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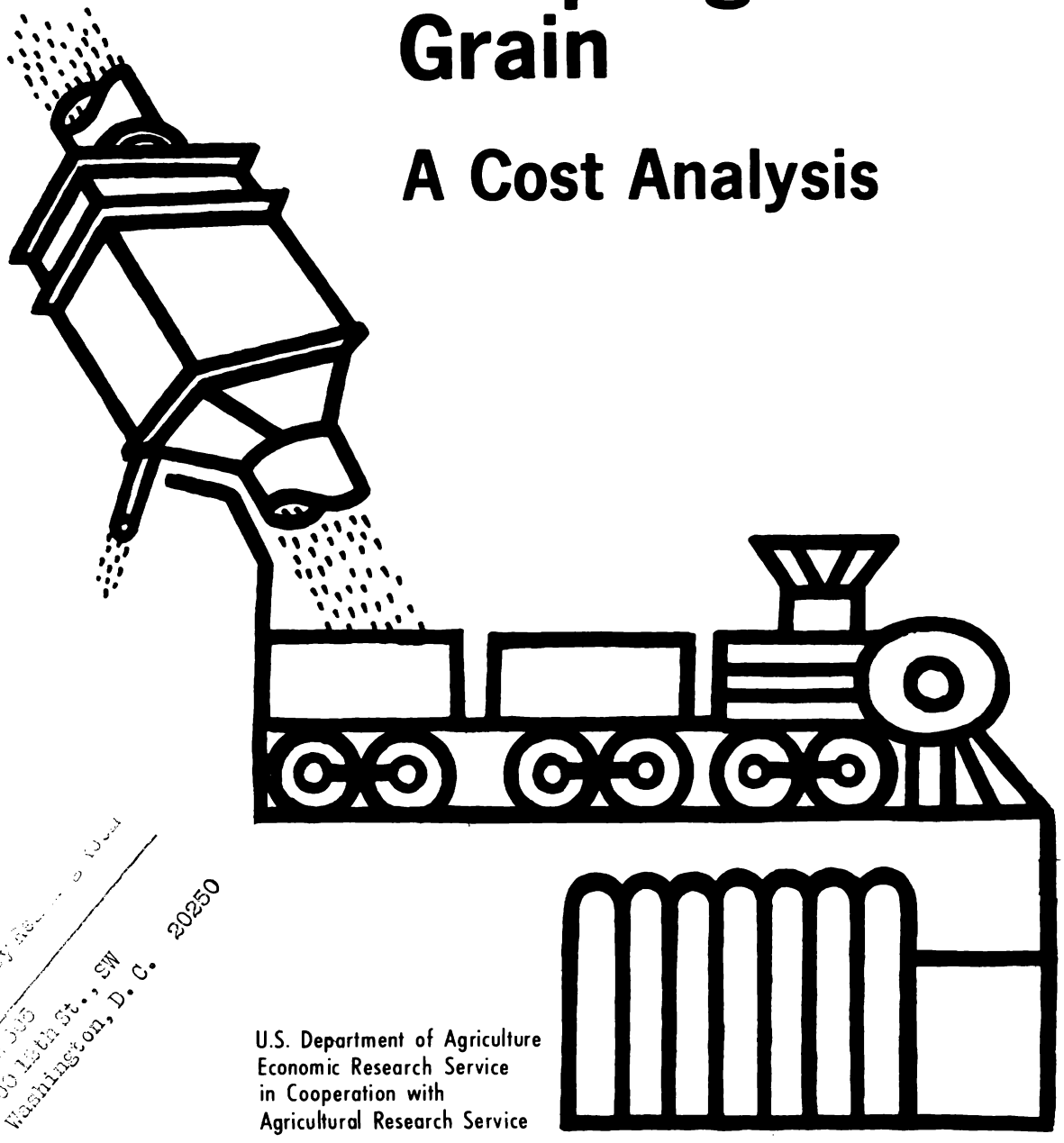
Diverter-Type Mechanical Sampling of Grain

A Cost Analysis



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ABSTRACT

Costs of sampling grain using a diverter-type mechanical sampler were synthesized for five sampler sizes operated at six levels of annual throughput. The ranges of annual operating costs (cents per bushel) for samples in the study were: (1) 6-inch sampler, 0.0740-0.6242; (2) 9-inch sampler, 0.0591-0.7618; (3) 10-inch sampler, 0.0529-0.7618; (4) 16-inch sampler, 0.0157-0.0439; and (5) 36-inch sampler, 0.0073-0.0602.

