51 LBS. (-2.00¢)
GRADE	#1 28.0% #2 33.0% #3 26.0% #4 8.0% #5 3.0% #6 2.0% SG (-.50¢)	#1 5.0% #2 37.0% #3 38.0% #4 16.0% #5 3.0% #6 1.0% SG (-.50¢)	(.00¢)
FOREIGN MATERIAL	.07% (.00¢)	.38% (.00¢)	.31% (.00¢)
DAMAGE	.02%	.25%	.23%
SHRUNKEN & BROKEN	.16% (.00¢)	1.70% (-.50¢)	1.54% (-.50¢)
TOTAL DEFECTS	.25% (.00¢)	2.36% (.00¢)	2.11% (.00¢)
PROTEIN		13.68%	13.68%
FACTOR DISCOUNT	-.50¢	-9.50¢	-9.00¢
VALUE OF DOCKAGE FORGIVEN			-6.51¢
TOTAL ECONOMIC IMPACT			-15.51¢
SAMPLE SIZE = 100			

Table B.16 Grading Accuracy of Elevator 12 (1995) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	13.57% (.00¢)	11.72% (.00¢)	-1.84% (.00¢)
DOCKAGE	4.38% (-7.00¢)	6.36% (-15.00¢)	1.97% (-8.00¢)
TEST WEIGHT	58.33 LBS. (.00¢)	58.03 LBS. (.00¢)	-.31 LBS. (.00¢)
GRADE	#1 35.4% #2 26.4% #3 20.2% #4 5.2% #5 3.0% #6 SG (-.50¢)	#1 18.2% #2 32.3% #3 33.3% #4 10.1% #5 6.1% #6 SG (-.50¢)	(.00¢)
FOREIGN MATERIAL	0% (.00¢)	.42% (.00¢)	.42% (.00¢)
DAMAGE	0% (.00¢)	.15%	.15%
SHRUNKEN & BROKEN	0% (.00¢)	1.83% (-.50¢)	1.83% (-.50¢)
TOTAL DEFECTS	0% (.00¢)	2.42% (.00¢)	2.42% (.00¢)
PROTEIN		13.43%	13.43%
FACTOR DISCOUNT	-7.50¢	-15.50¢	-8.00¢
VALUE OF DOCKAGE FORGIVEN			-6.90¢
TOTAL ECONOMIC IMPACT			-14.90¢
SAMPLE SIZE = 99			

Table B.17 Grading Accuracy of Elevator 13 (1995) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	14.00% (.00¢)	11.66% (.00¢)	-2.35% (.00¢)
DOCKAGE	2.23% (.00¢)	4.36% (-7.00¢)	2.13% (-7.00¢)
TEST WEIGHT	56.86 LBS. (-3.00¢)	56.37 LBS. (-4.00¢)	2.44 LBS. (-1.00¢)
GRADE	#1 5.0% #2 38.0% #3 40.0% #4 12.0% #5 4.0% #6 1.0% SG (-.50¢)	#1 3.0% #2 19.0% #3 48.0% #4 15.0% #5 10.0% #6 5.0% SG (-3.00¢)	(-2.50¢)
FOREIGN MATERIAL	0% (.00¢)	.41% (.00¢)	.41% (.00¢)
DAMAGE	0%	.19%	.19%
SHRUNKEN & BROKEN	0% (.00¢)	1.92% (.00¢)	1.92% (.00¢)
TOTAL DEFECTS	0% (.00¢)	2.44% (.00¢)	2.44% (.00¢)
PROTEIN		11.91%	11.91%
FACTOR DISCOUNT	-3.50¢	-14.00¢	-10.50¢
VALUE OF DOCKAGE FORGIVEN			-7.47¢
TOTAL ECONOMIC IMPACT			-17.47¢
SAMPLE SIZE = 100			

