J. OF THE NORTHEASTERN AGR. ECON. COUNCIL VOL. VII, NO. 2, OCTOBER, 1978

A COMPARISON OF MARKETING STRATEGIES FOR POTATOES IN UPSTATE NEW YORK

Ralph Young and William G. Tomek

A long-standing problem in agricultural marketing is the question of "optimal" marketing patterns for a seasonally produced crop. When futures markets exist, agricultural economists have often recommended their use to improve marketing decisions, but farmer use of futures as an aid to marketing is not common. This paper considers the potential benefits to upstate New York farmers of hedging using Maine potato futures contracts. Benefits are defined in terms of the mean and variance of returns from alternative marketing strategies for potatoes. A portfolio approach is implicit in the analysis which also relies, in part, on the formulation of a simple price-forecasting model.

BACKGROUND

Potato production in upstate New York forms a relatively small proportion of the total U. S. fall crop, but New York farmers produce both for the fresh (table stock) and processing markets. Production for the fresh market tends to occur on relatively small multi-enterprise farms, and production is apparently undertaken not infrequently to exploit the potential for large windfall gain arising from widely fluctuating prices. Producers for the processing market tend to be more specialized and larger, and often the potatoes are marketed via a contract with a processor. Thus, some growers will be too small to use futures, and those with forward cash contracts may not be interested in futures as a marketing tool. Nonetheless, some potato farmers may be interested in hedging strategies if they can increase returns and/or reduce the variability of returns.

The marketing decision is a temporal problem, viz. when to sell the crop during the limited storage period which potentially extends from time of harvest, usually in October, to April-May. To the extent that the grower is uncommitted in the timing of sales, his decision will tend to be determined by the storability of the harvested crop and by expectations regarding movements in price over the marketing period relative to storage costs. In some cases the effective decision period will not coincide with the marketing period, but will encompass the growing period as well. For example, if a grower expects that the futures price prevailing at planting time or during the growing period may exceed the price at harvest time or subsequently, he may wish to "lock in" a price by hedging in futures by taking a short position at a pre-harvest date. Thus, the grower may view the futures market as fulfilling a forward pricing role as well as an inventory marketing role (see Gray, and Tomek and Gray). This paper, however, limits analysis to price behavior during the storage period.

In the context of the upstate New York potato grower faced with the decision of when to market his crop, the portfolio approach appears to have direct relevance. The feasible set of risky assets includes a cash crop, either in the ground or in storage, contracts in the Maine potato futures market, and forward sales contracts. Each of these may be regarded as risky because the return is uncertain in the sense that the level of the actual return or the opportunity cost return is subject to fluctuations in the product price or in the quantity of the product available for sale. In this paper forward contracting is ignored.[1] Following Telser and Higinbotham, a futures contract is regarded as a "temporary abode of purchasing power in terms of the commodity" and in consequence has value as an asset. The choice variables are, therefore, the quantity of the cash crop and the quantity of future contracts. Because this paper is essentially illustrative, a portfolio model is not derived and specified, but the analysis proceeds on the basis that such an underlying model exists and that the results may be assessed in terms of mean and variance.[2]

Arising from the foregoing, three issues warrant comment.

(a) The measure of risk. What is risk from the producer's viewpoint? According to Peck, risk is the price forecast error resulting from imperfect information and the inevitable gestation period associated with commodity production. But reservations may be expressed about such a measure, at least in the case of many specialized potato growers. The alternate uses of the resources employed by potato growers, including land, is in many cases severely restricted. Accordingly the risk which faces such growers is not the error associated with a price forecast, but the occurrence of losses over one or more years which diminish wealth and in the extreme case result in bankruptcy. In other words the preference or utility function being maximized extends over the planning horizon of the grower. On this basis, the variance associated with profits or returns appears to be a more relevant measure of risk than forecast error.[3] Unfortunately variance (and forecast error) picks up both tails of the distribution of returns whereas the individual producer is likely to be concerned only with the left-hand tail of the distribution. This, however, must remain a problem for further research.

