AG ECON STAFF PAPER NO: 79-83

PAPER NO. 79-3525

ON-FARM GRAIN HANDLING COSTS - ENGINEERING AND ECONOMIC FACTORS

by

J.R. Skees and M.E. Rister
Research Associates*

R.C. Brook, Assistant Professor**
S.B. Harsh, Professor*
F.W. Bakker-Arkema, Professor**

* Department of Agricultural Economics
** Department of Agricultural Engineering
Michigan State University
East Lansing, MI 48824

For Presentation at the 1979 Winter Meeting
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Hyatt Regency Hotel
New Orleans, LA
December 11-14, 1979

SUMMARY:
A computer model is used to perform capital budgeting analysis to determine annual per bushel costs associated with five alternative on-farm grain drying and storage systems. Per bushel costs decrease as on-farm grain systems handle multiple grains instead of all corn.

American Society of Agricultural Engineers

St. Joseph, Michigan 49085

ON-FARM GRAIN HANDLING COSTS--ENGINEERING AND ECONOMIC FACTORS*

This paper addresses some of the many factors that influence the costs of various on-farm grain drying and storage systems. Initial investment costs and annual operating costs are major components. It can be demonstrated that multiple use of an on-farm grain system can reduce both operating and fixed costs on a per bushel basis. Use of traditional fixed and variable cost analysis (commonly referred to as the DIRTI method) for evaluating capital investment decisions has often been criticized (3, 4 and 7). It has been demonstrated that such an approach does not explain cash flow requirements, financing or income tax effects. A basic problem with the approach is that the ranking of alternatives can be heavily influenced by low investment costs, even though associated annual operating costs are high. Capital budgeting accounts for the net present value of alternative investments, allowing for comparison of investments with different annual flows of expenses and/or income.[1/] This approach considers such factors as interest rate and life of the loan, depreciation life and schedule chosen, marginal tax rate, eligibility for investment tax credit, and effects of inflation on variable costs.

A computer program (TELPLAN 3) that utilizes the net present value capital budgeting approach has been available in several states for the past several years.[2/] It has been used to evaluate the per-bushel annual costs of five on-farm grain drying and storage systems. Three types of drying systems are developed for various bushel capacity facilities: (1) deep in-bin, low-temperature drying (with dryer under a perforated floor), (2) batch in-bin, high-temperature drying (with dryer in the roof), and (3) portable batch, high-temperature drying. First, annual costs for each system are calculated, considering drying and storage of corn only. Next, similar costs are calculated, assuming both corn and soybeans are to be dried and stored, with soybean bushels constrained to the size of the smallest storage bin. Finally, such costs are calculated under the additional assumption that wheat is air-dried and stored until fall harvest of the same mix of corn and soybeans assumed above, thus making double use of the same storage capacity. Under this final scenario, the amount of wheat handled is constrained to one-half the size of the smallest bin.[3/] Under the all-corn and the corn-soybean scenario, the same total number of bushels flow through the systems. In the corn-soybeans-wheat case, the bushel flow is increased by the number of bushels of wheat.

---

* The authors gratefully acknowledge comments and suggestions by Gerry Schwab, Otto Loewer, Don Gregg, Jeanette Barbour and Linda Wilkes.

[1/] For illustration of the details of this approach, see references (1, 2, 4, 6, 7 and 8).

[2/] The reader is referred to reference (5) and Appendix B for more information on the TELPLAN system.

[3/] This assumption is based on observations on relative size of the respective enterprises on diversified farms.

It is emphasized that the estimated costs of these systems should be used only as references for comparison between systems--costs per bushel can vary considerably, depending upon what features are included in a system, as well as the many variables related to harvest conditions.

This analysis is not intended to develop definitive costs for on-farm grain drying and storage systems. Three primary objectives of this paper are: (1) to demonstrate the advantages of a capital budgeting approach over traditional fixed and variable cost analysis; (2) to illustrate use of the capital budgeting approach and major considerations in determining costs of alternative on-farm grain drying and storage systems; and (3) to illustrate how annual costs of on-farm grain systems are affected by multiple usage.

The Analysis

Each of the five systems was designed with engineering aspects in mind. Appendix A specifies the components of each system and their estimated 1979 investment costs.[4/] Before conclusions can be reached on choosing one system over another, it will be necessary not only to consider annual costs per bushel, but also the different design of each system and how it complements the total farm operation, including labor supply and anticipated future growth.