Table B.18 Grading Accuracy of Elevator 14 (1995) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	14.62% (-6.00¢)	14.68% (-6.00¢)	.06% (.00¢)
DOCKAGE	3.83% (-3.00¢)	3.82% (-3.00¢)	.01% (.00¢)
TEST WEIGHT	57.31 LBS. (-3.00¢)	57.79 LBS. (-2.00¢)	.48 LBS. (1.00¢)
GRADE	#1 #2 26.1% #3 65.2% #4 8.75 #5 #6 SG (-.50¢)	#1 #2 47.8% #3 30.4% #4 4.3% #5 #6 17.4% SG (-3.00¢)	(-2.50¢)
FOREIGN MATERIAL	0% (.00¢)	.21% (.00¢)	.21% (.00¢)
DAMAGE	0%	.74%	.74%
SHRUNKEN & BROKEN	.09% (.00¢)	.65% (.00¢)	.56% (.00¢)
TOTAL DEFECTS	.09% (.00¢)	1.60% (.00¢)	1.51% (.00¢)
PROTEIN		12.12%	12.12%
FACTOR DISCOUNT	-12.50¢	-14.00¢	-1.50¢
VALUE OF DOCKAGE FORGIVEN			.03¢
TOTAL ECONOMIC IMPACT			-1.47¢
SAMPLE SIZE = 23			

Table B.19 Grading Accuracy of Elevator 15 (1995) – West Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	12.11% (.00¢)	12.31% (.00¢)	.20% (.00¢)
DOCKAGE	.73% (.00¢)	2.65% (.00¢)	1.91% (.00¢)
TEST WEIGHT	57.95 LBS. (.00¢)	58.44 LBS. (.00¢)	.49 LBS. (.00¢)
GRADE	#1 17.2% #2 46.5% #3 20.2% #4 11.1% #5 4.0% #6 1.0% SG (-.50¢)	#1 16.2% #2 42.4% #3 21.2% #4 14.1% #5 2.0% #6 1.0% SG 3.0% (-.50¢)	(.00¢)
FOREIGN MATERIAL	.11% (.00¢)	.71% (.00¢)	.60% (.00¢)
DAMAGE	0%	.20%	.20%
SHRUNKEN & BROKEN	0% (.00¢)	1.65% (-.50¢)	1.65% (-.50¢)
TOTAL DEFECTS	0% (.00¢)	2.43% (.00¢)	2.43% (.00¢)
PROTEIN		12.51%	12.62%
FACTOR DISCOUNT	-.50¢	-1.00¢	-.50¢
VALUE OF DOCKAGE FORGIVEN			-6.69¢
TOTAL ECONOMIC IMPACT			-7.19¢
SAMPLE SIZE = 99			

Table B.20 Grading Accuracy of Elevator 16 (1995) – West Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER.
MOISTURE	11.86% (.00¢)	11.89% (.00¢)	.03% (.00¢)
DOCKAGE	1.37% (.00¢)	2.37% (.00¢)	1.00% (.00¢)
TEST WEIGHT	60.00 LBS. (.00¢)	57.78 LBS. (-2.00¢)	-1.22 LBS. (-2.00¢)
GRADE	#1 13.9% #2 40.6% #3 26.7% #4 7.9% #5 6.9% #6 4.0% SG (-.50¢)	#1 5.9% #2 40.6% #3 29.7% #4 18.8% #5 2.0% #6 1.0% SG 2.0% (-.50¢)	(.00¢)
FOREIGN MATERIAL	.73% (.00¢)	.63% (.00¢)	-.10% (.00¢)
DAMAGE	.97%	.54%	-.43%
SHRUNKEN & BROKEN	3.16% (-2.00¢)	2.17% (-1.00¢)	-.99% (1.00¢)
TOTAL DEFECTS	4.85% (.00¢)	3.23% (.00¢)	-1.62% (.00¢)
PROTEIN		11.90%	11.90%
FACTOR DISCOUNT	-2.50¢	-3.50¢	-1.00¢
VALUE OF DOCKAGE FORGIVEN			-3.49¢
TOTAL ECONOMIC IMPACT			-4.49¢
SAMPLE SIZE = 101			

Table B.21 Grading Accuracy of Elevator 1 (1996) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	11.72% (0.00¢)	11.34% (0.00¢)	-0.39% (0.00¢)
DOCKAGE	0.01% (0.00¢)	0.46% (-0.24¢)	0.45% (-0.24¢)
TEST WEIGHT	59.18 LBS. (-0.99¢)	58.75 LBS. (-1.68¢)	-0.42 LBS. (-0.68¢)
GRADE	#1 37.7% #2 46.2% #3 16.0% #4 #5 #6 SG (-0.77¢)	#1 17.8% #2 59.8% #3 16.8% #4 2.8% #5 1.9% #6 SG 0.9% (-1.23¢)	(-0.45¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.18% (-0.32¢)	0.18% (-0.32¢)
DAMAGE	0.00% (0.00¢)	0.08% (0.00¢)	0.08% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	1.07% (-0.03¢)	1.07% (-0.03¢)
TOTAL DEFECTS	0.00% (0.00¢)	1.33% (-0.21¢)	1.33% (-0.21¢)
PROTEIN		13.81%	13.81%
FACTOR DISCOUNT	-0.99¢	-2.49¢	-1.50¢
VALUE OF DOCKAGE FORGIVEN			-2.15¢
TOTAL ECONOMIC IMPACT			-3.65¢

