RISKY INVESTMENTS IN GRAIN DRYING
EQUIPMENT: THE SE COASTAL PLAINS CASE

Mark S. Lieblich
ERS-NED, USDA
Washington, D.C.

and

Clyde Kiker
Food and Resource Economics Department
University of Florida

August, 1984

RISKY INVESTMENTS IN GRAIN DRYING
EQUIPMENT: THE SE COASTAL PLAINS CASE

ABSTRACT

The hot humid climate and market conditions in the coastal plains introduce factors which influence harvesting and marketing strategies for corn. The return to investments in drying equipment is influenced by stochastic weather and price conditions. An appraisal of drying equipment investments for varying scales and cultural practices is made using simulation modeling and stochastic efficiency analysis.

1. INTRODUCTION

The hot, humid climate of the southeastern coastal plains creates conditions at harvest time that differ substantially from those of the corn belt. Field drying of corn under natural conditions exposes the crop to damage from weather, diseases, and insects. Conversely, if the producer is hoping to obtain a higher, early-season price, the corn must be harvested at a high moisture content and be artificially dried within a few days to prevent in-storage spoilage. With an early harvest, the farmer is put in a position where drying equipment must be on-hand or the relatively wet corn must be sold at a discounted price immediately upon harvesting. The question facing the corn farmer is: Under what conditions is it reasonable to invest in drying equipment and thereby expand the alternative strategies available at harvest time?

Numerous studies have addressed the evaluation of drying equipment purchases. Bridges et al. (1979a and 1979b) have utilized nonstochastic simulation models to aid in the selection of least-cost drying systems. Loewer et al. (1979 and 1980) have developed a simulation model (also nonstochastic) and have thereby approximated the optimal selection of drying facilities for static physical and economic settings. Hewitt, Schwart, and Schwart and Hill have provided a series of publications which detail equipment costs, fixed costs, and operating costs for a variety of drying and storage systems.

Foremost among the considerations which have been neglected in these studies are the influences of uncertain weather patterns, yield levels, and prices. The probabilistic conditions which may prevail during the life of a drying system investment have not been considered. Generally, there is a lack of quantitative information to assist SE corn producers in the decision to invest in artificial drying equipment.

The general objective of this paper is to evaluate the profitability and risk of the investment in on-farm drying systems as it occurs in the southern coastal plains and present the results in a manner which will aid farmers in the decision-making process. Allowing for the diversity of conditions under which the uncertain investment may occur permits the examination of any technical economies of scale and the influence of the irrigated cultural practice.

2. METHODOLOGY

The problem being addressed is viewed as one of capital budgeting for the producer. Formulating the problem to derive a net present value (NPV) serves to provide a measure of the investment's worth and permits the comparison of mutually exclusive investment alternatives which may have nonconventional cashflows (Levy and Sarnat). To facilitate the calculation of the NPV, the analysis details the investment's incremental cashflows for each project life through a partial budgeting procedure (Luening). As such, potential changes in the operations' profitability are disclosed.

Data series of future events are constructed to incorporate what Morey et al. have identified as the four major factors which influence the selection of an optimum corn harvesting strategy. The factors include (1) the recoverable yield, which changes throughout the season; (2) the average moisture content, which generally decreases throughout the season; (3) weather, which provides a stochastic input; and (4) the price of the grain, which varies through the season and across years.

Recoverable yield is determined for alternative harvesting strategies in a sequence of 17 years of weather conditions recorded at Chipley, Florida (HISARS). Potential, mature yields (29.5 percent moisture content, wet basis) were obtained by Amerling from a crop growth model developed by Duncan which simulates the study region. The amount of time required for the grain to field dry to selected levels is also calculated as a function of weather using Duncan's method. An expression provided by Morey et al. to determine which days are suitable for harvesting is adapted to reflect access to the crop by the harvesting machine. Harvested yields account for the losses which occur as the grain field dries and for harvesting efficiency under alternative harvesting schedules. In consultation with Shaw (personal communications, 1983), factors for the percent of grain lost per day of the harvesting period were drawn from research by Loewer et al. (1982) and Johnson and Lamp. The behavior of corn prices is represented with weekly prices of the Atlanta cash market for No. 2 field corn over a nine year period (Feedstuffs).

A computer-assisted simulation model enables a sequence of random sampling experiments from the data series for each investment situation to be performed. The representation of events which are deemed to behave in a stochastic manner is enabled by Monte Carlo sampling (Anderson et al., p. 267). The capital budgeting and stochastic simulation procedure, in its entirety, is illustrated in Figure 1. The ten year investment life is simulated 100 times for each set of conditions which are defined by the farmer's scale of crop production, cultural practice, and drying equipment. The investment is evaluated for conditions which are representative of field corn production operations in the region.