While recognizing that factors other than total annual costs are important in making investments in grain drying and storage systems, it is now important to turn to development of consistent assumptions that allow for such cost comparisons. One of the most important factors affecting variable costs is energy requirements for drying corn (in these cases approximately 10 points of moisture are removed). Table 1 develops the assumptions used in calculating per-bushel energy requirements, and Table 2 presents the energy costs per bushel for each system. It is noteworthy that the greatest contrast is between System 1 (6.97¢/bu) and System 2 (13.39¢/bu). This difference is explained by noting that System 2 uses electric heat, whereas System 1 uses propane. It should also be noted that energy costs decrease as multiple grains are dried; i.e., it takes less drying for soybeans and wheat than for corn. Assumptions concerning repairs, labor requirements and salvage value vary between systems, as presented in Table 3.

A number of assumptions do not vary between systems. These include: (1) a ten-year planning horizon, (2) purchase during August of the first year, (3) eligibility for the 10% investment tax credit, (4) use of double-declining balance with additional first-year depreciation (20%), (5) a 1.2¢/bu fuel cost for operating associated equipment (such costs as those associated with use of a pickup truck for management of the system), (6) a 30% marginal tax rate for the producer, (7) a 10% annual compounded

---

[4/] Systems 1, 4 and 5 were designed by BNDZN at the University of Kentucky (9). Systems 2 and 3 were designed with the aid of Michigan industry personnel.

Table 1

Per Bushel Energy Requirements of Alternative On-Farm Grain Drying and Storage Systems

Type of System	CORN				SOYBEANS				WHEAT a/
	Moisture Reduction	Pounds of Water Removed	KWH Electricity per Bu.	Gallons Propane per Bu.	Moisture Reduction	Pounds of Water Removed/Bu.	KWH Electricity per Bu.	Gallons Propane per Bu.	KWH Electricity per Bu.
1) Deep In-Bin (6,000 bu)	23-14%	6.56	.180 b/	.128 c/	17-14%	2.05	.054	.040	.32
2) Deep In-Bin (10,000 bu)	23-14%	6.56	2.160	d/	17-14%	2.05	.900	d/	.32
3) Batch In-Bin (30,000 bu)	25-15%	7.50	.155	.180	17-14%	2.05	.046	.049	.16
4) Portable Batch (33,000 bu)	25-15%	7.50	.215	.243	17-14%	2.05	.080	.066	.15
5) Portable Batch (53,000 bu)	25-15%	7.50	.233	.243	17-14%	2.05	.080	.066	.09

a/ Wheat is harvested at low moisture and only forced air is used during the storage period for conditioning.

b/ Electricity usages are estimates taken from reference (11).

c/ Per bushel energy requirements are calculated under the assumption it requires 1,800 BTU/lb. of water for deep-bin drying, 2,200 BTU/lb. of water for batch in-bin drying, and 3,000 BTU/lb. of water for portable batch drying.

d/ This system utilizes an electric heat unit; therefore, it requires no propane gas.

Table 2

Direct Energy Costs Per Bushel For Alternative On-Farm Grain Drying and Storage Systems[a/]

Type of System	Corn[b/]	Corn-Soybeans[c/]	Corn-Soybeans-Wheat[c/]
1) Deep In-Bin (6,000 bu)	$.0697	$.0529	$.0483
2) Deep In-Bin (10,000 bu)	.1339	.0949	.0798
3) Batch In-Bin (30,000 bu)	.0919	.0699	.0611
4) Portable Batch (33,000 bu)	.1244	.0949	.0824
5) Portable Batch (53,000 bu)	.1255	.0957	.0825

a/ Energy costs are based on November 1979 mid-Michigan prices of 6.2¢ per KWH and 45.7¢ per gallon of propane.

b/ Assumes system used to capacity with only corn; based on energy requirements for corn presented in Table 1.

c/ Multiple grain systems are utilized as illustrated in Table 3; energy requirements are a weighted average based on the respective amount of each type grain (Table 3) and the associated energy requirements (Table 1).

Table 3

Assumptions on Repairs, Labor and Salvage Value
for Alternative On-Farm Grain Drying and Storage Systems

Type of System	Repairs[a/]		Labor[b/]	Salvage Value[c/]
	Corn and Corn-Soybeans	Corn-Soybeans-Wheat	$/bu.	% of Initial Investment
1) Deep In-Bin (6,000 bu.)	$ 400	$ 500	$.024	25%
2) Deep In-Bin (10,000 bu.)	600	720	.024	27
3) Batch In-Bin (30,000 bu.)	1,800	2,100	.024	27
4) Portable Batch (33,000 bu.)	2,600	3,000	.015	29
5) Portable Batch (53,000 bu.)	4,000	4,600	.015	30

[a/] Repair costs are the present value of the costs over the entire 10-year period. They are distributed such that higher costs occur in latter years. A 4% annual inflation rate is assumed for repairs. It is also assumed that repairs are necessary for associated equipment (i.e., hauling vehicles in this case).