SAMPLE SIZE = 107

Table B.22 Grading Accuracy of Elevator 2 (1996) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.79% (-1.37¢)	12.70% (-1.37¢)	-1.10% (0.00¢)
DOCKAGE	0.28% (-0.43¢)	1.61% (-2.09¢)	1.32% (-1.66¢)
TEST WEIGHT	57.43 LBS. (-4.11¢)	57.10 LBS. (-6.06¢)	-0.34 LBS. (-1.98¢)
GRADE	#1 18.18% #2 29.5% #3 42.9% #4 8.0% #5 0.9% #6 SG (0.00¢)	#1 8.9% #2 19.6% #3 42.9% #4 23.2% #5 2.7% #6 2.7% SG (-2.92¢)	(-2.92¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.06% (0.00¢)	0.06% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.05% (0.00¢)	0.05% (0.00¢)
SHRUNKEN & BROKEN	1.05% (-0.43¢)	2.78% (-0.42¢)	1.73% (0.01¢)
TOTAL DEFECTS	1.05% (-0.21¢)	2.90% (-0.38¢)	1.84% (-0.17¢)
PROTEIN		13.88%	13.88%
FACTOR DISCOUNT	-6.54¢	-10.35¢	-3.82¢
VALUE OF DOCKAGE FORGIVEN			-6.28¢
TOTAL ECONOMIC IMPACT			-10.11¢

SAMPLE SIZE = 113

Table B.23 Grading Accuracy of Elevator 3 (1996) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.14% (-0.48¢)	12.59% (-0.05¢)	-0.55% (0.43¢)
DOCKAGE	0.00% (0.00¢)	0.67% (-0.58¢)	0.67% (-0.58¢)
TEST WEIGHT	57.81 LBS. (-3.86¢)	58.18 LBS. (-2.95¢)	0.37 LBS. (0.91¢)
GRADE	#1 17.7% #2 27.1% #3 38.5% #4 16.7% #5 #6 SG (-2.08¢)	#1 17.3% #2 31.7% #3 38.5% #4 11.5% #5 #6 SG 1.0% (-1.88¢)	(0.20¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.12% (-0.20¢)	0.12% (-0.20¢)
DAMAGE	0.00% (0.00¢)	0.07% (0.00¢)	0.07% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	1.69% (-0.05¢)	1.69% (-0.05¢)
TOTAL DEFECTS	0.00% (0.00¢)	1.88% (-0.11¢)	1.88% (-0.11¢)
PROTEIN		13.86%	13.86%
FACTOR DISCOUNT	-4.34¢	-3.94¢	0.40¢
VALUE OF DOCKAGE FORGIVEN			-3.17¢
TOTAL ECONOMIC IMPACT			-2.77¢

SAMPLE SIZE = 104

Table B.24 Grading Accuracy of Elevator 4 (1996) – West Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.30% (-1.31¢)	13.71% (-2.39¢)	0.41% (-1.08¢)
DOCKAGE	0.35% (-0.50¢)	0.77% (-0.59¢)	0.42% (-0.10¢)
TEST WEIGHT	57.75 LBS. (-4.38¢)	57.50 LBS. (-5.44¢)	-0.28 LBS. (-1.12¢)
GRADE	#1 23.1% #2 34.6% #3 26.0% #4 15.4% #5 1.0% #6 SG (0.00¢)	#1 13.6% #2 32.0% #3 26.2% #4 22.3% #5 5.8% #6 SG (-2.42¢)	(-2.42¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.01% (0.00¢)	0.01% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.01% (0.00¢)	0.01% (0.00¢)
SHRUNKEN & BROKEN	0.06% (-0.06¢)	1.56% (-0.07¢)	1.49% (-0.01¢)
TOTAL DEFECTS	0.06% (-0.05¢)	1.58% (-0.07¢)	1.52% (-0.03¢)
PROTEIN		14.65%	14.65%
FACTOR DISCOUNT	-6.30¢	-5.59¢	2.34¢
VALUE OF DOCKAGE FORGIVEN			-1.98¢
TOTAL ECONOMIC IMPACT			.36¢