These cost data will allow grain industry decisionmakers to analyze the costs against expected benefits of adopting the warehouseman's sample-lot inspection service of the U.S. Department of Agriculture. Widespread adoption of the warehouseman's sample-lot inspection of grain which utilizes the diverter-type mechanical sampler would contribute significantly to railcar utilization, and consequently to increased efficiency throughout the grain marketing-transportation complex.

Keywords: Grain marketing, mechanical sampling, sampling costs, yellow certificate, grain inspection

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SUMMARY

Grain warehousemen who wish to avail themselves of the warehouseman's sample-lot inspection service, now authorized by Congress for grain to be sold domestically, must install diverter-type mechanical samplers. Sampling of the grain is performed at the warehouse rather than at an inspection point under this system. It has several advantages which may offset the cost of installing the equipment.

To help warehousemen decide whether such installations are economically feasible for them, costs of sampling grain with diverter-type mechanical samplers installed in spouting were synthesized in this study for five sampler sizes at six levels of annual throughput.

The high and low costs per bushel estimated for a 6-inch sampler ranged from 0.6242 cent at an annual throughput of 100,000 bushels to 0.0740 cent at 1.5 million bushels annual throughput. The costs for 9 and 10-inch samplers at the same throughputs ranged from 0.7618 cent to 0.0591 cent for the 9-inch sampler and from 0.8712 cent to 0.0529 cent for the 10-inch sampler. The costs associated with a 16-inch sampler ranged from 0.0439 cent at a minimum throughput of 5 million bushels annually to 0.0157 cent at a maximum throughput of 30 million bushels annually. The high cost for the 36-inch sampler was 0.0602 cent at a minimum annual throughput of 5 million bushels, while the low cost was 0.0073 cent at a maximum annual throughput of 50 million bushels.

DIVERTER-TYPE MECHANICAL SAMPLING OF GRAIN

A Cost Analysis

by

L. D. Schnake and C. A. Watson[1]

INTRODUCTION

Grading of grain is one of the specialized functions performed in the matrix of grain marketing activities. The grading function may be termed a "facilitating" function, because the grade is the vehicle which describes the grain for all parties involved in the marketing process. The Congress of the United States has provided an official inspection system for grain (5).[2] Three basic official inspection certificates have been defined. They are (1) the "white certificate" which involves inspection performed by personnel licensed by the U.S. Department of Agriculture and employed by an official inspection agency (white certificate is required for any grain sold by grade for export), (2) the "yellow certificate" or warehouseman's sample-lot inspection service, which involves sampling with an approved diverter-type mechanical sampler operated by an officially licensed operator who may be an employee of the warehouse, and with grading performed by an official inspection agency (yellow certificate does not satisfy the Grain Standards Act for export grain inspection), and (3) the "pink certificate" or submitted-sample-inspection service, which provides for establishing a grade only on the sample submitted and no certification of sampling method or the lot from which the sample was taken. The "pink certificate" does not meet the Grain Standards Act for export grain inspection. Further information on offical inspection services available may be obtained from the Grain Division, Agricultural Marketing Service, USDA, 6525 Belcrest Road, Hyattsville, Md. 20782.

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[2] Underscored numbers in parentheses refer to items in the Literature Cited, p. 8.

A representative sample of a lot (truck, boxcar, hoppercar, barge, or ocean vessel) of grain to establish a grade is critical if the marketing system is to foster fairness for all parties participating in marketing grain. Several sampling methods are approved by USDA for sampling grain. However, there is a distinct advantage which approved diverter-type mechanical sampling has that no other sampling method affords. That is, diverter-type mechanical sampling is the best approved method of obtaining the most representative sample as documented by USDA's Agricultural Research Service (2).

Mechanical Sampling at the Origin by the Warehouse

Mechanical sampling by a diverter-type sampler is the heart of the warehouseman's sample-lot inspection service (yellow certificate), established by the U.S. Department of Agriculture in August 1971, as explained in a pamphlet (6) by the Agricultural Marketing Service.