[b/] Systems with transport augers are assumed to handle 500 bu./hr. Those with bucket elevators handle 800 bu./hr. Labor is required for placing grain in storage, removing it and management. Management is assumed to take the same number of hours as placing grain in storage. Labor charges begin at $4.00/hr. and are assumed to inflate at 6%/yr.

[c/] Salvage value for these systems is based on remaining useful life of the basic components at the end of 10 years. Items such as bin structure, floors, pits, concrete, etc. are assumed to last 20 years. Augers and other moving parts are assumed to last 10 years. The actual value of the system at the end of 10 years is inflated by 8%/yr. due to increased costs of a replacement system.

increase in fuel costs, (8) an annual insurance charge of 1% of the inventory value of investment, (9) an annual property tax of 1.6% of the inventory value of investment, and (10) a 6% annual compounded increase in investment costs of new grain systems (this affects salvage value). An Agricultural Stabilization and Conservation Service (ASCS) loan at 10.5% is assumed to cover the maximum of 85% of the investment. The remainder of the loan (15%) is financed through commercial markets at a 13% interest rate. The combined loan rate is 10.9% to be repaid over eight years.

An assumption that relates closely to the interest rate on borrowed money is the discount rate used in the analysis. The discount rate can be thought of as the return the manager seeks on invested capital. For this reason, it should be set above the rate on borrowed money (10.9%). The discount rate must cover risk of the investment, the time value of money, and opportunity costs associated with investing in a more profitable enterprise. The discount rate allows for net present value comparisons of uneven flows of cash. Under the assumption that investment in a total grain system such as those evaluated herein is a first-time investment, it should be considered risky. For these reasons, the before-tax discount rate was assumed to be 17% (an after-tax rate of 12%).

An additional advantage of the capital budgeting approach over traditional fixed and variable cost analysis concerns inflation of the annual custom operation charge. Whereas the traditional analysis assumes this charge to be constant, the capital budgeting approach allows such charges to inflate through time. In this case, costs of commercial drying and storage alternatives are assumed to increase at an annual rate of 6%. The computer model factors this into the annual costs of the on-farm systems since it represents a cost savings by avoiding the 6% annual compounded inflation of costs associated with commercial drying and storage.[5/]

Results

The annual present value for total, variable and fixed costs associated with each system appears in Table 4. The least expensive system per bushel is the 30,000-bushel batch in-bin drying and storage facility. Despite the fact that System 1 has a fixed cost of approximately 4¢/bu more than System 2, System 1 is less costly (by 5¢/bu in the all corn case). This can be explained by the higher variable costs associated with System 2 which requires more expensive electrical energy for drying purposes. Comparison of these two systems, using traditional fixed and variable cost analysis, results in just the opposite ranking, i.e., System 2 is less costly than System 1.[6/]

[5/] Appendix B includes the input form for TELPLAN 3 with assumptions for System 5 (53,000 bushels of corn).

[6/] See Appendix C for this analysis.

Table 4

Economic Analysis of Alternative On-Farm Grain Drying and Storage Systems

Type of System	Bushels of Grain Handled per Year: Corn	Soybeans	Wheat	Initial Capital Investment per bu.	Annual Costs: Present Value Fixed Cost per bu. (% of TC)	Present Value Variable Cost per bu. (% of TC)	Present Value Total Cost (TC) per bu.
				CORN			
1) Deep In-Bin (6,000 bu.)	6,000			$2.92	$.2053(58)	$.1475(42)	$.3528
2) Deep In-Bin (10,000 bu.)	10,000			2.42	.1664(41)	.2364(59)	.4028
3) Batch In-Bin (30,000 bu.)	30,000			1.80	.1265(42)	.1778(58)	.3043
4) Portable Batch (33,000 bu.)	33,000			2.34	.1656(44)	.2099(56)	.3755
5) Portable Batch (53,000 bu.)	53,000			1.86	.1253(37)	.2170(63)	.3423
				CORN-SOYBEANS			
1) Deep In-Bin (6,000 bu.)	3,900	2,100		$2.92	$.2053(62)	$.1240(38)	$.3293
2) Deep In-Bin (10,000 bu.)	5,000	5,000		2.42	.1664(48)	.1820(52)	.3484
3) Batch In-Bin (30,000 bu.)	20,000	10,000		1.80	.1265(46)	.1471(54)	.2736
4) Portable Batch (33,000 bu.)	22,000	11,000		2.34	.1656(49)	.1746(51)	.3402
5) Portable Batch (53,000 bu.)	35,334	17,666		1.86	.1253(42)	.1754(58)	.3007
				CORN-SOYBEANS-WHEAT			
1) Deep In-Bin (6,000 bu.)	3,900	2,100	1,000	$2.50	$.1760(60)	$.1180(40)	$.2940
2) Deep In-Bin (10,000 bu.)	5,000	5,000	2,500	1.94	.1332(45)	.1607(55)	.2939
3) Batch In-Bin (30,000 bu.)	20,000	10,000	5,000	1.54	.1084(45)	.1349(55)	.2433
4) Portable Batch (33,000 bu.)	22,000	11,000	5,500	2.00	.1369(47)	.1571(53)	.2940
5) Portable Batch (53,000 bu.)	35,334	17,666	9,000	1.59	.1071(40)	.1569(60)	.2641