Harvesting strategies are assigned to operations which utilize drying equipment and those which do not following conclusions drawn from a survey of North Florida field corn production practices which was performed by Hubbard. Field corn producers with drying equipment begin harvesting their grain when a moisture content of 26 percent is attained.

Artificial drying and additional field drying reduce the moisture content to 15.5 percent. Those operations relying upon a field drying process begin harvesting the grain at a moisture content of 16 percent.

Schwart and Hill and discussions with research and extension personnel in nine states contributed to the identification of four operating scales, measured by physical output (small scale of 5,000 bu./yr. up to large scale of 60,000 bu./yr.), which are recognized as influencing the overall profitability of an investment in drying equipment. The two cultural practices, dryland and irrigated, which were used for the calculations of mature yield and date of maturity are presented by Amerling.

The selection of each of four types of drying equipment for the study is based upon the considerations of the degree of control the producer has over the equipment's operation and the popularity of the method in the region. Information provided by Talbot and Hewitt regarding alternative drying methods suggest the selection of batch-in-bin, stirring batch-in-bin, automatic batch, and continuous-flow drying systems. To ensure the coordination of drying and handling equipment, their selection should be based upon the design for an integrated system (Hall). The designs of the drying and handling systems are obtained from Schwart and Hill.

The NPV measure provides a decision rule for the investment. When the outcome of the investment is known with certainty, the rule is to accept the project if the NPV is positive and to reject the project if the NPV is negative (Levy and Sarnat, p. 32). As each investment situation is evaluated, a distribution of NPVs is obtained. Anderson et al. (p. 23) present a method for determining a cumulative distribution function (CDF) for an uncertain variable. The CDF provides substantial information regarding an investment situation, including the value of the median NPV and the probability of an investment being positive or negative.

For the present study, the NPV for the investment in a system was determined using

$$NPV = -(IO) + \frac{(IC)}{(1+R)*(1+H)} + \sum_{t=1}^{5} \frac{(MT)*(D)}{(1+R)^t*(1+H)^t}$$
$$+ \sum_{t=1}^{10} \frac{(1-MT)*(S_t)}{(1+R)^t*(1+H)^t} - \frac{(I5)}{(1+R)^5} + \frac{(1-MT)*(SV)}{(1+R)^{10}}$$

where

NPV = the net present value of the investment, in dollars,

IO = the net initial investment outlay, in dollars,

IC = the investment tax credit received in nominal dollars, in year 1,

R = the real discount rate, 0.06

H = the general inflation rate, 0.034

MT = the marginal tax rate, 0.30

D = depreciation for tax purposes, in nominal dollars,

I5 = the investment outlay in year 5 in real dollars, for moisture testing equipment, \$499.00

SV = the salvage of the equipment in year 10 in real dollars.

The pretax incremental cashflow in nominal dollars for each year is

$$S_t = (PE_t)*(1+PI)^t*(QE_t)-(CA_t)*(1+H)^t-(PL_t)*(1+PI)^t*(QL_t)$$

where

S_t = the pretax incremental cashflow in year t expressed in nominal dollars,

PE_t = the price of corn in dollars per bushel when harvested early in year t,

PI = the nominal product price inflator, 0.036,

QE_t = the total yield obtained under the early harvesting strategy at a 15.5 percent moisture equivalent for year t, in bushels,

PL_t = the price of corn in dollars per bushel when harvested late in year t,

QL_t = the total yield obtained under the late harvesting strategy at a 15.5 percent moisture equivalent for year t.

The cost of drying in each year is

$$CA_t = (IR)*(IO)+(SU)*(WG)+\frac{(WG)*(HO)*(QE_t)}{(BU)} + (LP)*(GU)*(QE_t) + (EL)*(EU)*(QE_t)$$

where

CA_t = the cost of artificial drying in real dollars for year t,

IR = the yearly charge for insurance and repairs as a percent of the initial investment outlay, 0.033,

SU = the fixed amount of labor for drying equipment start-up each year, in hours,

WG = the hourly wage rate, $4.50,

HO = the daily hours of labor required to operate the drying equipment,

BU = the number of bushels harvested per day, 1,460 for all scales other than the 60,000 bu. scale which harvests 4,380,

LP = the cost of liquified petroleum gas, $0.887 per gallon,

GU = the gallons of liquified petroleum gas required to remove 10 percentage points of moisture from a bushel of corn,

EL = the cost of electricity, $0.07023 per kilowatt hour,

EU = the number of kilowatt hours required to remove 10 percentage points of moisture from a bushel of corn.