In addition to providing a more representative sample, mechanical sampling at the origin: (1) reduces grain door leakage in boxcars caused by inadvertent rupture of grain doors in opening the car for sampling, or in sampling; (2) avoids trimming (leveling the grain) of boxcar loads which must be done in probe-sampling at the origin; (3) avoids weather problems associated with sampling covered hopper cars; and (4) eliminates inspection-point billing and therefore increases railcar utilization--research has shown that inspections at intermediate points between origin and destination require from 3 to 5 days (3,4). Other possible advantages are (1) faster communication in the marketing system on the grade of grain; (2) improved transportation equipment arrangements and consequent transportation savings not otherwise possible; and (3) a "better" competitive position for operators where the mechanical sampling is economically feasible, when compared with those operations which do not have mechanical sampling.

Since the yellow certificate program involves inspection at the origin rather than at an inspection-point destination, more time may be required in getting samples to and inspection information from the inspection agency (6). However, it is possible that the warehouseman will know the official grade of the grain before the grain leaves the origin. Because some members of the grain industry may be reluctant to trade on the basis of the yellow certificate, the warehouseman should be sure the system is accepted in his market area before he adopts it.

OBJECTIVE

Before a warehouseman can decide whether to adopt mechanical sampling, he must compare the expected costs with the expected returns from the system. For illustrative purposes only, consider a warehouseman using an approved diverter-type sampler who obtains more nearly representative samples from 100,000 bushels of corn in a marketing year, from which he realizes an additional 10 cents per bushel revenue because of the higher grade of the grain. This translates into $10,000, which could be rightfully attributed to the mechanical sampler. Would this be enough savings, apart from any other saving which might accrue, to justify adopting mechanical sampling? The analysis in this report will help warehousemen to answer this question.

DIVERTER-TYPE MECHANICAL SAMPLING COSTS

The cost data requirements of this report are classified according to two general categories: ownership and use, and operating costs. Ownership and use costs include depreciation, interest on investment, insurance, and taxes. Operating costs include maintenance and repairs, and operator wages.

First, initial investment costs are discussed, then the associated ownership and use costs, and operating costs. Finally, cost information is reported for 6-, 9-, 10-, 16-, and 36-inch samplers. The 6-, 9-, and 10-inch samplers were costed at 100,000, 250,000, 500,000, 750,000, and 1,500,000 bushels annual throughput. The 16-inch sampler was costed at 5, 10, 15, 20, 25, and 30 million bushels annual throughput, and the 36-inch sampler at 5, 10, 15, 20, 25, and 50 bushels annually.

Initial Investment Costs

The initial investment cost includes both the sampler and its installation costs. Equipment costs vary, depending upon the manufacturer, the size of the equipment, and whether it is air operated or electrically operated. Installation costs vary with the facility and location within the facility where the equipment is installed. Another factor influencing installation costs is the type of container being sampled. Specifically, barge and cargo lots require facilities with a grain-return system and an extra divider because of the large sample which is drawn and subsequently reduced for inspection purposes. Generally, the more alterations to the existing facilities required, the higher the installation cost. However, many existing operations require only a simple insertion in the spouting. Costs reported for equipment were furnished by the manufacturers. Installation costs were reported by manufacturers, engineering firms serving the grain industry, and individual grain companies with diverter-type mechanical samplers. Table 1 presents equipment costs and installation costs for five sizes of spout samplers.

Table 1.--Equipment and installation costs for diverter-type mechanical samplers, 1973

Spout size, inches	Range in purchase price of equipment	Range in installation costs[1]	Range in price installed[1]
	Dollars	Dollars	Dollars
6	1,500-2,000	1,000- 2,000	2,500- 4,000
9	1,900-2,600	1,000- 2,500	2,900- 5,100
10	1,900-2,900	1,000- 3,000	2,900- 5,900
16	2,500-6,400	1,000- 3,500	3,500- 9,900
36	5,500-9,000	5,000-10,000	10,500-19,000

[1] These data represent a range of costs most often reported. Individual situations may vary extremely from these data at the upper range.

Costs of Ownership and Use

Interest on Investment

The effective rate of return used in this study was 8 percent on the average depreciable balance of the equipment plus installation charges. No salvage value was considered.

