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Res. rept. 16

Removing Nonwheat Material From Kansas Wheat

by Harvey L. Kiser

Research Report #16

Department of Agricultural Economics

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Manhattan, Kansas [1]/
July 1992

INTRODUCTION

When Kansas wheat is harvested, it contains nonwheat material, which is called foreign material and dockage[2]/. In the last 5 years, the average foreign material in Kansas wheat ranged between 0.1 and 0.2 percent, with 3 years at 0.1 percent. The average dockage in these 5 years ranged between 0.6 and 0.8 percent, with 1 year at 0.6 percent and 1 year each at 0.7 and 0.8 percent. Grain merchandisers reported that the 1990 crop was cleaner than the 1989 crop. This is verified by the average dockage in those years -- 0.6 percent and 0.8 percent, respectively.

The issue of removing nonwheat material from wheat has been a concern of the Kansas Wheat Commission (KWC) since the wheat research and development agency was organized in 1957. Among activities initiated by the commission were two studies on cleaning wheat published in the early 1980's. The two reports were titled "A View on the Economics of

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[1]/ This research project was funded by a grant approved by the commissioners of the Kansas Wheat Commission.

[2]/ Dockage = "All matter other than wheat that can be removed from the original sample by use of an approved device according to procedures prescribed in FGIS (Federal Grain Inspection Service) instructions. Also, underdeveloped, shriveled, and small pieces of wheat kernels removed in properly separating the material other than wheat and that cannot be recovered by properly rescreening or recleaning." All nonwheat material remaining in the sample is handpicked and is defined as foreign material. An approved device is the Carter Dockage Tester.

Contribution no. 92-625-D from the Kansas Agricultural Experiment Station, Kansas State University, Manhattan, KS 66506-4008.

Removing Dockage from Wheat," [3]/ and "Cleaning Wheat at a Country Elevator - A Case Study." [4]/ From the case study, a spreadsheet program was developed to evaluate the profitability of cleaning wheat. Subsequently, in cooperation with the KWC, a report was issued on how Kansas grain elevators measured dockage in the 1990 wheat harvest. [5]/

Public concern about cleaning wheat and modifying wheat standards has been a source of debate at conferences, by the Wheat Quality Workshop group of producers and merchandisers, and by the U.S. Congress. The 1990 Farm Act contained a section dealing with grain quality issues. The Act required the Federal Grain Inspection Service (FGIS) to estimate the economic impact of any major changes necessary to carry out the amendments to the Grain Standards Act. Among the amendments that the FGIS Administrator was required to consider was establishment of standards regarding cleanliness conditions of wheat as well as other grains.

Because of the KWC's continuing interest in the economic feasibility of cleaning wheat, this study was commissioned to further extend information about the cleaning of wheat at individual grain elevators.

More specifically, the objectives of this study were to:

1. determine the effectiveness of cleaning wheat,

2. determine if cleaning wheat increases the profitability of a grain elevator operation, and

3. compare cleaning of relatively clean wheat and of wheat with higher levels of dockage.

RESEARCH METHODOLOGY

Wheat was cleaned at 12 different times at country elevators and one farm operation. The cleaning devices used the principle of aspiration or a combination of screening and aspiration. The wheat was sampled just before entering the cleaning device and again upon exiting the cleaner. Most of the wheat came from the 1990 or 1991 crops, but one sample came from the 1982 crop.

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[3]/By Roxane Fridirci, Harvey L. Kiser, L.D. Schnake, and John Wingfield, July 1984.

[4]/ By Harvey L. Kiser, December 1984.

[5]/ "Dockage Treatment during the 1990 Kansas Wheat Harvest," by Harvey L. Kiser and David Frey, Research Report #14, Department of Agricultural Economics, January 1991.

Five to seven, paired, before-and-after samples were collected at each location. About 3 pounds were taken every 10 minutes, and the grade factors of all samples were determined by the Kansas Grain Inspection Department.

The percentage of the original wheat that was removed by cleaning was determined by dividing the number of pounds removed by the cleaner by the number of bushels cleaned. The pounds removed could be determined only at seven locations. The number of bushels cleaned was based upon measurements of the bin in which the wheat was located.

Wheat cleaning costs included investments in the cleaning devices, power, labor, and repair and maintenance. The original costs were $34,700 for a device that cleaned about 3,000 bushels per hour and $25,000 for one that cleaned about 5,000 bushels per hour. The former device has a set of four screens plus a fan to aspirate or blow air through the grain as it falls off one screen onto the next screen (Appendix Figure 1). The latter device consists of a fan blowing air through the grain as it cascades by gravity over several baffles from one level down to the next. Two of the sets of elevator samples and the farm samples were cleaned by a device using aspiration, with the one at the elevator having a scalper at the intake point (Appendix Figure 2). Not enough sampling data were collected to delineate any differences between these two types of cleaners.

Repair and maintenance were estimated at 1.3 percent of the original machine cost. Labor costs were estimated at $10.25 per hour for wages and benefits for an individual to monitor the machine about 85 percent of the time. Power costs for the cleaner can vary by business location and over time for the day and year, depending upon the scale of rates used by an electrical company. For this analysis, an estimate of 10.5 cents per kilowatt hour of electricity was used for an effective horsepower rating of 16.25 for the 3,000 bushel-per-hour device and 18.75 for the 5,000 bushel-per-hour device.

Transportation rates were those quoted by the elevator manager for moving wheat to the most predominant market, i.e., a terminal market to which most of the grain was sold. Most of these were truck rates. However, when wheat was moved by rail, the analysis used the rail rate.

Three models of effectiveness of cleaning were used.[6]/ The first estimated the average change in the characteristics of interest. The second model estimated the change in the characteristic of interest as a linear function of the initial level of that characteristic. The third

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[6]/The three models were from an unpublished paper "Measuring the Costs and Benefits of Cleaning Hard Red Winter Wheat in Kansas," by Steven S. Duncan, Assistant Professor, Department of Agricultural Economics and Harvey L. Kiser, Associate Professor and Senior Agricultural Economist, International Grains Program, Kansas State University, Manhattan, Kansas submitted to the Department of Agricultural Economics, Oklahoma State University, Enid, Oklahoma, September 1, 1991.

model estimated the change in the level of the characteristic as a simple percent of the initial level of the characteristic.

RESULTS AND DISCUSSION

Cleaning and Grading

The average amount of material removed by cleaning was 0.8 percent. The material removed can be used as an ingredient in feed. Because of the degree of fiber in the material, it is an excellent feed ingredient for ruminants. The protein percentage of the cleanings exceeds that of the wheat itself. In order for the cleanings to serve as a good feed ingredient and to allow it to flow well through equipment, its test weight should be 25 pounds per bushel or greater.[7]/

The estimated average change in the level of various grading factors and the statistical significance are incorporated in Table 1. The characteristics that were statistically different from zero at the 1% level are identified in Table 1. The other factors that were not statistically significant at the 1% level also were not significant at the 5% level. Cleaning reduced the dockage by an average of 0.41 percentage points; for example, a reduction from about 0.8% to about 0.4%. The reduction in shrunken and broken kernels was also statistically significant, as were total defects[8]/. Even when one outlier was removed from the data set, the reduction in foreign material was not significantly different from zero. However, dropping the outlier did change the conclusion on the significance of the increase in test weight from cleaning; the test weight per bushel increased 0.16 pounds.[9]/

Because the change in the level of a characteristic through cleaning is likely to be affected by the initial level of the characteristic, two additional models were estimated to account for that. Appendix Table 1 contains the results of the first regression, which estimated the change in the characteristic of interest as a linear function of the initial level of that characteristic. The linear function for Appendix Table 1 is: $Y = a + bX$, where Y = estimated change in the

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[7]/Brethour, John R., "Aspirated Wheat Liftings in Cattle Growing Rations," Roundup 1986, Report of Progress 498, Fort Hays Branch, Agricultural Experiment Station, Kansas State University, Manhattan, Kansas, April 1986, page 28. The test weight of the aspirated wheat liftings was 25 pounds per bushel which were compared against feeding a control ration of milo. "Nutritional value of the liftings was better than expected, and calves that received the test ration grew significantly ($p < 0.01$) faster."

[8]/Total defects include foreign material, shrunken and broken kernels, and total damage.

[9]/The author wishes to acknowledge the contribution of Steven S. Duncan, Assistant Professor, Department of Agricultural Economics, Kansas State University, Manhattan, Kansas to the statistical analysis of the sampling data.

level of the characteristic with cleaning and X = the level of the characteristic before cleaning. T-statistics on coefficients are in parentheses beneath the coefficients. Many of the coefficients in the models were significant at the 1 percent level. Estimated models for all but the total damage model had F-statistics that were significant at the 1 percent level.

Table 1. Average Change in Kansas Wheat Characteristics after Cleaning.