The difference in ranking noted above can be explained by the fact that the initial per-bushel investment costs for System 1 are higher than for System 2 and by the fact that fixed and variable cost analysis does not consider the time value of money or the assumed inflation rate on energy costs as well as on other operating costs. Also neglected are any income tax consequences associated with the capital investment. The capital budgeting approach includes such factors in the analysis, providing a more complete evaluation of the alternative investments than that produced by the traditional fixed and variable cost analysis.

A sharp contrast is apparent between System 3 (batch in-bin, 30,000 bushels) and System 4 (portable batch, 33,000 bushels). Table 4 reveals that total costs of System 3 are 30.43¢/bu versus 37.55¢/bu for System 4 in the all-corn case. Although capacity is very similar, Table 4 also reveals that the investment costs per bushel are $1.80 for System 3 and $2.34 for System 4. The differences can be accounted for by noting that System 4 has a pit with bucket elevator (leg), wet holding bin and portable batch dryer. System 3 has a less expensive in-roof dryer and utilizes a transport auger for grain handling. Although System 4 is more costly, features such as more rapid handling and drying of grain, less labor requirements and more flexibility for future expansion may make it the preferred system for some farms.

Results in Table 4 also indicate the reduction in per-bushel costs associated with multiple-grain usage. By going from all corn to a corn-soybean combination, per-bushel costs decrease from a range of 2.3¢ (System 1) to 5.4¢ (System 2). The decrease is accounted for by the decline in variable costs associated with less energy requirements for drying soybeans. Further cost decreases for the same storage area are apparent when wheat is stored for a couple of months and moved out before the fall harvest and storage of corn and soybeans. This indicates the potential for decreasing costs, since these examples assume relatively small amounts of wheat are stored. The savings must be considered against the disadvantage of moving wheat out in the fall and moving other grains out prior to wheat harvest.

One of the primary advantages of a computer model such as TELPLAN 3 is the ease with which the decision maker can test the sensitivity of certain assumptions. By changing only one variable and leaving the others intact, it is possible to determine the impact of that variable on annual costs. Table 5 indicates sensitivity tests on several variables for System 5 (using 53,000 bushels of corn as the benchmark).

Previous discussion of an appropriate level for the after-tax discount rate indicated that the rate should cover risks and other factors. If we assume the manager is experienced, the risk associated with an on-farm drying and storage system would diminish. With reduced risk, the discount rate should be reduced. Table 5 indicates that reduction of the after-tax discount rate from 12% to 9% has little impact on System 5, i.e., a .7¢/bu reduction in total annual costs. On the other hand, a decrease of 30% in the before-tax interest rate on borrowed money appears to have a greater impact on the costs of this system, i.e., a 1.94¢/bu reduction in total annual costs.

Table 5

Sensitivity Analysis on System 5--Portable Batch Dryer--
53,000 Bushels of Corn

Changes Made	Annual Total Costs	Changes From Base
	(¢/bu)	(¢/bu)
Base Run	34.23¢	--
After-Tax Discount Rate Reduced From 12% to 9%	33.53	-.70¢
Before-Tax Interest Rate on Loan Reduced From 10.9% to 7.8%	32.29	-1.94
Annual Inflation on Energy Increased From 10% to 15%	39.58	+5.38
Annual Inflation on Commercial Storage Reduced From 6% to 0%	45.11	+11.58

Table 5 also illustrates the importance of assumptions concerning energy costs. By assuming energy costs will increase at a 15% annual rate rather than a 10% rate, the annual costs of System 5 increase by 5.38¢/bu. The final item in Table 5 demonstrates the sensitivity of assumptions concerning alternatives to on-farm grain drying and storage. This analysis has assumed that variable cost items associated with on-farm systems will increase. If the decision maker does not allow for similar increases in costs of commercial drying and storage, the on-farm system will appear to be less profitable. As Table 5 indicates, by making the unlikely assumption that commercial drying and storage costs do not increase (in lieu of the assumption that they increase at an annual rate of 6%), the annual cost of System 5 increases by 11.58¢/bu.