(b) Time period of the analysis. Peck (pp. 410-11) raises the question of the appropriateness of considering the long-run view imposed by use of "traditional measures of return and risk." In addition, the measure of risk in terms of variance will vary with the time period. The appropriate time period will, however, be determined by the planning horizon of the producer. A number of factors which seem likely to influence the length of the planing horizon are themselves not restricted to a single crop year e.g. the budget or liquidity constraint facing the grower, the basis of past experience on which price expectations are derived, and the

Ralph Young is a graduate student and William G. Tomek a professor of agricultural economics, Cornell University. With the usual *caveat,* comments by R. Brian How are gratefully acknowledged.

1. Forward deliverable (cash) contracts are discussed by Paul et al.

2. The development of the portfolio approach is attributable to Markowitz. He shows that as the size of the portfolio grows (in terms of number of securities), the variance of the portfolio's returns depends more on the covariance of returns between each pair of securities than on the variance of returns of individual securities. In this paper, the implicit portfolio approach differs from that used by Markowitz; mean-variance measures are presented which relate to the net outcome of selected alternative "portfolios" of risky assets rather than for individual assets, and covariances are not used.

3. Forecast error and variance are only two of a number of possible measures of risk. Unfortunately there is no concensus about the appropriate empirical definition of risk or risk aversion in the literature. For a discussion of the topic see Anderson et al.

use of capital intensive and other inputs the productive life of which extends over more than one crop year. Therefore, the long run may be just as relevant as the short run (i.e. one year) for decision-making purposes. However, the problem of identifying the planning horizon of the grower remains, and too often it is determined by the data rather than by the decision-making process of the grower. Recognizing that the arbitrary choice of time period will influence the measure of risk, and hence the portfolio choice of the grower, does little to resolve the problem. This paper uses the 10 crop years 1967-68 to 1976-77 and does not analyze the sensitivity of results to the period used.

(c) Feasible set of portfolio assets. If it is assumed that no transaction costs exist and that the opportunity cost of the grower's time is zero, then conceptually an infinite number of asset combinations exists which the grower could select over the marketing period between harvest and sale. At any particular instant, however, the range of combinations will be quite limited. In practice, there are transactions costs, and the opportunity cost of the grower's time is likely to be non-zero so that the temporal range of asset combinations will also tend to be quite limited. In the present study the range of asset combinations is arbitrarily restricted. Since the study is intended to be illustrative only, this is not a matter of concern in this paper. However, potential combinations will in practice tend to cover assets in addition to cash crop and futures contracts, the only two choice variables considered in this paper.

In the analysis that follows certain assumptions are used to simplify computations and comparisons of alternatives. The assumptions include: the potato producer is risk averse with mean and variance of returns the only arguments in his preference function; the crop years 1967 through 1976 represent an appropriate period for analysis; the producer is a price taker; storage costs are approximately equal to 10% of the average cash price of potatoes for the week containing October 31;[4] the farmer's cash price can be represented by the price for round whites, U.S. No. 1, Size A sold in 50 lb. sacks as quoted by AMS in Western New York; the size of producer's crop is at least equal to the size of the Maine futures contract (50,000 lb.), and when hedged, it is fully hedged; the crop is storable at least until March 31; and the crop is stored as a whole (not in part).

ALTERNATIVE MARKETING STRATEGIES

Since the objective of this paper is to assess the effect of hedging on a farmer's returns, the basic comparison is between unhedged and hedged marketing patterns. If the producer does not hedge, he may, for the purposes of this paper, sell the crop at harvest or store and sell it by March 31. Three unhedged situations are considered: (1) routine (i.e. regularly every year) sale of crop on October 31; (2) routine storage of crop and sale on March 31; (3) selective storage depending on price forecast, namely store if price forecasted for March 31 exceeds the October 31 price by 10% (otherwise sell on October 31). The price forecast is derived from a formal regression model described below. Given the paper's objective, these unhedged strategies are used as the benchmarks for comparison.