Characteristic	Average Change in Level[1]	T-Statistic
Dockage	-0.41**	-3.93
Foreign Material (n=81)	-0.088	-1.25
Foreign Material (n=80)	-0.019	-1.32
Test Weight (n=81)	+0.11	+1.16
Test Weight (n=80)	+0.16**	+2.84
Shrunken & Broken Kernels	-0.25**	-3.94
Total Damage	-0.002	-0.03
Total Defects	-0.34**	-2.62

[1] Test weight - pounds change; other characteristics - percentage points change.
** Significant at the 1% level.

The second additional model estimated the change in the level of the characteristic as a simple percent of the initial level of the characteristic. A calculation was made of the change in the characteristics of a sample of wheat that had levels of the characteristics equal to those of the wheats actually cleaned (Table 2). The estimated change in each factor from cleaning is also presented along with the new level of each factor. As expected, dockage was reduced by a sizable amount but not completely removed. The total damage was essentially not reduced at all. Foreign material was reduced, but not by much. Test weight increased slightly.

Using the linear equation, the estimated percentage change was the greatest for dockage. The dockage level was reduced by 54.2 percent as seen in Table 2. The percentage reductions were 14.3 percent for foreign material, 15 percent reduction for shrunken and broken kernels, and 10.3 percent for total defects. These percent changes are at the average level for each characteristic. Appendix Table 1 contains the linear regression and percentage models to predict the levels for each characteristic after cleaning.

This statistical analysis indicates that cleaning wheat effects a significant change in test weight and in dockage, shrunken and broken kernels, and total defects percentages but not in foreign material percentage. Cleaning had the greatest impact on the dockage factor.

Table 2. Estimated Effect of Cleaning on an Average Sample of Kansas Wheat Actually Cleaned.

Characteristic	Average Level	Estimated Change[1] in Level	Level after Cleaning	Percent Change[2]
Dockage (%)	0.72	-0.39	0.33	-54.2
Test Weight (lbs)	60.1	+0.17	60.3	+0.3
Foreign Material(%)	0.14	-0.02	0.12	-14.3
Shrunken & Broken Kernels (%)	1.60	-0.24	1.36	-15.0
Total Damage (%)	0.77	-0.00	0.77	-0.0
Total Defects (%)	2.52	-0.26	2.26	-10.3

[1] Test weight-pounds change; other characteristics-percentage points change.
[2] Percent change at the average level for each characteristic.

Profitability of Cleaning Wheat

Quality Relationships

Profitability of cleaning wheat is dependent upon many factors. One critical factor is the level of cleanliness of the crop. The 1989 Kansas wheat crop had higher levels of dockage than either the 1990 or 1991 crop. Therefore, cleaning the 1989 crop would be expected to be more profitable than cleaning either the 1990 or 1991 crop. The quality of wheat in the three crop years is shown in Table 3.

Wheat quality data presented in Table 4 are for the 3 most recent years for each county. These six counties are where the eight elevators were located. The higher level of dockage in 1989 would indicate that it might be more profitable to clean wheat from that year's crop. Generally, test weights were lower for 1989.

When samples were taken of wheat before and after cleaning, a manager often would say that it was not necessary to clean the wheat. He indicated that number 1 or number 2 wheat was being loaded without any difficulty. Apparently, elevator managers will clean wheat when it appears to have a cleanliness or quality problem. See Table 5 for the specifications for each wheat grade.

Dockage is deducted by weight from total weight of the shipment, and whether it pays an elevator operator to remove the dockage by cleaning depends upon the level of dockage and how much the receiver or buyer will allow. Likewise, the amount of discounts for lower test weight and higher levels of foreign material, shrunken and broken kernels, and total defects will provide an incentive for cleaning the wheat. Thus, the problems of excess dockage and foreign material or insect damaged kernels will determine when cleaning wheat will be profitable. One operator said that, in 1989, he was able to pay for his cleaning equipment in one season by removing dockage and insect damaged kernels. The operator had been receiving $1.90 per bushel for the wheat in a $4.00 per bushel market, but after cleaning, the wheat sold with no discount.

The discounts for test weight, damaged kernels, foreign material, shrunken and broken kernels, and total defects used in this analysis are in Appendix Table 2 - Example A. Other examples of terminal schedules of discounts are also in Appendix Table 2 - Examples B and C.

Table 3. Kansas Wheat Quality, 1989-1991.

Year	Test Weight	Total Damaged Kernels	Foreign Material	Shrunken and Broken Kernels	Total Defects	Dockage
	(lbs)	(%)	(%)	(%)	(%)	(%)
1989	59.5	1.1	0.2	1.4	2.7	0.8
1990	60.7	0.2	0.1	2.1	2.4	0.6
1991	59.9	0.2	0.1	2.0	2.3	0.7

Source: Kansas WHEAT QUALITY, 1990 and 1991, Kansas State Board of Agriculture, Topeka, KS and Kansas Wheat Commission, Manhattan, KS.

Under Current Market Conditions

An analysis was conducted on the feasibility of cleaning the 1989, 1990, and 1991 wheat crops by eight elevators in six central Kansas counties. The analysis used a value for cleanings of $4.00 per hundredweight and a wheat value between $3.15 and $3.40 per bushel as representative of current prices. Truck transportation rates to move wheat to the most predominant market were usually 10 or 15 cents per hundredweight, with one at 50 cents. Rates for rail transportation, used by three elevators, ranged from 42 cents to 60 cents per hundredweight. Two different types of cleaners were assumed to be used, cleaning at rates of 3,000 and 5,000 bushels per hour.

Table 4. Test Weight and Levels of Dockage, Foreign Material, Shrunken and Broken Kernels in Wheat from Clay, Marion, McPherson, Reno, Sedgwick, and Harvey Counties, KS, 1989-1991.

County/Year	Test Weight	Dockage	Foreign Matter	Shrunken and Broken Kernels
	(lbs)	(%)	(%)	(%)
Clay				
1989[6]	57.6	1.9	1.2	1.2
1990	60.5	0.6	0.1	2.5
1991	59.4	0.6	0.2	2.2
Harvey				
1989	58.6	0.4	0.3	1.1
1990	60.2	0.5	0.1	1.7
1991	59.4	0.4	0.2	1.5
McPherson				
1989	58.0	1.4	0.3	1.1
1990	61.1	0.5	0.2	1.9
1991	59.8	0.3	0.1	1.1
Marion				
1989	57.7	0.7	0.2	1.0
1990	60.4	0.5	0.1	1.8
1991	59.2	0.6	0.3	1.8
Reno				
1989	59.1	0.6	0.3	1.7
1990	60.8	0.6	0.1	2.1
1991	60.4	0.5	0.3	1.8
Sedgwick				
1989	59.2	0.7	0.3	1.2
1990	60.7	0.6	0.2	1.9
1991	60.2	0.5	0.3	1.7

[6]1989 Clay County's data were insufficient, so Cloud County's data were used.
Source: Kansas WHEAT QUALITY, 1990 and 1991, Kansas State Board of Agriculture, Topeka, Kansas and Kansas Wheat Commission, Manhattan, Kansas.

This part of the analysis was designed to use the costs and benefits from the elevator's current market situation based upon cleaning a year's total wheat crop that moved through the respective elevators. For the purposes of this study, it was assumed that all the bushels handled by each elevator were cleaned. The annual amount handled and cleaned ranged from 250,000 to 1,200,000 bushels for these eight elevators.

The quality of wheat cleaned was assumed to be equal to the quality in the respective counties that was reported in the "Kansas Wheat Quality" reports. [10/] The same level of quality for each county was used in the standardized models analyzed later.

[10/] Reports for 1989, 1990, and 1991 crops, published by the Kansas State Board of Agriculture and the Kansas Wheat Commission.

Table 5. Grade Requirements for Wheat

Grade	Minimum test weight per bushel		Maximum Limits of						
			Defects					Wheat of other Classes[4]	
	Hard Red Spring Wheat or White Club Wheat[1]	All Other Classes	Heat Damaged Kernels	Damaged Kernels[2] (Total)	Foreign Material	Shrunken & Broken Kernels	Defects (total)[3]	Contrasting Classes	Wheat of Other Classes (total)[5]
	Pounds	Pounds	Percent	Percent	Percent	Percent	Percent	Percent	Percent
U.S. No. 1	58.0	60.0	0.2	2.0	0.5	3.0	3.0	1.0	3.0
U.S. No. 2	57.0	58.0	0.2	4.0	1.0	5.0	5.0	2.0	5.0
U.S. No. 3	55.0	56.0	0.5	7.0	2.0	8.0	8.0	3.0	10.0
U.S. No. 4	53.0	54.0	1.0	10.0	3.0	12.0	12.0	10.0	10.0
U.S. No. 5[6]	50.0	51.0	3.0	15.0	5.0	20.0	20.0	10.0	10.0

[1] These requirements also apply when Hard Red Spring wheat or White Club wheat predominates in a sample of Mixed wheat.

[2] Includes heat-damaged kernels.

[3] Defects include damaged kernels (total), foreign material, and shrunken and broken kernels. The sum of these three factors may not exceed the limit for defects for each numerical grade.