Finally, any decision to invest in an on-farm drying and storage system should take into account the costs of commercial drying and storage as well as the returns associated with any particular on-farm system. Current (1979) commercial drying and storage costs in the mid-Michigan area (excluding shrinkage charges) appear to be approximately 1.5¢ per point of moisture removed in a bushel of corn and 12¢/bu to hold corn until January (post-January storage charges are 2.5¢/bu/month). These costs sum to 37¢/bu if corn is held until the end of April. Isolated cases indicate these costs may even be higher. Compared with the annual total costs associated with the on-farm systems considered herein, these costs are relatively close. Comparison of the results from the traditional fixed and variable cost analysis (Appendix C) is not as reassuring.

It is also important to recognize that returns may differ from one system to the next. Reduced harvest losses can be an important return component. A more costly on-farm system may speed harvest and reduce harvest losses enough to offset the additional cost when it is compared with a system that slows harvest due to an inefficient drying method. Other returns to be considered include: seasonal price movements, flexibility in market options, and elimination of long waits in lines at local elevators during harvest. TELPLAN 3 allows for consideration of such cost savings (Input line 02).

Summary

These results present a consistent methodology for evaluating major investment decisions such as whether to acquire an on-farm grain drying and storage system. The analysis demonstrated the major factors that influence the costs of such on-farm grain systems. Reduction in per-bushel annual total costs was achieved by going from all corn to the handling of multiple grains, or by making double use of the same storage within one crop year. This paper has also displayed that results may differ when using traditional fixed and variable cost analysis versus the more dynamic capital budgeting approach (i.e., different ranking of investment alternatives can occur). Finally, the value of a computer model (such as TELPLAN 3) in performing this type of analysis and allowing for sensitivity test should not be overlooked.

REFERENCES

(1) Aplin, R. D., G. L. Casler and C. P. Francis. Capital Investment Analysis Using Discounted Cash Flows. 2nd Edition, Columbus: Grid, Inc., 1977.

(2) Bierman, J. and M. Schmidt. The Capital Budgeting Decision. 4th Edition, Macmillan Publishing Co., 1975.

(3) Black, J. Roy. Unpublished work at Michigan State University, Department of Agricultural Economics.

(4) Bloome, P. D., T. R. Nelson and C. E. Rowsh. "Engineering Economics in Continuing Education - Cash Flow and Present Value Analyses of Farm Investments." Transaction of the ASAE, 1975, pp. 770-776.

(5) Brook, R. C. and F. W. Bakker-Arkema. "Telplan: A Communication Network to Solve Agricultural Problems." Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers at Utah State University, Logan, Utah, June 27-30, 1978.

(6) Frey, Thomas L. "Time Value of Money and Investment Analysis: Explanation With Application to Agriculture." AET-15-76, Department of Agricultural Economics, University of Illinois at Urbana-Champaign, June 1976.

(7) Harsh, Stephen, L. Connor and G. Schwab. Managing the Farm Firm. (forthcoming text from Prentice-Hall).

(8) Hopkin, J. A., P. J. Barry and C. B. Baker. Financial Management in Agriculture. Chapters 9-13, Danville: The Interstate Printers and Publishers, Inc., 1973.

(9) Loewer, O. J., Jr., T. C. Bridges and D. G. Overhults. "Computer Layout and Design of Grain Storage Facilities." Transaction of the ASAE, 1976, pp. 1130-1137.

(10) Maddex, R. L. and F. W. Bakker-Arkema. "Reducing Energy Requirements for Harvesting, Drying and Storing Grain." Cooperative Extension Service, Michigan State University, Extension Bulletin E-1168, March 1978.

(11) Madsen, J. P., H. R. Jensen and V. R. Eidman. Economics of Owning and Operating Corn Drying and Storing Systems With Rising Energy Prices. Department of Agricultural and Applied Economics, University of Minnesota, Economic Report ER 78-5, July 1978.

APPENDIX A

Estimated 1979 Investment Costs for
Five On-Farm Grain Drying and Storage Systems

I. DEEP IN-BIN LOW TEMPERATURE DRYING AND STORAGE SYSTEM*
(6,000 bushels)

Estimated 1979 Investment Costs

Moisture Tester		$ 350.00
Grain Cleaner		550.00
Drying Bin (2,100 bu storage capacity)		
Bin Structure	$2,100.00	
Perforated Floor	1,375.00	
Unloading Auger and Motor	763.00	
Sweep Auger and Motor	383.00	
Concrete Foundation and Misc.	793.00	
In-Floor Dryer (10 HP with heater)	2,100.00	
Grain Spreader	350.00	
	$7,864.00	$ 7,864.00
Storage Bin (3,900 bu storage capacity)		
Bin Structure	$2,500.00	
Unloading Auger and Motor	515.00	
Sweep Auger and Motor	439.00	
Aeration Sub-Floor	320.00	
Aeration Fan (.25 HP)	469.00	
Concrete Foundation and Misc.	775.00	
Grain Spreader	350.00	
	$5,368.00	$ 5,368.00
Construction and Wiring		1,375.00
Transport Auger and Motor (41 ft; 5 HP)		2,000.00
Estimated Total Investment		$17,507.00

*Initial moisture content of grain is limited to 24% or less with this type of system.