The values used in the calculations are given in Table 1.

The comparison of investment situations across drying systems, cultural practices, and operating scales may be performed by repeatedly calculating the NPV for the sampled values. Stochastic dominance criteria permit the determination of efficient choices among the investment options (Anderson et al., pp. 282 to 290).

3. RESULTS

Each of the four drying system investments for the dryland operation producing at a scale of approximately 5,000 bushels per year exhibited a probability of zero for a profitable investment in drying systems. The two best investments for the 10,000 bushel dryland operation are shown in Figure 2. The batch-in-bin system investment displayed a median NPV of about negative 3,000 dollars with only a 27 percent probability of being profitable. Figure 2 also shows the two most advantageous investments for the 20,000 bushel scale, dryland operation. In this case, the stirring method presents the dominating investment with a median NPV of about 13,600 dollars and a high likelihood of being profitable.

Drying system investments for the 5,000 bushel scale, irrigated operation also exhibit a great probability of being a net loss. The 10,000; 20,000; and 60,000 bushel scale, irrigated operations' two best investments are shown in Figure 3. The investments are clearly marginal for the 10,000 bushel operation. A stirring device begins to provide a more profitable investment than the conventional batch-in-bin system for the 20,000 bushel operation. The irrigated operation which produces an average of 60,000 bushels provides opportunities for investments which are very profitable and nearly risk-free.

Tables 2 and 3 summarize the results for the seven sets of conditions under which the four investments were evaluated.

4. CONCLUSIONS

The investment in artificial drying equipment, along with the concomitant change in the harvesting strategy, has the potential to be a profitable and somewhat certain venture for some corn producers in the southern coastal plains region. For dryland operations that produce more than 20,000 bushels per year there is a high likelihood that the NPV is positive. Below the 20,000 bushels per year scale there is a low likelihood that the investment in drying equipment will pay. For irrigated operations of approximately 5,000 bushels per year there is also a low likelihood that the investment will pay. Irrigated operations at 10,000 bushels per year begin to show some possibility of return to the investment, while production scales greater than 20,000 bushels per year show certainty of a positive NPV.

To the degree that the conditions simulated represent those faced by individual producers, the information herein provides a preliminary evaluation of drying equipment investments for producers of the region. The model itself is set up for use on microcomputers and the expectation is that farmers will be able to input data regarding their own operations and obtain an even better projection of the likely payoff.

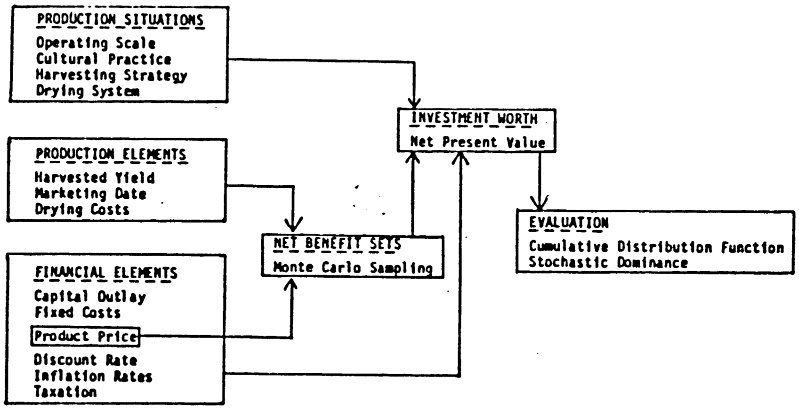

Figure 1. Components of the simulation model.