[4] Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.

[5] Includes contrasting classes.

[6] U.S. sample grade is not shown. Wheat is graded U.S. sample grade when the wheat does not meet the requirements for grades U.S. No. 1, 2, 3, 4, or 5; or exceeds specified limits for insect damaged kernels per 100 grams of wheat; stones, glass, crotalaria seeds, castor beans, unknown foreign substances, rodent pellets, bird dropping or other animal filth per 1,000 grams of wheat; or has a musty odor, or commercially objectionable foreign odor; or is heating or otherwise of distinctly low quality.

Table 6 contains the profit or loss per bushel for the 3 years in the study. The elevator operations generally would have made money from cleaning wheat only in 1989. Five of the eight would have shown a profit with one of the cleaners and three with the other cleaner. All of the elevators were assumed to ship all of the wheat by truck or by rail as shown in the table. The profit would have been less for those shipping by rail if a lower truck rate had been used instead of the higher rail rate, because transportation savings would not have been as great. For the years of 1990 and 1991, it would have cost these eight elevators to clean wheat, except for one in 1991 that had a very small profit.

In all cases, an estimate of 0.5 cent per bushel of an additional benefit from cleaning was assumed in this analysis because of savings from operating aeration, drying, and air pollution control equipment. Cleaning grain prior to various operations reduces energy costs. The cost savings will vary depending on the degree of non-wheat material in the wheat and if aeration, drying, and/or air pollution control equipment operate. A conservative estimate of benefits from cleaning on the operating of aeration and drying equipment was $0.005 per bushel. A higher estimate would be $0.0075 per bushel, which was not used.[11]/ If this cleaning benefit were not allowed, all the net per bushel benefits from cleaning as shown in Tables 6, 7, and 8 would be lowered by $0.005 per bushel (0.5 cent per bushel). If cleaning is not profitable, a market premium would be needed to cover the cleaning cost or to provide a profit.

Table 6. Annual per Bushel Profit from Cleaning Wheat by Eight Kansas Elevators Based on the Operating Conditions at Current Wheat Prices and Cleanings Valued at $4.00 per cwt., with Freight Rates to the Predominant Market for 1989, 1990, & 1991.

Country Elevator	1989		1990		1991		Bushels Cleaned
	3,000[1]	5,000[2]	3,000[1]	5,000[2]	3,000[1]	5,000[2]	
	cents/bushel						
1--T[3]	-0.44	0.07	-0.77	-0.26	-1.09	-0.94	650,000
2--T	0.40	0.89	-1.08	-0.59	-1.09	-0.59	700,000
3--R	-1.66	-0.50	-3.30	-2.14	-2.98	-1.82	250,000
4--R	1.97	2.31	-0.41	-0.07	-0.25	0.09	1,200,000
5--R	-0.71	0.18	-2.36	-1.47	-2.03	-1.14	350,000
6--T	-2.95	-1.85	-2.97	-1.87	-3.49	-2.33	255,000
7--T	-2.44	-1.53	-2.46	-1.55	-2.79	-1.88	320,000
8--T	2.62	3.26	-1.29	-0.64	-1.29	-0.64	500,000

[1] 3,000 = 3,000 bushels cleaned per hour; [2] 5,000 = 5,000 bushels cleaned per hour; [3] T = truck rate; R = rail rate. Wheat prices varied from $3.15 to $3.40 per bushel.

Comparison of Cleaning Wheat with High and Low Levels of Dockage

To develop an analysis on the profitability of cleaning wheat because of different original dockage levels, a comparison was made of 1 year with a high and 1 year with a low level of dockage. One of the counties in which one of the study elevators was located had average

[11]/ "AnswerQUICK -- Wheat Cleaning Analysis, User's Guide," Cooperative Extension Service, Kansas State University, Manhattan, Kansas, November 1987, page 12.

dockage levels of 1.4% in 1989 and 0.3% in 1991. Table 7 shows a comparison from different combinations of two different levels of material removed by cleaning, three prices for the cleanings or material removed, two wheat prices, and two shipping rates. The comparison shows that cleaning wheat was much more profitable in 1989 than in 1991. In fact, cleaning generally lost money in 1991 or at best gave a relatively low profit.

Table 7. Comparing Cleaning Wheat in Central Kansas - Elevator #4 with Different Scenarios

Variable	Specifications Levels								
Bu. Cleaned (Mil.)	1.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Material Removed[1/] (%)	0.8	0.8	0.8	0.8	0.8	0.6	0.8	0.8	0.8
Cleanings Price ($/Cwt)	4.00	4.00	3.00	4.00	4.00	4.00	3.00	3.00	7.00
Wheat Price ($/Bu)	3.40	3.40	3.40	2.50	3.40	3.40	2.50	2.50	3.40
Shipping Rate ($/Cwt)	0.60	0.60	0.60	0.60	0.10	0.60	0.60	0.10	0.60
	Cents per Bushel								
1989 Dockage Reduction 1.4% to 0.5%									
Clean at 3,000 Bu/Hr	1.96	2.24	1.76	2.15	2.00	2.36	1.67	1.43	3.68
Clean at 5,000 Bu/Hr	2.30	2.50	2.02	2.41	2.26	2.62	1.93	1.69	3.94
1991 Dockage Reduction 0.3% to 0.2%									
Clean at 3,000 Bu/Hr	-0.26	0.02	-0.46	0.64	-0.22	0.14	0.16	-0.08	1.46
Clean at 5,000 Bu/Hr	0.08	0.28	-0.20	0.91	0.04	0.41	0.43	0.19	1.72

[1/]The material removed by cleaning includes dockage, foreign material, and shrunken and broken kernels.

Under Standardized Operating Conditions -- Cleaning 3,000 Bushels/Hour

To investigate what size of operation might make cleaning profitable for country elevators, two model sizes were compared. This analysis used a device that cleaned at 3,000 bushels per

hour, cleaning 1 million bushels versus 2 million bushels. For each size, profitability was determined during the first year of operation and during the eighth year, when the 7-year loan was repaid and the equipment had been fully depreciated. Results of this analysis are shown in Table 8.

Profitability was greatest in 1989 for both sizes of elevators for the first and eighth years of operation. However, elevators cleaning 1 million bushels during the first year of operation showed losses in both 1990 and 1991. Even cleaning 2 million bushels during the first year of a cleaning operation gave an average profit of only 0.04 and 0.02 cents per bushel in 1990 and 1991, respectively.

Table 8. Annual Profit of Wheat Cleaned when 1 Million Bushels and 2 Million Bushels Are Cleaned at 3,000 Bushels per Hour by an Elevator in Six Kansas Counties in 1989, 1990, and 1991.[1]

County	1 Million Bushels			2 Million Bushels		
	1989	1990	1991	1989	1990	1991
	(cents/bushel)			(cents/bushel)		
1st Year of Operation						
Sedgwick	0.06	-0.25	-0.55	0.51	0.19	-0.11
Reno	-0.23	-0.25	-0.55	0.21	0.19	-0.11
Harvey	0.85	-0.55	-0.55	1.30	-0.11	-0.11
Marion	1.05	-0.55	-0.25	1.49	-0.11	0.19
McPherson	1.55	-0.55	-0.36	1.99	-0.11	0.09
Clay	3.43	-0.25	-0.25	3.88	0.19	0.19
Average	1.12	-0.40	-0.42	1.56	0.04	0.02
8th Year of Operation						
Sedgwick	0.90	0.59	0.29	0.93	0.61	0.31
Reno	0.61	0.59	0.29	0.63	0.61	0.31
Harvey	1.70	0.29	0.29	1.72	0.31	0.31
Marion	1.89	0.29	0.59	1.91	0.31	0.61
McPherson	2.39	0.29	0.48	2.41	0.31	0.51
Clay	4.28	0.59	0.59	4.30	0.61	0.61
Average	1.96	0.44	0.42	1.98	0.46	0.44

[1] Cleaned 3,000 bushels per hour. Portable cleaners are available for prices as low as $25,000 although the 3,000 bushel per hour of cleaning in this example cost more.

Comparison of Net Benefits from Cleaning Wheat at #4 Elevator Using Different Scenarios for the 1989 and 1991 Crops

To understand the impact from changing one of the several parameters or factors that affect the benefits from cleaning 2 million bushels of wheat, each factor was entered at several levels. The factors changed were the cleanings price, freight costs, percent of material removed,

and wheat price. These comparisons are shown in Table 9. The average dockage level in 1989 was 1.4 percent for that elevator's county, and cleaning would reduce it to 0.5 percent. For 1991, the average dockage level was 0.3 percent, and cleaning would drop the dockage level only down to 0.2 percent. As in the above example, the benefit from cleaning wheat was higher in 1989 than in 1991.