SAMPLE SIZE = 104

Table B.25 Grading Accuracy of Elevator 5 (1996) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	12.41% (-1.23¢)	12.08% (-1.59¢)	-0.36% (-0.36¢)
DOCKAGE	0.69% (-0.35¢)	0.98% (-0.95¢)	0.29% (-0.60¢)
TEST WEIGHT	60.02 LBS. (-0.83¢)	59.85 LBS. (-1.49¢)	-0.16 LBS. (-0.65¢)
GRADE	#1 56.1% #2 20.4% #3 19.4% #4 4.1% #5 #6 SG (-0.54¢)	#1 43.7% #2 32.3% #3 14.6% #4 7.3% #5 2.1% #6 SG (-0.78¢)	(-0.24¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.02% (0.00¢)	0.02% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.02% (0.0¢)	0.02% (0.00¢)
SHRUNKEN & BROKEN	0.70% (-0.17¢)	1.62% (-0.11¢)	0.91% (0.06¢)
TOTAL DEFECTS	0.70% (-0.16¢)	1.66% (-0.10¢)	0.95% (0.06¢)
PROTEIN		13.56%	13.56%
FACTOR DISCOUNT	-2.75¢	-4.25¢	-1.49¢
VALUE OF DOCKAGE FORGIVEN			-1.62¢
TOTAL ECONOMIC IMPACT			-3.12¢

SAMPLE SIZE = 98

Table B.26 Grading Accuracy of Elevator 6 (1996) – Southwest Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	11.99% (-1.37¢)	11.88% (-1.09¢)	-0.11% (0.28¢)
DOCKAGE	1.58% (-2.34¢)	0.94% (-0.77¢)	-0.65% (1.55¢)
TEST WEIGHT	59.53 LBS. (-1.28¢)	59.68 LBS. (-0.74¢)	0.14 LBS. (0.55¢)
GRADE	#1 51.2% #2 41.9% #3 5.8% #4 #5 1.2% #6 SG (-0.36¢)	#1 41.4% #2 41.4% #3 14.9% #4 1.1% #5 1.1% #6 SG (-0.70¢)	(-0.33¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.03% (0.00¢)	0.03% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.02% (0.00¢)	0.02% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	2.16% (-0.18¢)	2.16% (-0.18¢)
TOTAL DEFECTS	0.00% (0.00¢)	2.21% (-0.18¢)	2.21% (-0.18¢)
PROTEIN		12.97%	12.97%
FACTOR DISCOUNT	-4.98¢	-2.96¢	2.03¢
VALUE OF DOCKAGE FORGIVEN			3.08¢
TOTAL ECONOMIC IMPACT			5.11¢

SAMPLE SIZE = 87

Table B.27 Grading Accuracy of Elevator 7 (1996) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	12.70% (-0.10¢)	12.92% (-0.98¢)	0.42% (-0.88¢)
DOCKAGE	0.83% (-0.59¢)	0.78% (-0.64¢)	-0.04% (-0.04¢)
TEST WEIGHT	56.95 LBS. (-5.40¢)	56.15 LBS. (-8.73¢)	-0.80 LBS. (-3.32¢)
GRADE	#1 #2 16.5% #3 69.7% #4 13.8% #5 #6 SG (-2.83¢)	#1 #2 10.0% #3 36.4% #4 51.8% #5 1.8% #6 SG (-3.74¢)	(-0.91¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.13% (-0.11¢)	0.13% (-0.11¢)
DAMAGE	0.00% (0.00¢)	0.09% (0.00¢)	0.09% (0.00¢)
SHRUNKEN & BROKEN	3.78% (-1.07¢)	1.82% (-0.09¢)	1.96% (+0.98¢)
TOTAL DEFECTS	3.78% (-0.98¢)	2.03% (-0.18¢)	1.75 (+0.80¢)
PROTEIN		14.56%	14.56%
FACTOR DISCOUNT	-8.14¢	-10.71¢	-2.57¢
VALUE OF DOCKAGE FORGIVEN			0.21¢
TOTAL ECONOMIC IMPACT			-2.36¢