4. The use of 10% of the cash price as a proxy for storage costs is somewhat arbitrary. Using the harvest-time cash price as a base for storage costs does get at the idea of opportunity cost since the crop could have been sold at harvest and the funds used elsewhere. Also, spoilage losses in storage can be linked to the price of the crop.

For hedging to be successful, the cash and futures prices must be correlated, and the difference between the prices —the basis — must narrow as the delivery month approaches. Using the price of the April delivery option for Maine potatoes and the farm price defined above, it is clear that the basis tends to narrow over the storage period. However, the basis is highly unstable, and successful hedging would require excellent management skills. That is, in each of the 10 years considered, a general tendency existed for the basis to narrow from October to April, but within this period, the basis fluctuated considerably, often with several weeks of a widening basis. Thus, having placed a hedge, favorable opportunities invariably existed for lifting the hedge, but this is not to say that storing and hedging are sure things. In addition to the possibility of the crop deteriorating in storage and forcing an early sale, there is the point that time is irreversible. The passing of one or more favorable opportunities does not mean that further opportunities will necessarily occur before the crop finally must be sold.

Thus, in considering whether to hedge, the farmer is considering several types of price risk. If he does not hedge, there is the risk that cash prices will not rise sufficiently to cover storage costs. If he does hedge, the basic risk may be so large that he is not assured (as theory would imply) of a return to storage. If one does assume that a hedge "locks in" a given return, then in some years profits will be foregone in the cash market (as well as losses being prevented in other years). These are, of course, questions which we hope to answer, at least in part, by the analysis to follow.

Three hedging strategies are analyzed and compared with the unhedged marketing patterns. (4) Potatoes are placed in storage on October 31 and held until March 31; this decision is routinely hedged by the sale of April futures on October 31 and the purchase of the April futures on March 31.

(5) A selective storage and hedging strategy is followed based on the expected change in the basis. A hedge is placed when the narrowing of the basis is expected to at least cover storage costs. As mentioned in the assumptions, the cost of storage is defined as 10% of the cash price of potatoes for the week of October 31. The decision rule is to hedge when the expected change in the basis is equal to or larger than this cost. The expected change in the basis is the observed October 31 basis (using April futures and New York cash) minus an estimate of the basis for the last part of March. This estimate is the median basis for the last two weeks of March during the previous three crop years. All of these prices are available to the farmer and could be used in decision making.

(6) In alternative (3) above, the farmer is assumed to use a price forecast to make a storage decision. This forecast also can be used in conjunction with hedging: (a) If the price forecast for the end of March exceeds the October 31 cash price by 10% and if the April future price exceeds the October cash price by 10%, the potatoes are stored and hedged. (b) If the April basis is not sufficiently large, the potatoes are stored unhedged. (c) If the forecast price is less than 10% above the October 31 cash price, the potatoes are sold on October 31.

The price forecasts used in alternatives (3) and (6) are based on the following equation (t ratios in parentheses):[5]

$$PCM_t = 7.974 + \underset{(6.6)}{2.336}PCO_t - \underset{(1.9)}{0.048}PRF_{t-1},\ R^2 = .88,\ d = 1.8,$$