The price for the cleanings was varied by 50-cent intervals from $7.00 to $1.00 per hundredweight (cwt). The higher value might be what someone could earn if the cleanings were incorporated in a range cube (large pellet) [12]/ for cattle. Range cubes may have protein levels from 20 to 36 percent with up to 10 percent fiber. The value of cleanings would depend upon its test weight and the price of competing products such as wheat, wheat mids, corn, and sorghum. As the value of cleanings was reduced, the benefit from cleaning was reduced. With each 50 cent/cwt drop, the net benefit from cleaning dropped 0.24 cent per bushel based upon cleaning 2 million bushels a year.

The break-even point for cleaning wheat based upon the value assigned to the cleanings can be seen in Figure 1. The break-even cleanings price for cleaning 1991 wheat was $3.98 per bushel for 3,000 bushels per hour and $3.43 per bushel for 5,000 bushels per hour. However, for the 1989 wheat crop, cleaning remained profitable no matter how low the cleanings price went. With the 1989 situation, the value of the cleanings could be negative and cleaning could break even. If the operator of a cleaner would have to pay someone to transport a worthless product, then the cleanings would have a negative value. Cleaning would break even for the 1989 crop with cleanings priced at $-0.66 for cleaning 3,000 bushels per hour or $-1.21 per hundredweight for cleaning 5,000 bushels per hour.

If an elevator operation already had a pellet mill or one was available next door from another company, the 25 pound test weight cleanings might be sold as pelleted feed for $6 to $7 per cwt. Cleanings with a minimum 25 pound test weight is considered necessary to have a product that will easily flow through the elevator handling equipment and be of sufficient nutrient value to serve as a feed ingredient. If a wheat reclamation system were operated along with the cleaning operation, investment cost in the equipment would be higher, the operator would sell more wheat, but the cleanings would be of little value because it would be mostly fiber. If an add-on pellet plant had to be built, the cost could range from $364,000 for a 2.5 ton-per-hour facility to $439,000 (not including rail siding investment) for a 5 ton-per-hour facility. To produce 1,000 tons annually, the cost per ton would be $55.57 or $2.78 per cwt, and to produce 2,500 tons annually, the cost per ton would be $24.44 or $1.22 per cwt.[13]/

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[12]/Range cubes: Large pellets designed to be fed to cattle on the ground; may be called range wafers. They are designed be fed as a supplement with protein ranging from 20% to as high as 36% and the percentage of carbohydrates depending upon the nature of the protein source.

[13]/ Schnake, L.D., "Grain-Dust Pelleting Costs and Capital Requirements for Stationary and Portable Plants," Washington, D.C., U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, ESCS-71, pages 20 and 21.

Table 9. Comparing Net Profit from Cleaning 2 Million Bushels of Kansas Wheat at #4 Elevator Using Different Scenarios for the 1989 and 1991 Crops*

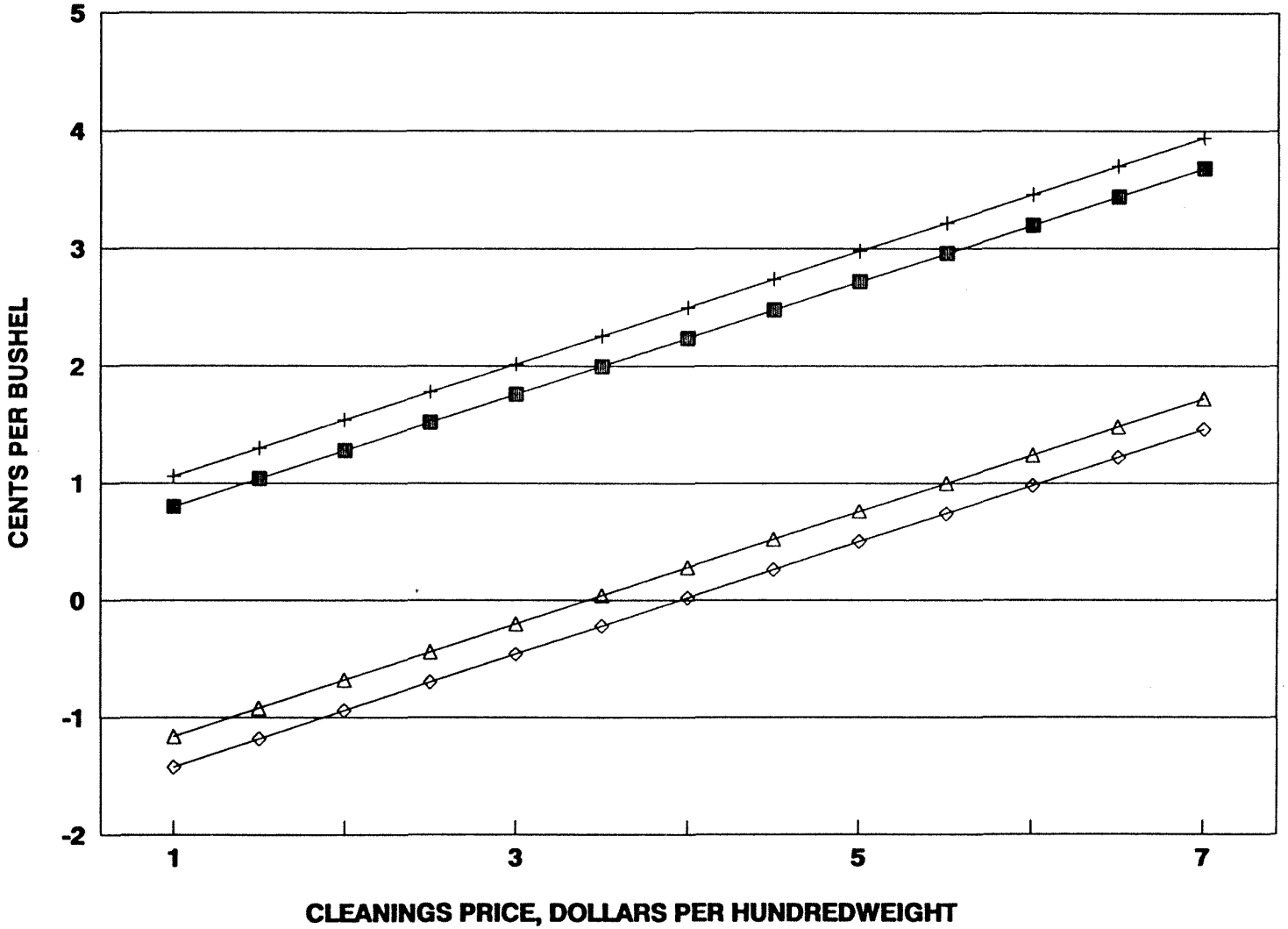
Parameter	1989**		1991**	
	3,000 Bu/Hr	5,000 Bu/Hr	3,000 Bu/Hr	5,000 Bu/Hr
	(Cents/Bushel)			
Cleanings Price ($/Cwt)				
$7.00	3.68	3.94	1.45	1.72
$6.50	3.44	3.70	1.21	1.48
$6.00	3.20	3.46	0.97	1.24
$5.50	2.96	3.22	0.73	1.00
$5.00	2.72	2.98	0.49	0.76
$4.50	2.48	2.74	0.25	0.52
$4.00***	2.24	2.50	0.01	0.28
$3.50	2.00	2.26	-0.23	0.04
$3.00	1.76	2.02	-0.47	-0.20
$2.50	1.52	1.78	-0.71	-0.44
$2.00	1.28	1.54	-0.95	-0.68
$1.50	1.04	1.30	-1.19	-0.92
$1.00	0.80	1.06	-1.43	-1.16
Wheat Price ($/Bu)				
$5.00	2.41	2.67	-1.10	-0.84
$4.50	2.35	2.62	-0.75	-0.49
$4.00	2.30	2.57	-0.40	-0.14
$3.50	2.25	2.51	-0.05	0.21
$3.40	2.24	2.50	0.01	0.28
$3.00	2.20	2.46	0.30	0.56
$2.50	2.15	2.41	0.64	0.91
$2.00	2.09	2.36	0.99	1.26
Freight ($/Cwt)				
$1.00	2.43	2.71	0.21	0.47
$0.90	2.38	2.65	0.16	0.42
$0.80	2.34	2.60	0.11	0.37
$0.70	2.29	2.55	0.06	0.33
$0.60	2.24	2.50	0.01	0.28
$0.50	2.19	2.46	-0.03	0.23
$0.40	2.14	2.41	-0.08	0.18
$0.30	2.10	2.36	-0.13	0.13
$0.20	2.05	2.31	-0.18	0.09
$0.10	2.00	2.26	-0.23	0.04

* Cleaned 2 million bushels of wheat per year and in first year of operation.

** Dockage level in 1989 cleaned from 1.4% to 0.5%.
Dockage level in 1991 cleaned from 0.3% to 0.2%.

*** Shading indicates the standard specifications used.

FIGURE 1. COMPARING NET PROFIT FROM CLEANING KANSAS WHEAT AS CLEANINGS PRICE VARIES



SOURCE: TABLE 9.