SAMPLE SIZE = 110

Table B.28 Grading Accuracy of Elevator 8 (1996) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.11% (-0.80¢)	12.69% (-0.37¢)	-0.42% (0.42¢)
DOCKAGE	0.00% (0.00¢)	0.72% (-0.66¢)	0.72% (-0.66¢)
TEST WEIGHT	57.73 LBS. (-4.25¢)	57.00 LBS. (-6.70¢)	-0.73 LBS. (-2.45¢)
GRADE	#1 25.5% #2 29.1% #3 30.0% #4 10.9% #5 4.5% #6 SG (-1.78¢)	#1 3.6% #2 37.3% #3 30.0% #4 15.5% #5 13.6% #6 SG (-2.78¢)	(-1.00¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.09% (-0.12¢)	0.09% (-0.12¢)
DAMAGE	0.00% (0.00¢)	0.04% (0.00¢)	0.04% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	2.08% (-0.24¢)	2.08% (0.24¢)
TOTAL DEFECTS	0.00% (0.00¢)	2.21% (-0.26¢)	2.21% (-0.26¢)
PROTEIN		14.86%	14.86%
FACTOR DISCOUNT	-5.05¢	-8.36¢	-3.31¢
VALUE OF DOCKAGE FORGIVEN			-3.41¢
TOTAL ECONOMIC IMPACT			-6.72¢

SAMPLE SIZE = 110

Table B.29 Grading Accuracy of Elevator 9 (1996) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.11% (-1.07¢)	13.02% (-0.83¢)	-0.09% (0.24¢)
DOCKAGE	0.00% (0.00¢)	0.91% (-0.98¢)	0.91% (-0.98¢)
TEST WEIGHT	58.07 LBS. (-3.14¢)	56.65 LBS. (-8.58¢)	-1.42 LBS. (-5.44¢)
GRADE	#1 26.5% #2 42.9% #3 18.4% #4 11.2% #5 1.0% #6 SG (-1.56¢)	#1 8.2% #2 31.6% #3 22.4% #4 22.4% #5 14.3% #6 1.0% SG (-3.22¢)	(-1.65¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.15% (-0.18¢)	0.15% (-0.18¢)
DAMAGE	0.00% (0.00¢)	0.05% (0.00¢)	0.05% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	2.22% (-0.54¢)	2.22% (-0.54¢)
TOTAL DEFECTS	0.00% (0.00¢)	2.41% (-0.56¢)	2.41% (-0.56¢)
PROTEIN		14.68%	14.68%
FACTOR DISCOUNT	-4.21¢	-11.64¢	-7.44¢
VALUE OF DOCKAGE FORGIVEN			-4.29¢
TOTAL ECONOMIC IMPACT			-11.73¢

SAMPLE SIZE = 98

Table B.30 Grading Accuracy of Elevator 10 (1996) – Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	12.92% (-0.62¢)	12.71% (-0.53¢)	-0.21% (0.09¢)
DOCKAGE	0.00% (0.00¢)	11.31% (-1.88¢)	1.31% (-1.88¢)
TEST WEIGHT	57.19 LBS. (-6.46¢)	56.69 LBS. (-8.76¢)	-0.50 LBS. (-2.30¢)
GRADE	#i 20.0% #2 30.9% #3 19.1% #4 20.9% #5 9.1% #6 SG (-2.38¢)	#1 10.7% #2 22.3% #3 27.7% #4 25.9% #5 12.5% #6 0.9% SG (-3.10¢)	(-0.72¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.08% (0.00¢)	0.08% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.05% (0.00¢)	0.05% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	2.26% (-0.40¢)	2.26% (-0.40¢)
TOTAL DEFECTS	0.00% (0.00¢)	2.40% (-0.42¢)	2.40% (-0.42¢)
PROTEIN		14.46%	14.46%
FACTOR DISCOUNT	-7.08¢	-11.99¢	-4.91¢
VALUE OF DOCKAGE FORGIVEN			-6.25¢
TOTAL ECONOMIC IMPACT			-11.16¢