5. The sources of the data are Federal-State Market News Service, New York Mercantile Exchange, and the USDA.

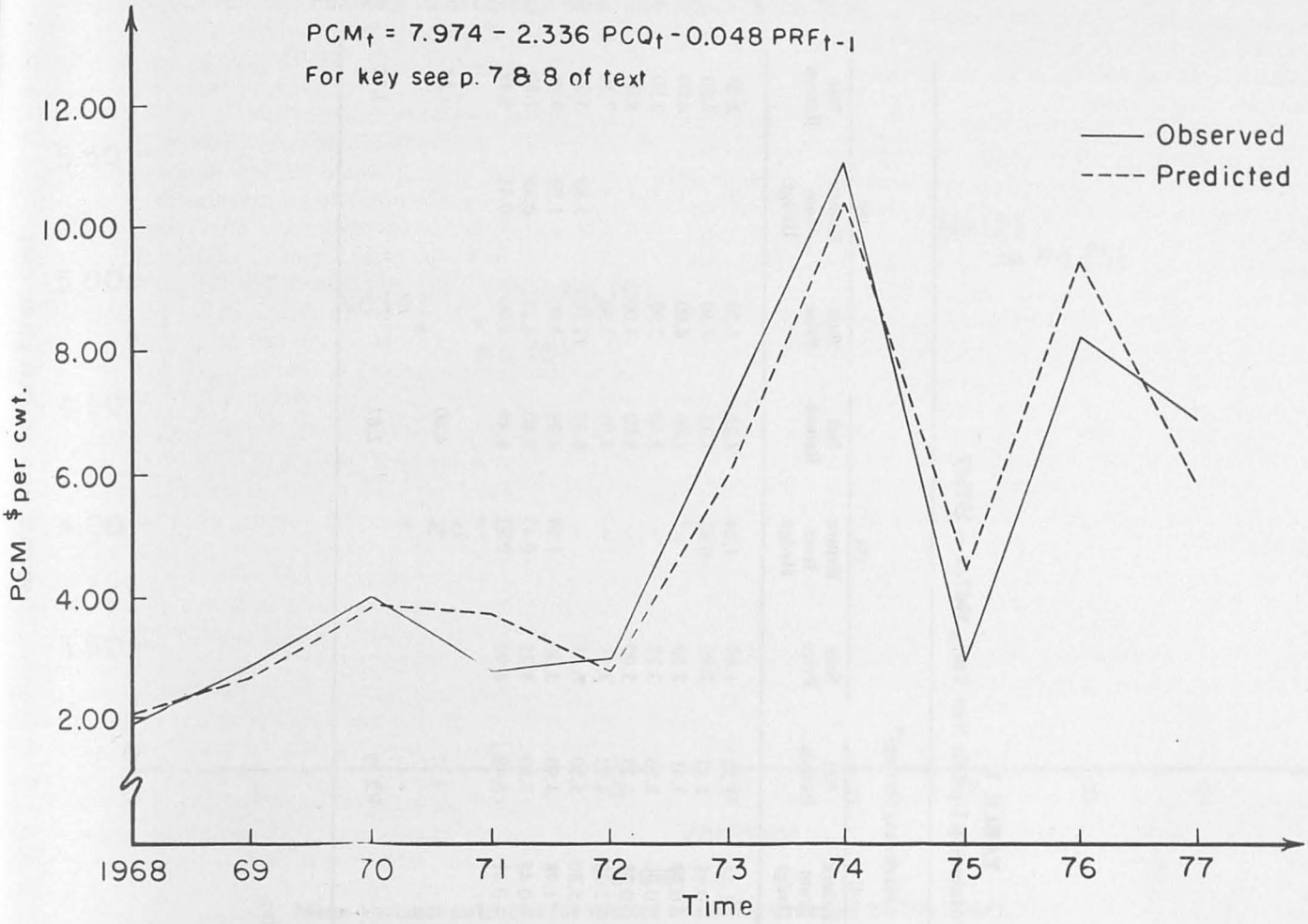

FIGURE 1.
Observed and Predicted prices of potatoes on March 31st., 1968-1977.

where PCM_t = midpoint of price range last full week in March for Western and Central New York round whites, U.S. No. 1, Size A in 50 lb. sacks, price converted to $ per cwt.

PCO_t = same measure as PCM but for last full week of the preceding October

PRF_{t-1} = total production of fall potatoes in U.S., previous crop year, in cwt.