The freight rate began at $1.00 per hundredweight (cwt) and was reduced in 10-cent intervals down to $0.10 per cwt. For each 10 cent per hundredweight drop, the net benefit from cleaning decreased about 0.05 cent per bushel.

The break-even point for cleaning wheat based upon the freight rate is shown in Figure 2. The break-even freight rate for cleaning the 1991 crop was at $0.58 per hundredweight from cleaning at 3,000 bushels per hour or $0.03 per hundredweight from cleaning at 5,000 bushels per hour. In the 1989 situation, cleaning remained profitable no matter how low a transportation rate went.

Wheat prices were decreased in 50-cent intervals beginning at $5.00 per bushel and dropping to $2.00 per bushel. In 1989, for each 50-cent drop in wheat price, the net benefit from cleaning dropped about 0.05 cent per bushel. However, in 1991, for each 50-cent drop in wheat price, the net benefit from cleaning increased 0.35 cent per bushel. Figure 3 shows that for 1989, profit from cleaning increased as the price of wheat went up and the break-even point was never attained, remaining profitable. Whereas for 1991, profit decreased as the price of wheat went up. The break-even wheat price for cleaning the 1991 crop was at $3.42 for cleaning 3,000 bushels per hour and at $3.80 for cleaning 5,000 bushels per hour.

The difference in the effect of wheat prices between the 2 years can be explained. In 1989, when the original dockage level was 1.4%, the removal of 0.8% by cleaning and a deduction of 0.5% for the dockage remaining in the wheat after cleaning resulted in more wheat being delivered to the market after cleaning than when the uncleaned wheat received a 1.4% deduction for the original dockage level. On the other hand in 1991, the removal of 0.8% by cleaning and the deduction for the remaining 0.2% dockage left less wheat to be marketed than when only a 0.3% deduction occurred for the dockage in the original and uncleaned wheat. Consequently, in 1991, when the wheat price level was increased, the elevator operator would lose more money from cleaning because less wheat would be sold after cleaning. However, in the 1989 situation, as the wheat price dropped, cleaning would be more profitable because more wheat would be marketed after cleaning.

The difference between any 2 years, such as 1989 and 1991, is related to the beginning dockage level. Cleaning profit increases with increasing wheat prices when the dockage is 1.3% or greater. However, cleaning profit decreases with a drop in the wheat price when the original dockage is 1.2% or less. For each 0.1% decrease in the beginning dockage percentage, the cleaning profit for each $0.50 reduction in the wheat price decreases by about 0.035 cent per bushel.[14/]

If cleaning removes more or less material than the 0.8 percent actually removed, then the profitability of cleaning will be altered. The percent of material removed was assumed to

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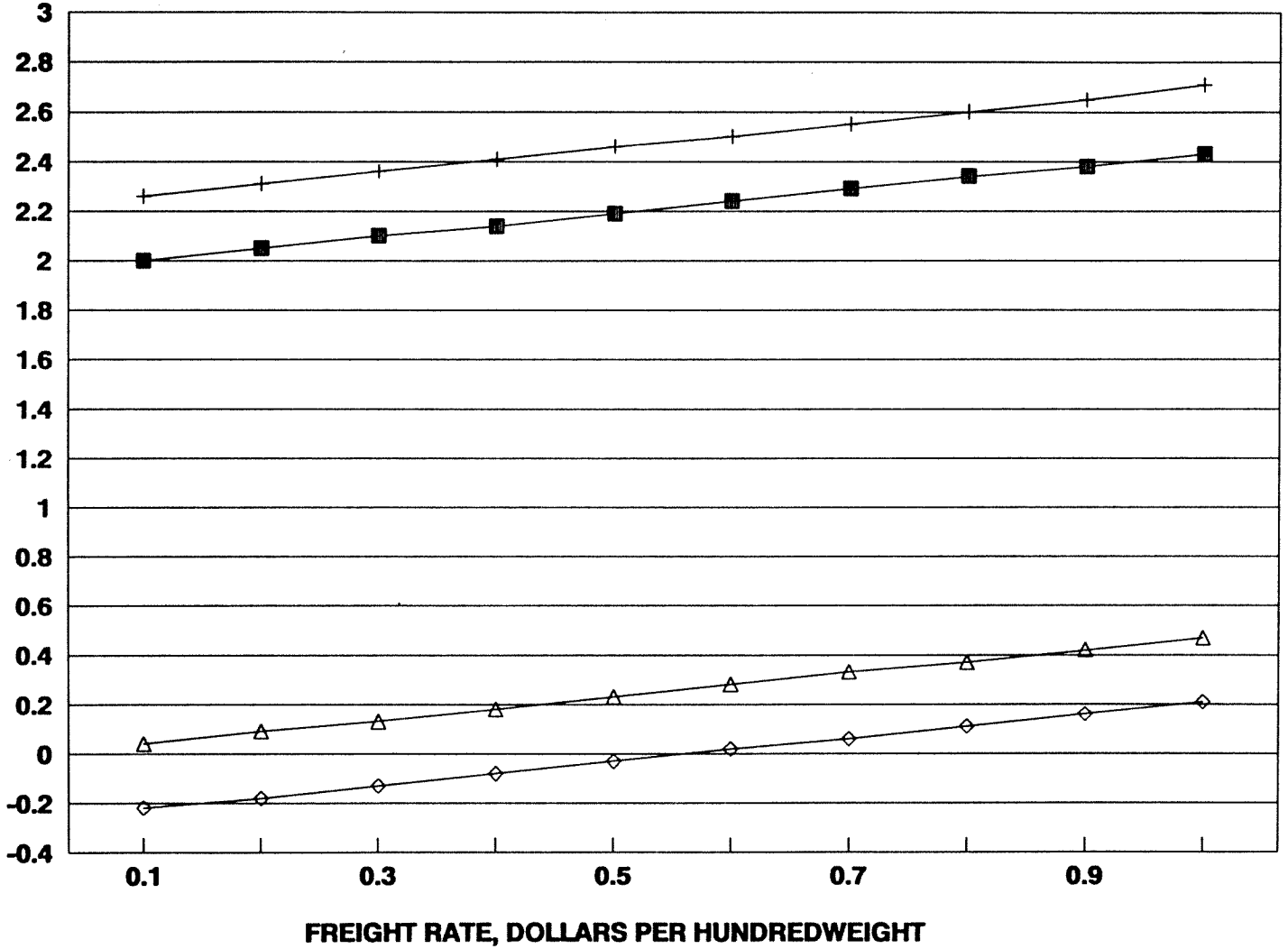
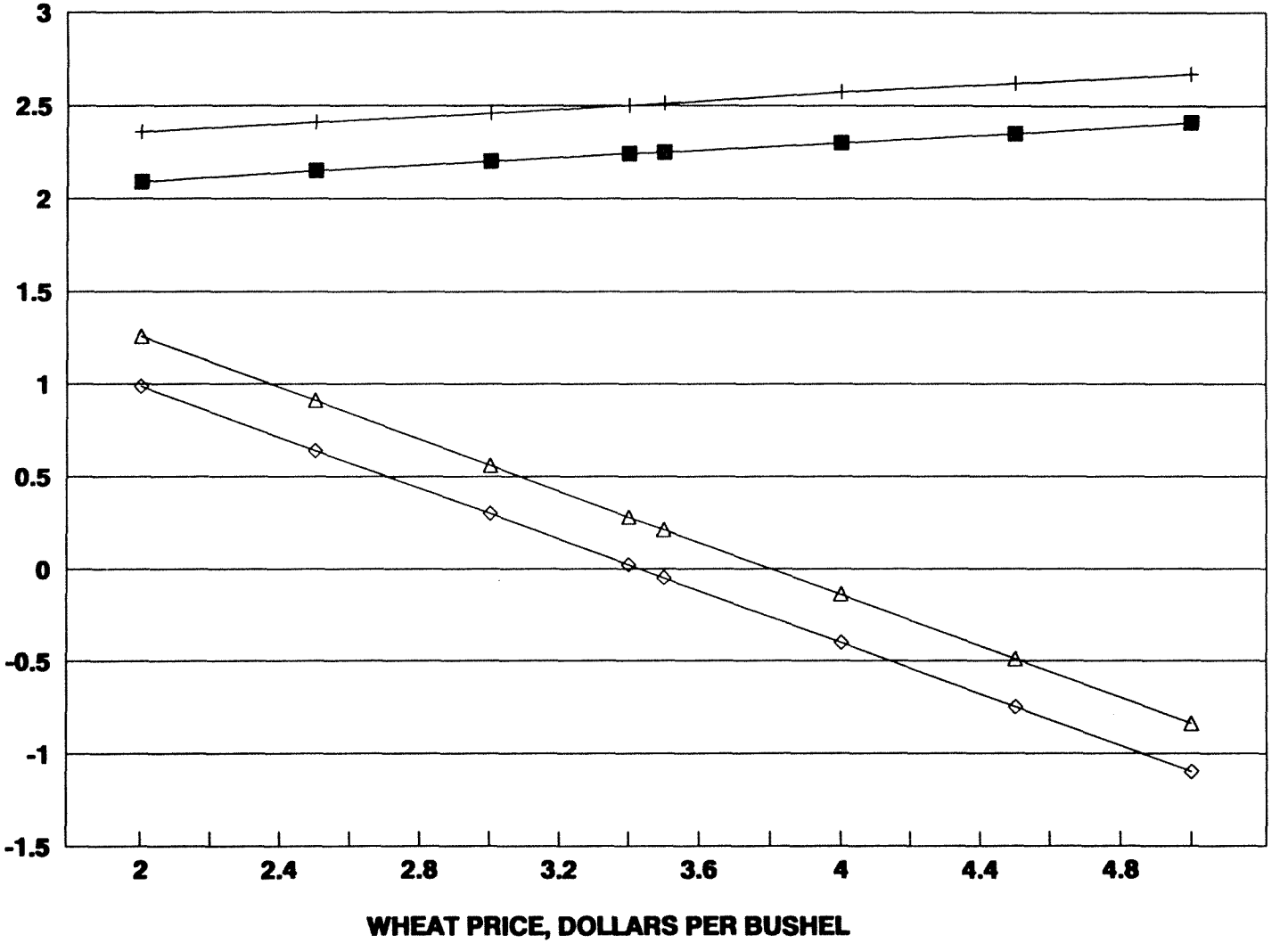
[14/] Although the market trades wheat at 0.1% intervals, the calculations for the new dockage levels to compare the profit differences were carried to 4 decimal points and the profit calculations to 5 decimal points in the cents per bushel to eliminate differences due to rounding.