II. DEEP IN-BIN STORAGE LOW TEMPERATURE DRYING AND STORAGE SYSTEM*
(10,000 bushels)

Estimated 1979 Investment Costs

Moisture Tester		$ 250.00
Grain Cleaner		550.00
6" Transport Auger		1,800.00
Grain Spreader		350.00
Grain Bins (two-capacity of each is 5,000 bu.)		
27' diameter by 11' ht. Bin	$3,610.00	
False Floor	1,152.00	
Bin Sweep and Unloading Auger	700.00	
10 HP, 1.5 cfm Fan	1,500.00	
Heater Unit	500.00	
Fan to Bin Transition	167.00	
Erection Costs	1,100.00	
Electrical Work Costs	500.00	
	$9,229.00	X 2 = $18,458.00
Stirrer Unit for One Bin		2,800.00
Estimated Total Investment		$24,208.00

*Initial moisture content of grain limited to 24% or less when using this type of system.

III. BATCH IN-BIN HIGH TEMPERATURE DRYING AND STORAGE SYSTEM
(30,000 bushels)

Estimated 1979 Investment Costs

Moisture Tester		$ 350.00
Grain Cleaner		550.00
6" Transport Auger (2 @ $2,860.00)		5,720.00
1,800 bu. Wet Holding Bin		3,450.00
Drying Bin (10,000 bu. storage capacity)		
27' diameter by 21'4" ht. Bin (includes drying unit in roof, false floor, bin sweep and unloading auger)	$21,875.00	
Erection Costs	2,200.00	
Electrical Work Costs	1,000.00	
	$25,075.00	$25,075.00
Storage Bin (20,000 bu. storage capacity)		
42' diameter by 26'0" ht. Bin	$ 9,800.00	
Bin Sweep and Unloading Auger	1,100.00	
1.5 HP, .1 cfm Fan	481.00	
Fan to Bin Transition	143.00	
Thermocouples	1,000.00	
Erection Costs[1/]	4,400.00	
Electrical Work Costs	2,000.00	
	$18,924.00	$18,924.00
Estimated Total Investment		$54,069.00

[1/] Aeration surface is built into foundation.

IV. PORTABLE BATCH HIGH TEMPERATURE DRYING AND STORAGE SYSTEM (33,000 bushels)

Estimated 1979 Investment Costs

Moisture Tester			$ 350.00
Grain Cleaner			550.00
Grain Bins (three-capacity of 11,000 bu. each)			
Bin Structure	$5,200.00		
Aeration Fan (.75 HP)	468.00		
Unloading Auger and Motors	745.00		
Sweep Augers and Motors	563.00		
Concrete Foundation	548.00		
Aeration Sub-Floor	406.00		
Grain Spreaders	350.00		
	$8,280.00	X 3	= $24,840.00
Pit (Structure and Auger)			6,184.00
Bucket Elevator (Leg Downspouts, Motors, etc.)			11,839.00
Portable Dryer (400 bu./hr.)			18,500.00
Wet Holding Bin (812 bu.)			1,227.00
Surge Bin (100 bu.)			1,125.00
Construction and Wiring			8,539.00
Miscellaneous			4,000.00
Estimated Total Investment			$77,154.00

V. PORTABLE BATCH HIGH TEMPERATURE DRYING AND STORAGE SYSTEM (53,000 bushels)

Estimated 1979 Investment Costs

Moisture Tester			$ 350.00
Grain Cleaner			550.00
Grain Bins (three-capacity of 17,666 bu. each)			
Bin Structure	$ 8,334.00		
Aeration Fan (.75 HP)	467.00		
Unloading Augers and Motors (1 HP)	875.00		
Sweep Augers and Motors (1 HP)	794.00		
Concrete Foundation	898.00		
Aeration Sub-Floor	467.00		
Grain Spreaders	350.00		
	$12,185.00	X 3	= $36,555.00
Pit (Structure and Auger)			6,084.00
Bucket Elevator (Leg Downspouts, Motors, etc.)			11,839.00
Portable Dryer (400 bu./hr.)			18,500.00
Wet Holding Bin (812 bu.)			1,227.00
Surge Bin (100 bu.)			1,124.00
Construction and Wiring			10,680.00
Center Building (660 sq. ft.)			6,600.00
Miscellaneous			5,000.00
Estimated Total Investment			$98,509.00