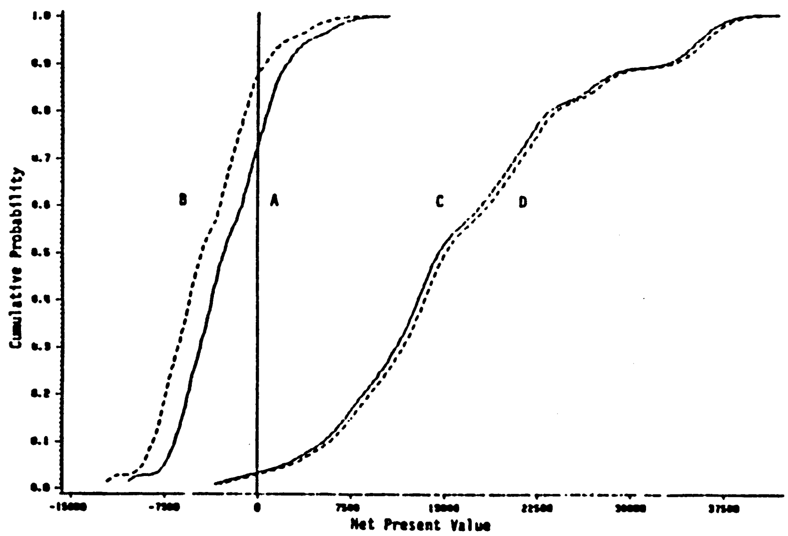

Figure 2. Investments for the 10,000 bushel dryland operation for (A) batch-in-bin and (B) stirring batch-in-bin equipment and for the 20,000 bushel dryland operation for (C) batch-in-bin and (D) stirring batch-in-bin equipment.

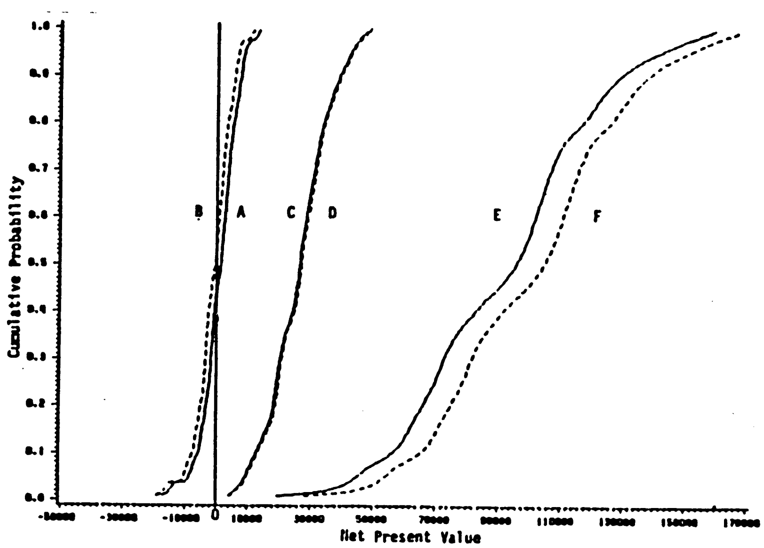

Figure 3. Investments for the 10,000 bushel irrigated operation for (A) batch-in-bin and (B) stirring batch-in-bin equipment and for the 20,000 bushel irrigated operation for (C) batch-in-bin and (D) stirring batch-in-bin equipment and for the 60,000 bushel irrigated operation for (E) batch-in-bin and (F) stirring batch-in-bin equipment.

Table 1. Parameter values for the simulation model.

Parameter	Batch-in-Bin	Stirring Batch-in-Bin	Automatic Batch	Continuous-Flow
	System			
ID, 5,000 bu. scale	$7,435	$9,705	$19,444	$22,804
ID, 10,000 bu. scale	$9,829	$12,099	$19,444	$22,804
ID, 20,000 bu. scale	$13,390	$13,023	$19,444	$22,804
ID, 60,000 bu. scale	$27,395	$18,730	$36,748	$32,649
GU	0.165	0.165	0.21	0.165
EU	0.15	0.106	0.113	0.106
SU	10.0	10.0	3.0	3.0
HO	3.0	3.0	13.0	13.0
IR	0.033	0.033	0.033	0.033

SOURCES: Farnbach, personal communication; Schwart; Schwart, personal communication; and Schwart and Hill.

Table 2. Median net present value and the probability of a positive net present value for drying system investments by dryland operations.

Drying System	Operating Scale					
	5,000 bu.		10,000 bu.		20,000 bu.	
	Median NPV,	P(NPV≥0)	Median NPV,	P(NPV≥0)	Median NPV,	P(NPV≥0)
Batch-in-bin	-$5,600	0%	-$3,000	27%	$13,100	97%
Stirring batch-in-bin	-$7,400	0%	-$5,000	12%	$13,600	97%
Automatic batch	-$17,000	0%	-$14,000	0%	$3,300	72%
Continuous-flow	-$18,000	0%	-$15,000	0%	$3,800	75%

Table 3. Median net present value and the probability of a positive net present value for drying system investments by irrigated operations.