FIGURE 2. COMPARING NET PROFIT FROM CLEANING KANSAS WHEAT AS FREIGHT RATE VARIES



SOURCE: TABLE 9.

FIGURE 3. COMPARING NET PROFIT FROM CLEANING KANSAS WHEAT AS WHEAT PRICE VARIES



SOURCE: TABLE 9.

be as high as 0.85 percent to as low as 0.60 percent, dropping in 0.05 percent intervals. For each 0.05 percent drop in material removed, the profit from cleaning increased 0.03 cent per bushel.

Analyzing the data in Table 9, indicates that the price of cleanings will have the greatest impact on the benefit from cleaning. In cases where the dockage level in the wheat crop is relatively low, the price of wheat can also have an important impact on the level of profitability of cleaning.

SUMMARY

This statistical analysis indicates that cleaning wheat effects significant changes in pounds of test weight, in percentages of dockage, shrunken and broken kernels and total defects but not in foreign material percentage. Cleaning has the greatest impact on the dockage factor.

Cleaning wheat would have been most profitable in 1989 compared to 1990 and 1991.

Cleaning wheat by smaller, individual elevators does not appear to be a profitable operation, unless excess nonwheat material is present. Number 4 elevator cleaning the largest amount of wheat and shipping by rail would have earned the greatest amount of profit in 1989, except for elevator number 8. The profitability level in 1989 for elevator number 8 could be attributed to the fact that dockage level was 1.9 percent.

The average profit from cleaning the amount of wheat equal to the storage capacity of the 8 elevators in this analysis would have been 0.35 of a cent per bushel for the 1989 crop for the device cleaning 5,000 bushels per hour. However, for the device cleaning 3,000 bushels per hour in 1989 would have had an average cost of 0.40 cent per bushel, and both devices in 1990 and 1991 would have had average cleaning costs ranging between 1.0 cent and 2.0 cents per bushel respectively. These average profits/costs include 0.5 cent per bushel of cleaning benefits captured because of savings from benefits assumed in the aeration and drying operations. To cover these costs, the elevator operator would need to receive a premium for cleaner wheat or, if competition would permit, increase the operating margins in buying wheat.

Under the standardized models of cleaning 1 and 2 million bushels, profitability from cleaning wheat was higher for the 2-million-bushel operation. The improvement in profit for the 2-million-bushel case existed for both the first year and the eighth year of operation. The average profits for the first year of operation of the 3,000 bushel per hour cleaner were highest in 1989 -- 1.12 and 1.56 cents per bushel for cleaning 1 million bushels and 2 million bushels, respectively. However, cleaning resulted in losses of 0.4 cent a bushel in 1990 and 1991 for 1 million bushels and in very small profits (0.04 and 0.02 cent a bushel) in 1990 and 1991 for cleaning 2 million bushels.

The price level for cleanings appears to have the most influence upon the profitability of cleaning. If wheat is relatively free of dockage, the cleaning of wheat cannot be justified and, as a result, the higher the wheat price, the greater will be the losses from cleaning. These losses occur because the net or settlement bushels were more for not cleaning and deducting the small amount of dockage than for cleaning and deducting the even smaller amount of dockage.

However, when the dockage level in the wheat is relatively low, price of wheat has a great, if not greater, impact on the profitability of cleaning.

CONCLUSIONS

Smaller elevator operations usually are not able to clean wheat. Only in years when the wheat crop contains a higher level of nonwheat material is it profitable to clean wheat. This confirms conversations with grain elevator operations. Several elevator operators said that they cleaned wheat in 1989 using equipment already owned, bought, or rented.

The number of bushels of wheat cleaned seems to have an important impact on the profitability of cleaning. The larger elevator (2 million bushels per year in this study) had a greater chance of receiving a profit from cleaning.

In those cases when an elevator operator paid for the cleaner in the first or second year because of a serious problem with nonwheat material, then cleaning wheat might be profitable in succeeding years because no interest would be paid on capital borrowed.

An elevator manager keeps in mind a matrix of factors in analyzing whether to clean wheat or not. The level of cleanings, wheat price, the freight savings, and the percent of material removed influence returns from cleaning. But most of all, the level of prices for cleanings seems to have the greatest influence on the decision to clean.

The analysis in this report provides guidance to companies about the profitability of cleaning wheat at an elevator facility. Managers may use the information about the profitability of cleaning wheat or about a needed premium to cover the cost of cleaning wheat. In other words, this is a "micro" analysis. The effect of cleaning wheat on sales to overseas markets is the subject of a more comprehensive "macro" analysis. Will wheat export sales be enhanced from cleaning or will wheat export sales be lost because of not cleaning wheat throughout the entire industry? The price responsiveness of cleaned wheat and the degree of substitutability for different levels of clean wheat from multiple origins are parts of the "macro" analysis.

APPENDIX

Appendix Table 1 contains the results of the linear regression model and Appendix Table 2 contains the estimates of the percentage change model. Both tables account for the fact that the change in the level of a characteristic through cleaning is likely to be affected by the initial level of that characteristic. The R-Square is higher for the linear regression model than for the percentage model, which indicates that the change in a characteristic because of cleaning is explained more completely by the linear regression model.

The linear regression model is defined by the following equation.

$Y = a + bX$; where X = the original level of the characteristic before cleaning and Y = the change in the level of the characteristic with cleaning.

The coefficients in Appendix Table 1 multiplied by 100 indicate the percent reduction in the characteristic, because these coefficients are negative (except for test weight where the coefficient is interpreted as the percent increase in test weight).

If a wheat sample contained 0.9% dockage, the linear model would predict that the dockage level after cleaning would be 0.4% (after rounding).

The percentage model would predict that, if a wheat sample contained 0.9% dockage, the level after cleaning would be 0.3% (after rounding).

Appendix Table 1. Linear Regression Model on Change and Percentage Model in the Grade Characteristic as a Result of Cleaning Kansas Wheat.

Characteristic	Constant	Initial Level	R-Squared	F-Statistic
	Linear Regression Model[1]			
Dockage	+0.115**	-0.707**	0.92	905.61**
	(3.32)[2]	(30.09)[2]		
Foreign Matter[3]	+0.060**	-0.582**	0.53	89.72**
	(4.67)	(-9.47)		
Test Weight[3]	+8.107**	-0.132**	0.14	13.72**
	(3.79)	(-3.70)		
Shrunken &	+0.285*	-0.326**	0.26	28.65**
Broken Kernels	(2.51)	(-5.35)		
Total Damaged	+0.025	-0.036	0.00	0.31
	(0.29)	(-0.56)		
	Percentage Model[4]			
Dockage	0	-0.668**	0.91	11.28**
		(31.06)[2]		
Foreign Matter[3]	0	-0.397**	0.41	22.36**
		(-9.47)		
Test Weight[3]	0	0.003**	0.00	14.75**
		(2.90)		
Shrunken &	0	-0.192**	0.21	6.44**
Broken Kernels		(-6.37)		
Total Damaged	0	-0.0254	0.00	0.08
		(-0.49)		

[1] Percentage model was specified with the change in the characteristic as a function of the initial level of the characteristic.
[2] T-Statistics on coefficients in parentheses.
[3] Sample size is 80 instead of 81.
[4] Percentage model was specified with the change in the characteristic as a function of the initial level of the characteristic, restricting the constant to equal zero.
* Indicates significance at the 5% level.
** Indicates significance at the 1% level.