APPENDIX B

Program No: 03
Form No: 3
System: TOUCH-TONE PHONE

TELPLAN 03 INPUT FORM
SYSTEM 5 - PORTABLE BATCH DRYER
53,000 Bushels of Corn

CAPITAL INVESTMENT MODEL -- INCLUDING BUY OR CUSTOM HIRE
A TELPLAN PROGRAM

EXAMPLE

NAME ______________________ ADDRESS ______________________

PHONE ______________________ DATE RUN NOVEMBER 13, 1979

Problem: To evaluate the investment of capital to reduce or eliminate costs including custom hire and leasing, or to generate new income.

INPUT: LINE NO. ADJUSTED ANALYSIS

Section I. Costs Reducing (Custom Hire Or Leasing) Or Income Producing Information.

PER 100 BU.

1a. Cost savings (or income produced) per unit* for a certain class of expenses (or income). For example, custom rate per unit ($)
01. | 0 3 4 . 2 3 | (A) — *This number is varied to do break-even analysis.*

PER 100 BU.

2a. Cost savings (or income produced) per unit* for a second class of expenses (or income). For example, additional per unit annual losses associated with custom hire ($)
02. | 0 0 0 . 0 0 | (A) — *It is possible to account for other returns to drying and storing grain in this line.*

THERE ARE 530 - 100 BU. UNITS = 53,000 BU.

3a. Normal number of units* per year on which costs will be reduced (or income generated).
b. Percent of units* indicated in Line 3a that will be absorbed by investment in the year of purchase.
03. | 0 0 0 5 3 0 | (A) | 1 0 0 | (B) ______

Section II. Investment Information.

4a. Total dollar cost including undepreciated balance of trade-in items.
b. Percentage undepreciated value of trade-in items is of total cost.
04. | 0 9 8 5 0 9 | (A) | 0 0 | (B) ______

5a. If a used item enter estimated new cost of item. If new item enter same value entered in Line 4a.
b. Years plan to use the investment.
05. | 0 9 8 5 0 9 | (A) | 1 0 | (B) ______

---

* It is very important to be consistent in your units. (For example, if the custom rate is stated on acres all the other units are also to be stated in acres).

This computer program was designed by Stephen B. Harsh, Michigan State University.

LINE NO. | ADJUSTED ANALYSIS

6a. Depreciation years
b. Salvage percent
c. Month of purchase (01=Jan,...., 12=Dec.).
d. Depreciation type (0=Have model choose best depreciation method to use; 1=Straight line; 2=Straight line with additional 20%; 3=Double decline balance; 4=Double decline balance with additional 20%; 5=1.5 decline balance; 6=1.5 decline balance with additional 20%; 7=Sum-of-digits; 8=Sum-of-digits with additional 20%).
e. Does investment qualify for investment credit (0=no; 1=yes).

06. |1 0|3 0|0 8|4|1| (A | B | C | D | E) ______

7a. Percent of total cost (input line 4a) borrowed.
b. Repayment period of loan-years
c. Annual rate of interest on loan(%)

07. |1 0 0|0 8|1 0 . 9| (A | B | C) ______

PER 100 BU.

8a. Per hour[x] fuel cost of operating investment** ($)
b. Per hour[x] fuel cost of operating associated equipment** ($)

08. |1 2 . 5 5|0 1 . 2 0| (A | B) ______

PER 100 BU.

9a. Per hour[x] labor cost of operating investment & associated equipment.
b. Per hour[x] cost of supplies of operating investment & associated equipment.

09. |0 1 . 5 0|0 0 . 0 0| (A | B) ______

10a. Repairs costs of investment: Enter estimated repairs costs over period or use in today's dollars (amount must exceed $25) OR enter type*** of machine to have model estimate repairs costs. Types of machines are: 1=tractors; 2=Self-P. Combine, Self-P. Forage harvester, Rotary Cutter; 3=Pull type combine. Pull type forage harvester, Flail harvester; 4=Self-P. swather, Self-U.L. Wagon, Side D. Rake; 5=Fertilizer equip; 6=Potato harvester, Sugar beet harvester, PTO Bailer; 7=Tillage tools, Mower; 8=Seeding equip; Boom sprayers; 9=truck; 10=Air Blast Sprayer.