Depreciation

The serviceable life of a mechanical sampler may be a function of time, but is more likely a function of use. Industry sources who have kept records on their equipment report that estimating the expected life for a diverter-type mechanical sampler in terms of either bushels or years is difficult. Equipment in given installations may not wear as well as in other installations. For example, installation in inclined spouting results in more wear to particular parts. The Internal Revenue Service lists 10 years as the guideline for depreciating "...assets used in carrying out the activities of purchasing, assembling, storing, sorting, grading and selling of goods at both the wholesale and retail level" (9, p. 51). Industry sources reported 12-year-old equipment in use with no known replacements. In some instances, there had been "normal" repairs. The function which the sampler performs would seem to make it imperative that the equipment be kept in good working condition. Depreciation costs are presented in tables 2-6.

Taxes

Property taxes on diverter-type samplers were estimated by converting the cost of the installed equipment to an assessed value and applying the average U.S. property tax rate (70 mills per $1 valuation) computed from data in (8, p. 416). The ratio of the assessed value to the cost of the new equipment installed(0.31) was computed by applying the ratio of assessed value to market value of real property as taken from Bureau of the Census data (7, p. 428).

Insurance

Fire insurance coverage on mechanical samplers will vary according to the structure in which it is located. For this study, a figure of 10 cents per $100 value on 100 percent of the replacement cost was used. This figure was considered representative for concrete structures and was advised by a major fire insurance company underwriting in the grain industry.[3]

Operating Costs

Maintenance and Repairs

There is a general lack of documented data on the cost of maintenance and repairs of mechanical samplers. Warehousemen, engineering firms, and manufacturers only reported judgments about maintenance and repairs costs. As with any equipment, a good preventative maintenance program for mechanical samplers will reduce operating problems, down-time, and more costly major repairs. Engineering firms and warehouse maintenance personnel reported fewer problems with electrically operated units than with air-operated units. However, one equipment manufacturer's representative indicated that his company did not have many problems with their air-operated units. Units installed in vertical spouting receive less wear than those in sloped spouting.

The cost of maintenance and repairs for mechanical samplers was reported to be a function of throughput; that is, the greater the volume sampled by a unit, the greater the total maintenance and repair costs. The maintenance and repair costs reported in tables 2-6 were derived from records of samplers in use. Costs tended to be relatively higher for smaller samplers than for larger samplers.

Utilities

The cost for utilities to run the mechanical sampler is a function of the running time and the horsepower of the power source. Utility costs are rather insignificant in comparison with the other costs associated with mechanical sampling. Separate data are not reported for air-operated and electrically operated equipment. Data were synthesized for electrically operated units and were assumed to be equally applicable to air-operated units. The following procedure was used to develop electricity costs: (1) the power input was equal to the horsepower rating of the motor multiplied by 1.2 if the motor was rated ½ horsepower or less, or by 1.0 if the motor was rated greater than ½ horsepower (1, p. 31); (2) the kilowatt-hours consumed for billing purposes were equal to the power input multiplied by the running time in

[3] Rates of $1.00 per $100 value on 100 percent of the replacement cost for equipment in frame structures, and 15 cents per $100 value on 100 percent of the replacement cost for equipment in steel structures were considered representative by the underwriter for respective structures.

hours divided by 1,000; and (3) the price per kilowatt-hour was 2.5 cents. The cost for utilities was computed utilizing loading rates of 5,000, 8,000, 10,000, 18,000, and 60,000 bushels per hour, for 6-, 9-, 10-, 16-, and 36-inch sampler sizes, respectively.

Operator Wages

Wages paid to operators of mechanical samplers are quite variable depending upon location, the size of the operation, the shift worked, whether or not unionized, and the individual operator. For this study, the wages of operators were assumed to be $2.50 per hour.[4] The cost for operator wages was computed utilizing the loading rates listed in the preceding section. Annual operator costs are presented in tables 2-6.

Total Annual Costs of Owning and Operating Mechanical Samplers

The total average costs for owning and operating various sizes of mechanical samplers at different levels of annual throughput are presented in tables 2-6. These costs are only the costs for owning and operating the mechanical sampler. No costs are included for down-time. Down-time may be costly if spare parts are not kept by the warehouse and if repairs cannot be made immediately. For example, if a port elevator is loading a ship which is on demurrage of $5,000 per day and a breakdown occurs which results in 24 hours down-time, an additional $5,000 cost is incurred by the warehouse to pay this demurrage, and $50 for check-testing the sampler after repairs.[5] Assuming this is the only down-time for that sampler in sampling 100 million bushels, the additional cost per bushel of that mechanical sampler is 0.00505 cent.