Appendix Table 2. Three Examples of Terminal Discounts for Quality Factors that Are Below an Elevator's Buying Grade

Example A: Discount Schedule Used in this Analysis of Cleaning Wheat

TEST WEIGHT DISCOUNT	DAMAGED KERNELS	SHRUNK & BROKEN
59# - 59.9 = ½¢	2.1 - 3.0 = 3 ¢	3.1 - 5.1 = ½¢
58# - 58.9 = 1 ¢	3.1 - 4.0 = 4 ¢	5.1 - 6.0 = 1½¢
57# - 57.9 = 2 ¢	4.1 - 5.0 = 5 ¢	6.1 - 7.0 = 3 ¢
56# - 56.9 = 3 ¢	5.1 - 6.0 = 6 ¢	7.1 - 8.0 = 4 ¢
55# - 55.9 = 5 ¢	6.1 - 7.0 = 7 ¢	8.1 - 9.0 = 5 ¢
54# - 54.9 = 7 ¢	7.1 - 8.0 = 8 ¢	
53# - 53.9 = 10 ¢	8.1 - 9.0 = 9 ¢	FOREIGN MATTER
52# - 52.9 = 13 ¢	9.1 - 10.0 = 10 ¢	.6 - .9 = ½¢
51# - 51.9 = 16 ¢	10.1 - 11.0 = 50 ¢	1.0 - 1.4 = 1 ¢
50# - 50.9 = 19 ¢	20.1 - 30.0 = $1.00	1.5 - 1.9 = 1½¢
49# - 49.9 = 22 ¢	30.1 = $1.50	2.0 - 2.4 = 2 ¢
48# - 48.9 = 25 ¢		2.5 - 2.9 = 2½¢
47# - 47.9 = 28 ¢	TOTAL DEFECTS	3.0 - 3.4 = 3 ¢
46# - 46.9 = 32 ¢	3.1 - 5.0 = ½ ¢	3.5 - 3.9 = 3½¢
45# - 45.9 = 36 ¢	5.1 - 8.0 = 1 ¢	
44# - 44.9 = 40 ¢	8.1 - 15.0 = 10 ¢	
43# - 43.9 = 45 ¢	15.0 - 50.0 = 50 ¢	
42# - 42.9 = 50 ¢	50.0 = $1.00	
41# - 41.9 = 55 ¢		
40# - 40.9 = 60 ¢		

Example B: An Alternative Discount Schedule Used in Grain Marketing

TEST WEIGHT DISCOUNT
59# - 59.9 = ½¢
58# - 58.9 = 1 ¢
57# - 57.9 = 3 ¢
56# - 56.9 = 4 ¢
55# - 55.9 = 7 ¢
54# - 54.9 = 10 ¢
53# - 53.9 = 14 ¢

FOREIGN MATERIAL
.6 - 1.0 = 1¢
1.1 - 1.5 = 2¢
1.6 - 2.0 = 3¢
2.1 - 2.5 = 4¢
2.6 - 3.0 = 6¢
3.1 - 3.5 = 8¢

TOTAL DEFECTS
3.1 - 5.0 = ½¢
5.1 - 6.0 = 1½¢
6.1 - 7.0 = 2 ¢
7.1 - 8.0 = 3 ¢
8.1 - 9.0 = 4 ¢
9.1 - 10.0 = 5 ¢

MOISTURE DISCOUNTS
13.51 - 13.75 = 1¢
13.76 - 14.00 = 2¢
14.01 - 14.25 = 3¢
14.26 - 14.50 = 4¢
14.51 - 14.75 = 5¢
14.76 - 15.00 = 6¢

ANY WHEAT OVER 14% IS SUBJECT TO REJECTION

HEAT DAMAGE
From 0.2% to 1.0% = 1¢ ea. 1/10%

OTHER CLASSES
3.1 - 5.0 = 1¢
5.1 - 7.0 = 3¢
7.1 - 10.0 = 5¢

Mixed or SRW wheat will be discounted at 10¢ per bushel. This discount may change, but we will notify prior to any adjustment.

DAMAGED KERNELS
2.1 - 3.0 = 1¢
3.1 - 4.0 = 2¢
4.1 - 5.0 = 4¢
5.1 - 6.0 = 7¢
6.1 - 7.0 = 10¢
7.1 - 8.0 = 13¢
8.1 - 9.0 = 16¢
9.1 - 10.0 = 19¢
Plus 4¢ ea. 1% up

SHRUNKEN & BROKEN
3.1 - 5.0 = ½¢
5.1 - 6.0 = 1½¢
6.1 - 7.0 = 3 ¢
7.1 - 8.0 = 4 ¢
8.1 - 9.0 = 5 ¢

CONTRASTING CLASSES
1.1 - 2.0 = 2¢
2.1 - 3.0 = 3¢
3.1 - 6.0 = 4¢
6.1 - 10.0 = 5¢

I D K DISC SCALE
No discount on 0 thru 10 count
1¢ ea count on 11 thru 32 count
Above 32 count, subject to rejection

Sample grade wheat is always subject to subject to rejection. If sample is accepted, the following discounts will apply:

Weevily = 10¢/bu.
Sour = 15¢/bu.
Cofo = 20¢/bu.
Stones = 20¢/bu.
Smutty = 15¢/bu.
Garlicky = 10¢/bu.
Musty = 10¢/bu.

Example C: A Second Alternative Discount Schedule Used in Grain Marketing

TEST WEIGHT DISCOUNT

59# - 59.9 = ½¢
58# - 58.9 = 1 ¢
57# - 57.9 = 2 ¢
56# - 56.9 = 3 ¢
55# - 55.9 = 4 ¢
54# - 54.9 = 5 ¢
53# - 53.9 = 6 ¢
52# - 52.9 = 7 ¢
51# - 51.9 = 9 ¢
50# - 50.9 = 11 ¢
49# - 49.9 = 14 ¢
48# - 48.9 = 17 ¢
47# - 47.9 = 20 ¢
46# - 46.9 = 23 ¢
45# - 45.9 = 26 ¢

FOREIGN MATERIAL

0.6 - 1.0 = 1 ¢
1.1 - 1.5 = 2 ¢
1.6 - 2.0 = 3 ¢
2.1 - 2.5 = 4 ¢
2.6 - 3.0 = 5 ¢
3.1 - 3.5 = 7 ¢
3.6 - 4.0 = 8 ¢
4.1 - 4.5 = 9 ¢
4.6 - 5.0 = 10 ¢
5.1 - 5.5 = 11½¢
5.6 - 6.0 = 13 ¢
6.1 - 6.5 = 14½¢
6.6 - 7.0 = 16 ¢
7.1 - 7.5 = 17½¢
7.6 - 8.0 = 19 ¢
8.1 - 8.5 = 20½¢
8.6 - 9.0 = 22 ¢
9.1 - 9.5 = 23½¢
9.6 - 10.0 = 25¢

MOISTURE DISCOUNTS

13.6 - 13.7 = 1¢
13.8 - 14.0 = 2¢
14.1 - 14.2 = 3¢
14.3 - 14.5 = 4¢
14.6 - 14.7 = 5¢
14.8 - 15.0 = 6¢
15.1 - 15.2 = 8¢
15.3 - 15.5 = 10¢
15.6 - 15.7 = 12¢
15.8 - 16.0 = 14¢
16.1 - 16.2 = 16¢
16.3 - 16.5 = 18¢
16.6 - 16.7 = 20¢
16.8 - 17.0 = 22¢
17.1 - 17.2 = 25¢
17.3 - 17.5 = 28¢
17.6 - 17.7 = 31¢
17.8 - 18.0 = 34¢
18.1 - 18.2 = 37¢
18.3 - 18.5 = 40¢
18.6 - 18.7 = 43¢
18.8 - 19.0 = 46¢
19.1 - 19.2 = 49¢
19.3 - 19.5 = 52¢

ANY WHEAT OVER 14% IS SUBJECT TO REJECTION

TOTAL DEFECTS

3.1 - 5.0 = ½¢
5.1 - 6.0 = 2 ¢
6.1 - 8.0 = 3 ¢
8.1 - 10.0 = 4 ¢
10.1 - 12.0 = 5 ¢
12.1 - 14.0 = 6 ¢
14.1 - 16.0 = 7 ¢
16.1 - 18.0 = 8 ¢
18.1 - 20.0 = 9 ¢

DAMAGED KERNELS(TTL)

2.1 - 3.0 = 1¢
3.1 - 4.0 = 2¢
4.1 - 5.0 = 3¢
5.1 - 6.0 = 4¢
6.1 - 7.0 = 5¢
7.1 - 8.0 = 6¢
8.1 - 9.0 = 7¢
9.1 - 10.0 = 8¢
10.1 - 11.0 = 9¢
11.1 - 12.0 = 10¢
12.1 - 13.0 = 11¢
13.1 - 14.0 = 12¢
14.1 - 15.0 = 13¢
15.1 - 16.0 = 14¢
16.1 - 17.0 = 15¢
17.1 - 18.0 = 16¢
18.1 - 19.0 = 17¢
19.1 - 20.0 = 18¢