10. |0 4 0 0 0| (A) ______

1 UNIT = 100 BU.

11a. Number of units* handled per hour[x]

11. |0 0 0 1 . 0 0| (A) ______

---

* Refer to Page 1

** See instructions for Program 03, Form 3 for suggested guidelines.

*** If you cannot find your machine in the list, try to match to a machine that is similar or enter estimate of repairs costs.

x Hours are used as a measure for expressing costs in lines 8a, 8b, 9a, 9b and as a conversion factor in line 11. You can use a different measure as long as you are consistent in these lines.

ADJUST
ANALYSI

LINE NO. | ADJUSTED ANALYSIS

Section III. Federal Tax, Rate Of Return And Cash Flow Information.

12a. Tax bracket in year of purchase. b. Tax bracket for first 1/2 years of investment. c. Tax bracket for last 1/2 years of investment.	12.	3 0 (A) | 3 0 (B) | 3 0 (C)	________
13a. Desired percentage discount rate of return on investment for first 1/2 years of investment. b. Desired percentage rate of return on investment for last 1/2 years of investment. c. Additional debt load (annual principal & interest payment in thousands of dollars) that the current business can withstand.	13.	1 2 (A) | 1 2 (B) | 0 0 0 . 0 (C)	________

Section IV. Modification Of Assumptions[xx]
(Enter "0" on line following last modification to be made. If none, enter "0" on line 14)

14a. Assumption value desired b. Assumption code	14.	0 1 . 0 (A) | 0 1 (B)	*Allows for break-even analysis.*
15a. Assumption value desired b. Assumption code	15.	0 6 . 0 (A) | 0 2 (B)	*6.0% annual increase in costs of commercial storage and drying.*
16a. Assumption value desired b. Assumption code	16.	1 0 . 0 (A) | 0 5 (B)	*10% annual increase in energy costs.*
17a. Assumption value desired b. Assumption code	17.	0 8 . 0 (A) | 0 8 (B)	*8% annual increase in replacement costs of system.*
18a. Assumption value desired b. Assumption code	18.	0 1 . 0 (A) | 0 9 (B)	*1% insurance charge.*
19a. Assumption value desired b. Assumption code	19.	0 1 . 6 (A) | 1 0 (B)	*16% property tax.*
20a. Assumption value desired b. Assumption code	20.	0 0 . 0 (A) | 0 0 (B)	________

---

xx See instructions for Program 03, Form 3 on how to use this section.

at is
as a
you

APPENDIX C

Fixed and Variable Costs Analysis on Systems 1 and 2

Use of Corn Only

	System 1 (6,000 Bu.)	System 2 (10,000 Bu.)
Investment Costs	$17,507	$24,208
Salvage Value at the End of 10 Years	$ 4,377	$ 6,536
Before-Tax Interest Charge	17%	17%
Repairs	$ 400	$ 600
Property Taxes (% of average investment)	1.6%	1.6%
Insurance (% of average investment)	1%	1%
Variable Costs Items	¢/Bu.	¢/Bu.
Direct Energy (drying)	6.97¢	13.39¢
Indirect Energy (use of pickup truck)	1.20	1.20
Maintenance Energy (15% of above)	1.23	2.19
Labor	2.40	2.40
Total Variable Costs	11.80¢	19.18¢

Calculation of Fixed Costs

	System 1 (6,000 Bu.)		System 2 (10,000 Bu.)	
Depreciation	$\frac{17{,}507-4{,}377}{10}$ =	$1,313	$\frac{24{,}208-6{,}536}{10}$ =	$1,767
Interest	$\frac{17{,}507+4{,}377}{2}$ X .17 =	1,860	$\frac{24{,}208+6{,}536}{2}$ X .17 =	2,613
Repairs	400÷10 =	40	600÷10 =	60
Property Taxes	$\frac{17{,}507+4{,}377}{2}$ X .016 =	175	$\frac{24{,}208+6{,}536}{2}$ X .016 =	246
Insurance	$\frac{17{,}507+4{,}377}{2}$ X .01	109	$\frac{24{,}208+6{,}536}{2}$ X .01 =	154
Total		$3,497		$4,840
Per Bushel Annual Fixed Costs		58.28¢		48.40¢
Per Bushel Annual Variable Costs		11.80¢		19.18¢
Total Per Bushel Annual Costs		70.08¢		67.58¢

These estimates compare with capital budgeting estimates as follows:

System 1   70.08¢/Bu. Vs. 35.28¢/Bu.

System 2   67.58¢/Bu. Vs. 40.28¢/Bu.

Fixed and variable costs analysis suggest System 2 is 2.5¢/Bu. cheaper than System 1. The more realistic capital budgeting approach suggests System 1 is 5¢/Bu. cheaper than System 2.