Costs for the initial check-test of a newly installed sampler and training of the operator are also not included in tables 2-6. The initial check-test fee would be the same as any check-test of the equipment. The training fee would be nominal on a bushel basis because this cost would be spread over all the bushel volume throughput for the years the operator was employed.

Costs associated with transporting the sample from the warehouse to the official inspection point are not included in this analysis. The total cost of a warehouseman's sample lot inspection would include the costs of ownership and use described above plus the laboratory charge for analyzing the sample and the transportation cost between the warehouse and the laboratory.

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[4] Reported by a company renting sampling equipment to be the average wage that company paid sampler operators.

[5] Fifty dollars for check-testing the sampler after repairs is an assumed average of charges, including a mileage fee, reported by official inspection agencies for check-testing mechanical samplers.

INDICATIONS

Unit costs per bushel invested for mechanical sampling equipment appear to be low when total annual costs are considered in relation to the possible payoffs from more representative sampling, possible transportation savings, elimination of losses due to grain door damage, improved market communications, and other benefits.

For each sampler size, as the throughput increases, operating costs increase (tables 2-6). Thus the total annual cost increases, but at a decreasing rate, as is evidenced by the declining unit costs. Examination also reveals that a small annual throughput in a large sampler may cause unit sampling costs to be greater than with a smaller sampler. For example, at 100,000 bushels annual throughput, the 6-inch sampler had a lower unit cost than either the 9-inch or the 10-inch sampler. This is due to higher costs of ownership and use for the larger samplers spread over the same number of units as for the 6-inch sampler. Likewise, costs for the 9-inch sampler at the lower cost range for 100,000 bushels annual throughput are higher than those for either the 6-inch or the 10-inch sampler at the same range. This is because the 9- and 10-inch samplers have the same lower range initial investment cost, but the 9-inch sampler has a lower hourly loading rate and thus higher operator wage costs than the 10-inch sampler. This might not be the case in all situations.

Costs for the 16-inch sampler are relatively low, indicating that river houses might expect considerable savings by using the yellow certificate with diverter-type mechanical sampling at the origin.[6]

Tables 2-4 suggest that country warehouses (houses using diverter-type mechanical samplers up to a 10-inch size) might expect costs ranging from 0.0529 to 0.8712 cent per bushel for respective annual throughputs of 1.5 million bushels and 100,000 bushels, depending upon sampler size, initial cost, and annual throughputs. Subterminal and terminal houses (using 10-inch and larger samplers, with an annual throughput of 1.5 million bushels or more) could expect costs ranging up to 0.0828 cent per bushel, depending again upon sampler size, initial cost, and throughput. Port houses, moving extremely large volumes, may experience diverter-type mechanical sampling costs as low as 0.0073 cent per bushel for the 36-inch sampler at 50 million bushels annual throughput (table 6).

Table 7 presents a summary of cost ranges for the samplers considered in this study. It must be pointed out that for peculiar circumstances such as extreme installation costs, the data in this report will not be representative. In any instance, equipment manufacturers and engineering firms can provide estimates for a specific installation.

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[6] Industry sources indicated that river houses commonly have 16-inch samplers for barge load-out.

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Table 2.--Six-inch diverter-type mechanical sampler: Estimated annual costs for sampling grain at various levels of annual throughput, 1973

Item	Annual throughput (1,000 bushels)											
	100		250		500		750		1,000		1,500	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	--- Dollars ---											
Costs of ownership and use:												
Interest on investment	100.00	160.00	100.00	160.00	100.00	160.00	100.00	160.00	100.00	160.00	100.00	160.00
Depreciation	250.00	400.00	250.00	400.00	250.00	400.00	250.00	400.00	250.00	400.00	250.00	400.00
Taxes	5.42	8.68	5.42	8.68	5.42	8.68	5.42	8.68	5.42	8.68	5.42	8.68
Insurance	2.50	4.00	2.50	4.00	2.50	4.00	2.50	4.00	2.50	4.00	2.50	4.00
Operating costs:												
Maintenance and repairs	0.17	1.50	0.43	3.75	0.86	7.50	1.29	11.25	1.72	15.00	2.57	22.50
Electricity 1/	-	-	-	-	-	-	-	-	-	-	-	-
Operator wages	50.00	50.00	125.00	125.00	250.00	250.00	375.00	375.00	500.00	500.00	750.00	750.00
Total annual costs:	408.09	624.18	483.35	701.43	608.78	830.18	734.21	958.93	859.64	1,087.68	1,110.49	1,345.18
	--- Cents ---											
Cost per bushel:	0.4081	0.6242	0.1933	0.2806	0.1218	0.1660	0.0979	0.1279	0.0860	0.1088	0.0740	0.0897