SHRUNKEN & BROKEN

3.1 - 5.0 = ½¢
5.1 - 6.0 = 2 ¢
6.1 - 8.0 = 3 ¢
8.1 - 10.0 = 4 ¢
10.1 - 12.0 = 5 ¢
12.1 - 14.0 = 6 ¢
14.1 - 16.0 = 7 ¢
16.1 - 18.0 = 8 ¢
18.1 - 20.0 = 9 ¢

HEAT DAMAGE

0.3% - 0.5% = 2¢
0.6% - 1.0% = 4¢
1.1% - 1.5% = 6¢
1.6% - 2.8% = 8¢

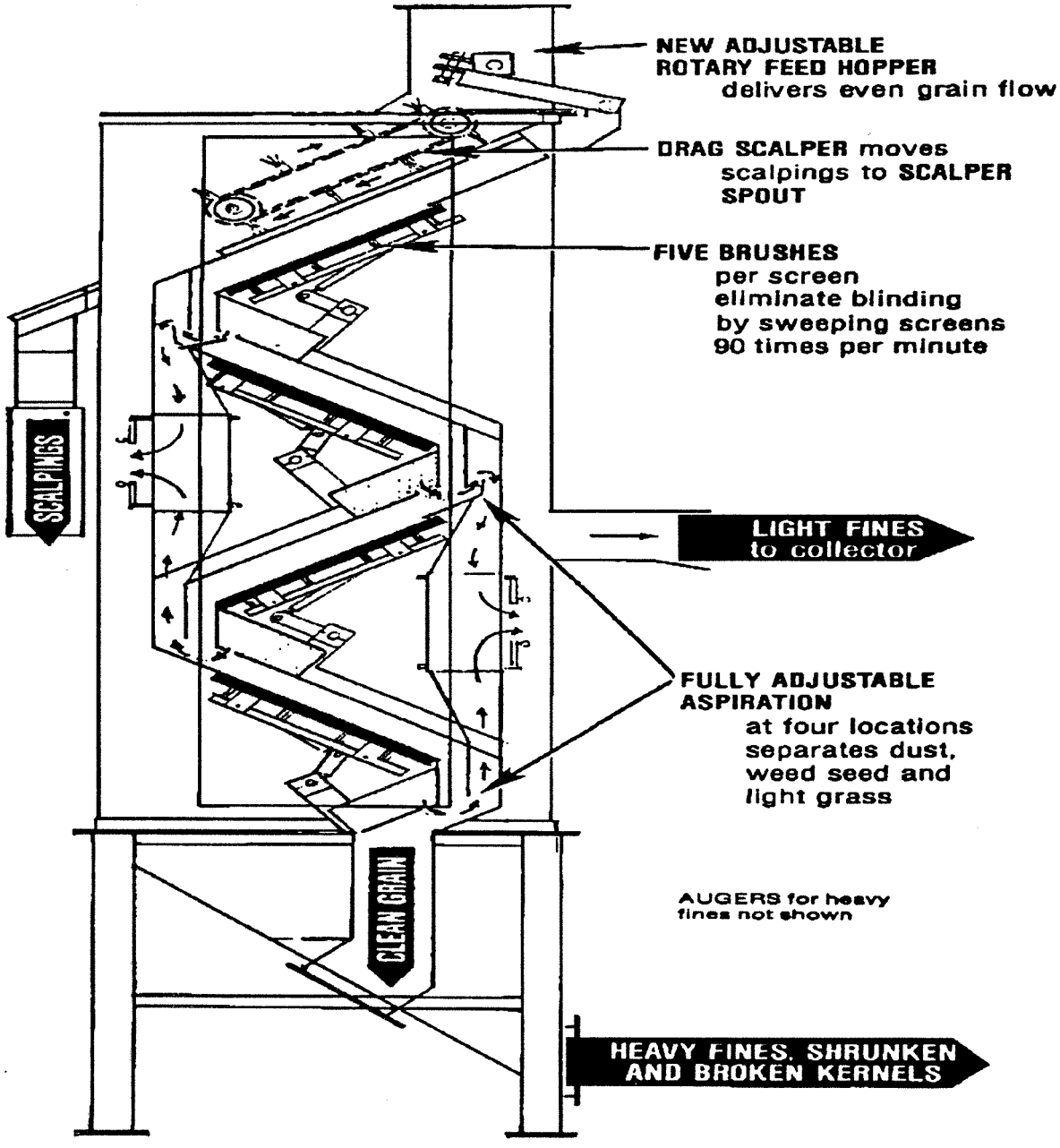
Musty = 5¢/bu
Smutty = 10¢/bu
Insect infest = 5¢/bu

Sour = 5¢/bu
Stones = 25¢/bu

Light smut = 5¢/bu
Animal filth = 25¢/bu

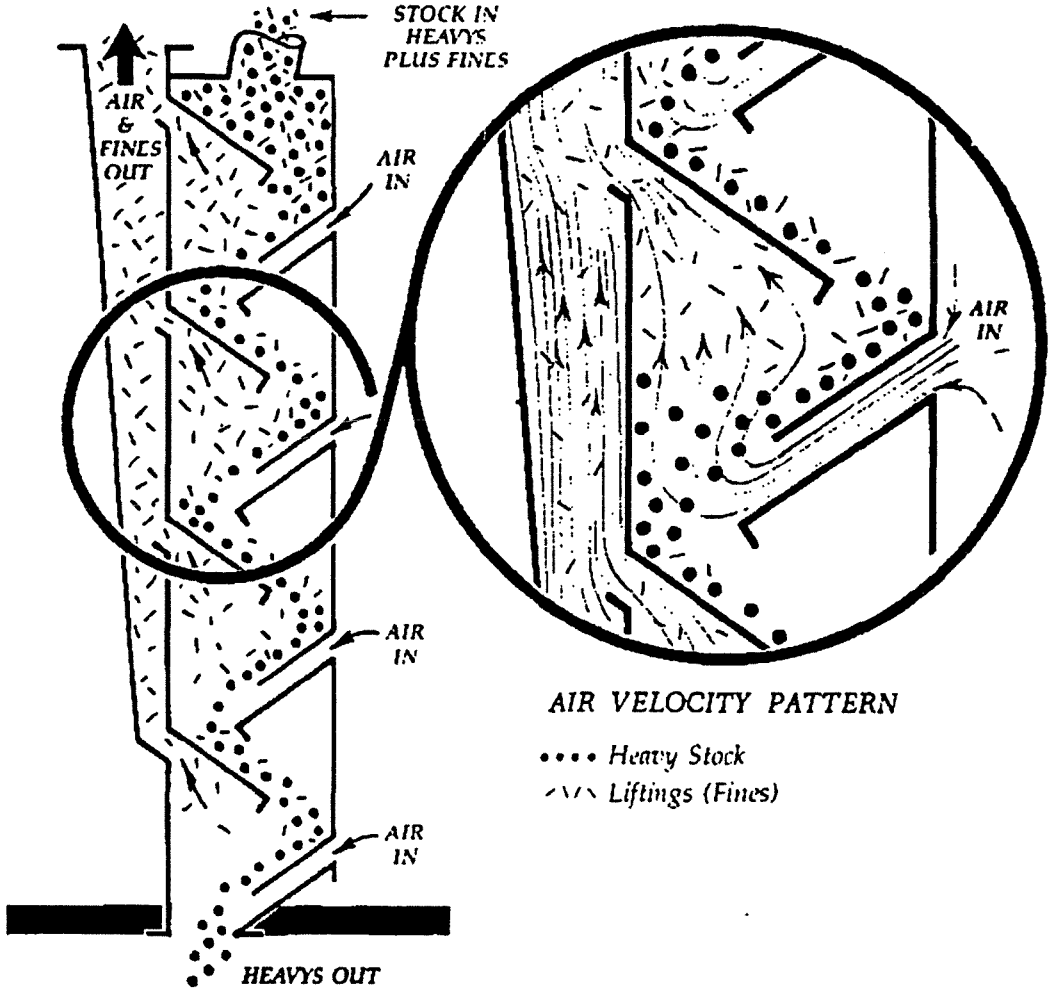
APPENDIX FIGURE 1

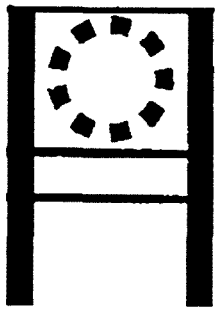
DIAGRAM OF CLEANER WITH SCREEN AND AIR



APPENDIX FIGURE 2

DIAGRAM OF CLEANER WITH AIR PLUS A SCALPER





The scalper was a cylinder with a ¼ inch mesh screen the full length of opening or inlet of the machine to separate large foreign material.

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Department Report August 1992