Drying System	Operating Scale							
	5,000 bu.		10,000 bu.		20,000 bu.		60,000 bu.	
	Median NPV,	P(NPV≥0)	Median NPV,	P(NPV≥0)	Median NPV,	P(NPV≥0)	Median NPV,	P(NPV≥0)
Batch-in-bin	-$5,000	4%	$800	55%	$24,700	100%	$96,000	100%
Stirring batch-in-bin	-$7,500	3%	-$800	44%	$26,600	100%	$104,000	100%
Automatic batch	-$17,000	0%	-$10,400	3%	$13,900	93%	$76,000	100%
Continuous-flow	-$19,000	0%	-$11,200	5%	$14,800	95%	$90,000	100%

Amerling, C.B. (in preparation). Irrigation Investment Decisions for Row Crop Farmers in North Florida. Unpublished M.S. Thesis. Gainesville: University of Florida.

Anderson, J.R., J.L. Dillon, and J.B. Hardaker. 1977. Agricultural Decision Analysis. Ames, Iowa: The Iowa State University Press.

Bridges,, T.C., O.J. Loewer, Jr., and D.G. Overhults. 1979a. "The Influence of Harvest Rate and Drying Time on Grain Drying and Storage Facility Selection." Transactions of the American Society of Agricultural Engineers, 22: 174-177.

Bridges, T.C., O.J. Loewer, Jr., J.N. Walker, and D.G. Overhults. 1979b. "A Computer Model for Evaluating Corn Harvesting, Handling, and Storage Systems." Transactions of the American Society of Agricultural Engineers, 22: 618-629.

Duncan, W.G. 1976. Simaiz Dictionary (Unpublished paper). Agronomy Department, University of Florida, Gainesville.

Feedstuffs. 1975 to 1983. Minneapolis, Minnesota: Miller Publishing Company.

Hall, C.W. 1980. Drying and Storage of Agricultural Crops. Westport, Connecticut: AVI Publishing Company, Inc..

Hewitt, T.D. 1983. Comparison of On-Farm Drying Systems. Food and Resource Economics Department, University of Florida, ARC, Quincy.

HISARS-Hydrologic Information Storage and retrieval System. 1975. Department of Statistics, University of Florida, Gainesville.

Hubbard, S.P. 1979. "A Model for Estimating Differences in the Degrees of Risk Preferences Between Small and Large North Central Florida Field Corn Producers." Unpublished M.S. Thesis. Gainesville: University of Florida.

Johnson, W.H., and B.J. Lamp. 1966. Corn Harvesting. Westport, Connecticut: AVI Publishing Company, Inc..

Levy, H., and M. Sarnat. 1982. Capital Investment and Financial Decisions. Englewood Cliffs, New Jersey: Prentice Hall, Inc..

Loewer, O.J., Jr., T.C. Bridges, G.M. White, and D.G. Overhults. 1979. "A Computer Model for Determining the Economics of On-The-Farm Drying, Storage, and Feed Processing Systems for Corn." American Society of

Agricultural Engineers, Paper No. 79-5020. St. Joseph, Michigan.

Loewer, O.J., Jr., T.C. Bridges, G.M. White, and D.G. Overhults. 1980. "The Influence of Harvesting Strategies and Economic Constraints on the Feasibility of Farm Grain Drying and Storage Facilities." Transactions of the American Society of Agricultural Engineers, 23: 468-480.

Loewer. O.J., Jr. T.C. Bridges, G.M. White, and R.R. Razor. 1982. "Energy Expenditures for Drying and Harvesting Losses as Influenced by Harvesting Capacity and Weather." American Society of Agricultural Engineers, Paper No. 82-3515. St. Joseph, Michigan.

Luening, R.A. 1974. "Partial Budgeting." Journal of the American Society of Farm Manager and Rural Appraiser, 38: 33-38.

Morey, R.V., G.L. Zachariah, and R.M. Peart. 1971. "Optimum Policies for Corn Harvesting." Transactions of the American Society of Agricultural Engineers, 14: 787-792.

Schwart, R.B. 1982. "Investment, Ownership, and Energy Costs of New Bin Storage and of Hot Air Drying Facilities for Corn." Farm Economics: Facts and Opinions, No. 82-10. Department of Agricultural Economics, University of Illinois, Urbana.

Schwart, R.B., and L.D. Hill. 1977. "Comparative Costs of Conditioning and Storing Corn." AERR No. 152. Department of Agricultural Economics, University of Illinois, Urbana.

Talbot, M.T. 1982. "Grain Drying and Storage on Florida Farms." Agricultural Engineering Extension Report No. 82-30. Gainesville, Florida: Florida Cooperative Extension Service.