1/Electricity costs for operation of the mechanical sampler at a rate of 2.5 cents per KWH are less than 1 cent at the levels of throughput considered in this table.

Table 3.--Nine-inch diverter-type mechanical sampler: Estimated annual costs for sampling grain at various levels of annual throughput, 1973

Item	Annual throughput (1,000 bushels)											
	100		250		500		750		1,000		1,500	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	--- Dollars ---											
Costs of ownership and use:												
Interest on investment	116.00	204.00	116.00	204.00	116.00	204.00	116.00	204.00	116.00	204.00	116.00	204.00
Depreciation	290.00	510.00	290.00	510.00	290.00	510.00	290.00	510.00	290.00	510.00	290.00	510.00
Taxes	6.29	11.07	6.29	11.07	6.29	11.07	6.29	11.07	6.29	11.07	6.29	11.07
Insurance	2.90	4.00	2.90	4.00	2.90	4.00	2.90	4.00	2.90	4.00	2.90	4.00
Operating costs:												
Maintenance and repairs	0.17	1.50	0.43	3.75	0.86	7.50	1.29	11.25	1.72	15.00	2.57	22.50
Electricity 1/	-	-	-	-	-	-	-	-	-	-	-	-
Operator wages	31.25	31.25	78.12	78.12	156.25	156.25	234.38	234.38	312.50	312.50	468.75	468.75
Total annual costs:	446.61	761.82	493.74	810.94	572.30	892.82	650.86	974.70	729.41	1,056.57	886.51	1,220.32
	--- Cents ---											
Cost per bushel:	0.4466	0.7618	0.1975	0.3244	0.1145	0.1786	0.0868	0.1300	0.0729	0.1057	0.0591	0.0814

1/Electricity costs for operation of the mechanical sampler at a rate of 2.5 cents per KWH are less than 1 cent at the levels of throughput considered in this table.

Table 4.--Ten-inch diverter-type mechanical sampler: Estimated annual costs for sampling grain at various levels of annual throughput, 1973

Item	Annual throughput (1,000 bushels)											
	100		250		500		750		1,000		1,500	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	--- Dollars ---											
Costs of ownership and use:												
Interest on investment	116.00	236.00	116.00	236.00	116.00	236.00	116.00	236.00	116.00	236.00	116.00	236.00
Depreciation	290.00	590.00	290.00	590.00	290.00	590.00	290.00	590.00	290.00	590.00	290.00	590.00
Taxes	6.29	12.80	6.29	12.80	6.29	12.80	6.29	12.80	6.29	12.80	6.29	12.80
Insurance	2.90	5.90	2.90	5.90	2.90	5.90	2.90	5.90	2.90	5.90	2.90	5.90
Operating costs:												
Maintenance and repairs	0.17	1.50	0.43	3.75	0.86	7.50	1.29	11.25	1.72	15.00	2.57	22.50
Electricity 1/	-	-	-	-	-	-	-	-	-	-	-	-
Operator wages	25.00	25.00	62.50	62.50	125.00	125.00	187.50	187.50	250.00	250.00	375.00	375.00
Total annual costs:	440.36	871.20	478.12	910.95	541.05	977.20	603.98	1,043.45	666.91	1,109.70	792.76	1,242.20
	--- Cents ---											
Cost per bushel:	0.4404	0.8712	0.1912	0.3644	0.1082	0.1954	0.0805	0.1391	0.0667	0.1110	0.0529	0.0828

1/Electricity costs for operation of the mechanical sampler at a rate of 2.5 cents per KWH are less than 1 cent at the levels of throughput considered in this table.