SAMPLE SIZE = 112

Table B.31 Grading Accuracy of Elevator 11 (1996) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.56% (-2.27¢)	13.35% (-2.12¢)	-0.17% (0.15¢)
DOCKAGE	1.75% (-2.75¢)	1.36% (-1.78¢)	-0.39% (0.97¢)
TEST WEIGHT	55.83 LBS. (-11.16¢)	55.53 LBS. (-12.20¢)	-0.29 LBS. (-1.04¢)
GRADE	#1 2.8% #2 10.4% #3 29.2% #4 35.8% #5 19.8% #6 SG 1.9% (-4.07¢)	#1 1.9% #2 10.3% #3 24.3% #4 46.7% #5 15.0% #6 1.9% SG (-4.28¢)	(-0.21¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.13% (-0.02¢)	0.13% (-0.02¢)
DAMAGE	0.00% (0.00¢)	0.13% (0.00¢)	0.13% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	2.18% (-0.11¢)	2.18% (-0.11¢)
TOTAL DEFECTS	0.00% (0.00¢)	2.44% (-0.20¢)	2.44% (-0.20¢)
PROTEIN		14.34%	14.34%
FACTOR DISCOUNT	-16.17¢	-16.43¢	-0.25¢
VALUE OF DOCKAGE FORGIVEN			1.84¢
TOTAL ECONOMIC IMPACT			1.59¢

SAMPLE SIZE = 107

Table B.32 Grading Accuracy of Elevator 12 (1996) – North Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	10.93% (-0.77¢)	13.29% (-0.96¢)	2.38% (-0.19¢)
DOCKAGE	0.52% (-0.86¢)	1.13% (-1.35¢)	0.62% (-0.50¢)
TEST WEIGHT	59.04 LBS. (-1.13¢)	58.69 LBS. (-2.20¢)	-0.36 LBS. (-1.07¢)
GRADE	#1 51.5% #2 34.0% #3 12.6% #4 1.9% #5 #6 SG (-0.64¢)	#1 24.8% #2 41.0% #3 28.6% #4 1.9% #5 1.9% #6 1.9% SG (-1.33¢)	(-0.69¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.07% (0.00¢)	0.07% (0.00¢)
DAMAGE	0.00% (0.00¢)	0.03% (0.00¢)	0.03% (0.00¢)
SHRUNKEN & BROKEN	0.00% (0.00¢)	1.49% (-0.04¢)	1.49% (-0.04¢)
TOTAL DEFECTS	0.00% (0.00¢)	1.60% (-0.03¢)	1.60% (-0.03¢)
PROTEIN		14.66%	14.66%
FACTOR DISCOUNT	-2.76¢	-4.59¢	-1.83¢
VALUE OF DOCKAGE FORGIVEN			-2.88¢
TOTAL ECONOMIC IMPACT			-4.72¢

SAMPLE SIZE = 105

Table B.33 Grading Accuracy of Elevator 13 (1996) – West Central Region

	AVERAGE ELEVATOR GRADE (DISCOUNT)	AVERAGE OFFICIAL GRADE (DISCOUNT)	DIFFER. (OFFICIAL MINUS ELEVATOR)
MOISTURE	13.85% (-0.80¢)	13.52% (-0.72¢)	-0.33% (0.08¢)
DOCKAGE	0.00% (0.00¢)	0.83% (-0.85¢)	0.83% (-0.85¢)
TEST WEIGHT	58.75 LBS. (-2.26¢)	58.34 LBS. (-2.82¢)	-0.41 LBS. (-0.56¢)
GRADE	#1 30.1% #2 35.4% #3 23.9% #4 7.1% #5 3.5% #6 SG (0.00¢)	#1 20.9% #2 38.3% #3 27.0% #4 10.4% #5 3.5% #6 SG (-1.58¢)	(-1.58¢)
FOREIGN MATERIAL	0.00% (0.00¢)	0.09% (-0.09¢)	0.09% (-0.09¢)
DAMAGE	0.00% (0.00¢)	0.03% (0.00¢)	0.03% (0.00¢)
SHRUNKEN & BROKEN	2.57% (-0.44¢)	1.83% (-0.09¢)	-0.74% (0.35¢)
TOTAL DEFECTS	2.57% (-0.41¢)	1.96% (-0.16¢)	-0.62% (0.25¢)
PROTEIN		13.97%	13.97%
FACTOR DISCOUNT	-3.91¢	-4.74¢	-0.82¢
VALUE OF DOCKAGE FORGIVEN			-3.93¢
TOTAL ECONOMIC IMPACT			-4.75¢

SAMPLE SIZE = 115

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VITA

ROY DON ATTAWAY

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