Table 5.--Sixteen-inch diverter-type mechanical sampler: Estimated annual costs for sampling grain at various levels of annual throughput, 1973

Item	Annual throughput (million bushels)											
	5		10		15		20		25		30	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	- - - Dollars - - -											
Costs of ownership and use:												
Interest on investment	140.00	396.00	140.00	396.00	140.00	396.00	140.00	396.00	140.00	396.00	140.00	396.00
Depreciation	350.00	990.00	350.00	990.00	350.00	990.00	350.00	990.00	350.00	990.00	350.00	990.00
Taxes	7.60	21.48	7.60	21.48	7.60	21.48	7.60	21.48	7.60	21.48	7.60	21.48
Insurance	3.50	9.90	3.50	9.90	3.50	9.90	3.50	9.90	3.50	9.90	3.50	9.90
Operating costs:												
Maintenance and repairs	8.58	83.58	17.16	167.16	25.74	250.74	34.32	334.32	42.91	417.91	51.49	501.49
Electricity	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Operator wages	694.45	694.45	1,388.90	1,388.90	2,083.33	2,083.00	2,777.75	2,777.75	3,472.23	3,472.23	4,166.68	4,166.68
Total annual costs:	1,204.14	2,195.42	1,907.17	2,973.45	2,610.19	3,751.47	3,313.19	4,530.57	4,016.27	5,307.55	4,719.30	6,085.58
	- - - Cents - - -											
Cost per bushel:	0.0241	0.0439	0.0191	0.0297	0.0174	0.0250	0.0166	0.0227	0.0161	0.0212	0.0157	0.0203

Table 6.--Thirty-six-inch diverter-type mechanical sampler: Estimated annual costs for sampling grain at various levels of annual throughput, 1973

Item	Annual throughput (million bushels)											
	5		10		15		20		25		50	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	- - - Dollars - - -											
Costs of ownership and use:												
Interest on investment	420.00	760.00	420.00	760.00	420.00	760.00	420.00	760.00	420.00	760.00	420.00	760.00
Depreciation	1,050.00	1,900.00	1,050.00	1,900.00	1,050.00	1,900.00	1,050.00	1,900.00	1,050.00	1,900.00	1,050.00	1,900.00
Taxes	22.78	41.23	22.78	41.23	22.78	41.23	22.78	41.23	22.78	41.23	22.78	41.23
Insurance	10.50	19.00	10.50	19.00	10.50	19.00	10.50	19.00	10.50	19.00	10.50	19.00
Operating costs:												
Maintenance and repairs	8.58	83.58	17.16	167.16	25.74	250.74	34.32	334.32	42.91	417.91	85.81	835.81
Electricity 1/	-	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Operator wages	208.33	208.33	416.68	416.68	625.00	625.00	833.33	833.33	1,041.68	1,041.68	2,083.33	2,083.33
Total annual costs:	1,720.19	3,012.14	1,937.12	3,304.07	2,154.03	3,595.98	2,370.94	3,888.90	2,587.88	4,179.83	3,672.44	5,639.39
	- - - Cents - - -											
Cost per bushel:	0.0344	0.0602	0.0194	0.0330	0.0143	0.0240	0.0119	0.0194	0.0135	0.0167	0.0073	0.0113

1/Electricity costs for operation of the mechanical sampler at throughputs of 5 and 10 million bushels annually are less than 1 cent when costed at a rate of 2.5 cents per KWH.

Table 7.--Annual operating costs per bushel of grain, five sizes of diverter-type mechanical samplers at six annual throughputs, 1973

Spout size, inches	Throughput (million bushels)											
	0.1		0.25		0.50		0.75		1.0		1.5	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	- - - Cents - - -											
6	0.4081	0.6242	0.1933	0.2806	0.1218	0.1660	0.0979	0.1279	0.0860	0.1088	0.0740	0.0897
9	0.4466	0.7618	0.1975	0.3244	0.1145	0.1786	0.0868	0.1300	0.0729	0.1057	0.0591	0.0814
10	0.4404	0.8712	0.1912	0.3644	0.1082	0.1954	0.0805	0.1391	0.0667	0.1110	0.0529	0.0828
	5		10		15		20		25		30	
16	0.0241	0.0439	0.0191	0.0297	0.0174	0.0250	0.0166	0.0227	0.0161	0.0212	0.0157	0.0203
	5		10		15		20		25		50	
36	0.0344	0.0602	0.0194	0.0330	0.0143	0.0240	0.0119	0.0194	0.0135	0.0167	0.0073	0.0113