The equation was selected from several alternatives on the basis of goodness-of-fit. The predicted and observed prices for March 31, 1968 to March 31, 1977 are shown in figure 1.

ANALYSIS OF ALTERNATIVES

The returns per cwt. for the six alternatives are computed in three steps. The first is to obtain the annual sale price on the date of the sale. For the first three strategies (no hedges), the "net return" in table 1 is the cash sale price, and the price varies simply because of the difference in timing of sale.

The second step is to calculate the gain or loss in each year resulting from taking positions in futures (as specified in alternatives (4) to (6)). This gain/loss is given in column 2 of table 1 for each alternative. The gain/loss is added to the cash sale price to get the "net return" for the hedging alternatives as reported in the third column for each alternative.[6]

The final step is to compute the mean net cash return per cwt. per year and the variance of the returns for the 10 year period for each of the strategies. These estimates appear in the bottom two rows of table 1. To facilitate comparisons, the mean-variance outcomes are plotted in figure 2.

An inspection of the results suggests the following: (a) Returns are increased by storing the crop, whether hedged or unhedged, relative to the routine sale of the crop at harvest (alternative (1)). The increase is almost $1.15 per cwt., or 23 cents per month, a level that more than covers storage costs in that period. (b) Hedging the stored crop results in a substantial decrease in risk (variance) to the unhedged situations (strategies (2) and (3)). However, the large variances characterizing marketing without hedging appear largely related to price fluctuations on the upside rather than on the downside. Thus, the use of variance as a measure of risk may exaggerate the degree of risk associated with these strategies during the period under study.

6. Transactions costs are ignored in table 1. Current commissions for one sale and one purchase of a potato contract would be about eight cents per cwt. (commissions vary with brokers). Thus, the net returns shown for the hedging alternatives are overstated.

TABLE 1.

Returns from Marketing Potatoes in Upstate New York, 1967/8 — 1976/7

Crop Year (Oct. 31 — Mar. 31)	Marketing Strategy[a] (1) Net Return[b]	(2) Net Return[b]	(3) Net Return[b]	(4) Sale Price	(4) Return from Hedge	(4) Net Return	(5) Sale Price	(5) Return from Hedge	(5) Net Return	(6) Sale Price	(6) Return from Hedge	(6) Net Return
1967/68	2.20	1.98	2.20	1.98	1.24	3.22	1.89	1.24	3.22	2.20	–	2.20
1968/69	2.50	2.90	2.50	2.90	0.43	3.33	2.90	0.43	3.33	2.50	–	2.50
1969/70	2.80	4.00	4.00	4.00	−0.59	3.41	2.80	–[c]	2.80	4.00	–	4.00
1970/71	3.10	2.90	2.90	2.90	0.06	2.96	3.10	–	3.10	2.90	–	2.90
1971/72	3.00	3.00	3.00	3.00	0.28	3.28	3.00	–	3.00	3.00	–	3.00
1972/73	4.95	7.30	7.30	7.30	−2.38	4.92	4.95	–	4.95	7.30	–	7.30
1973/74	6.35	11.10	11.10	11.10	−5.80	5.30	6.35	–	6.35	11.10	−5.80	5.30
1974/75	3.70	3.00	3.00	3.00	1.98	4.98	3.00	1.98	4.98	3.00	1.98	4.98
1975/76	6.55	8.25	8.25	8.25	−0.45	7.80	8.25	−0.45	7.80	8.25	−0.45	7.80
1976/77	4.75	6.90	6.90	6.90	−0.41	6.49	6.90	−0.41	6.49	6.90	−0.41	6.49
Mean return per cwt	3.99	5.13	5.12			4.57			4.60			4.65
Variance of returns	2.29	8.34	8.40			2.39			2.87			3.77

[a] See text for definitions of strategies by number.
[b] For strategies (1), (2) and (3), net return is defined as the sales price.
[c] No hedge.

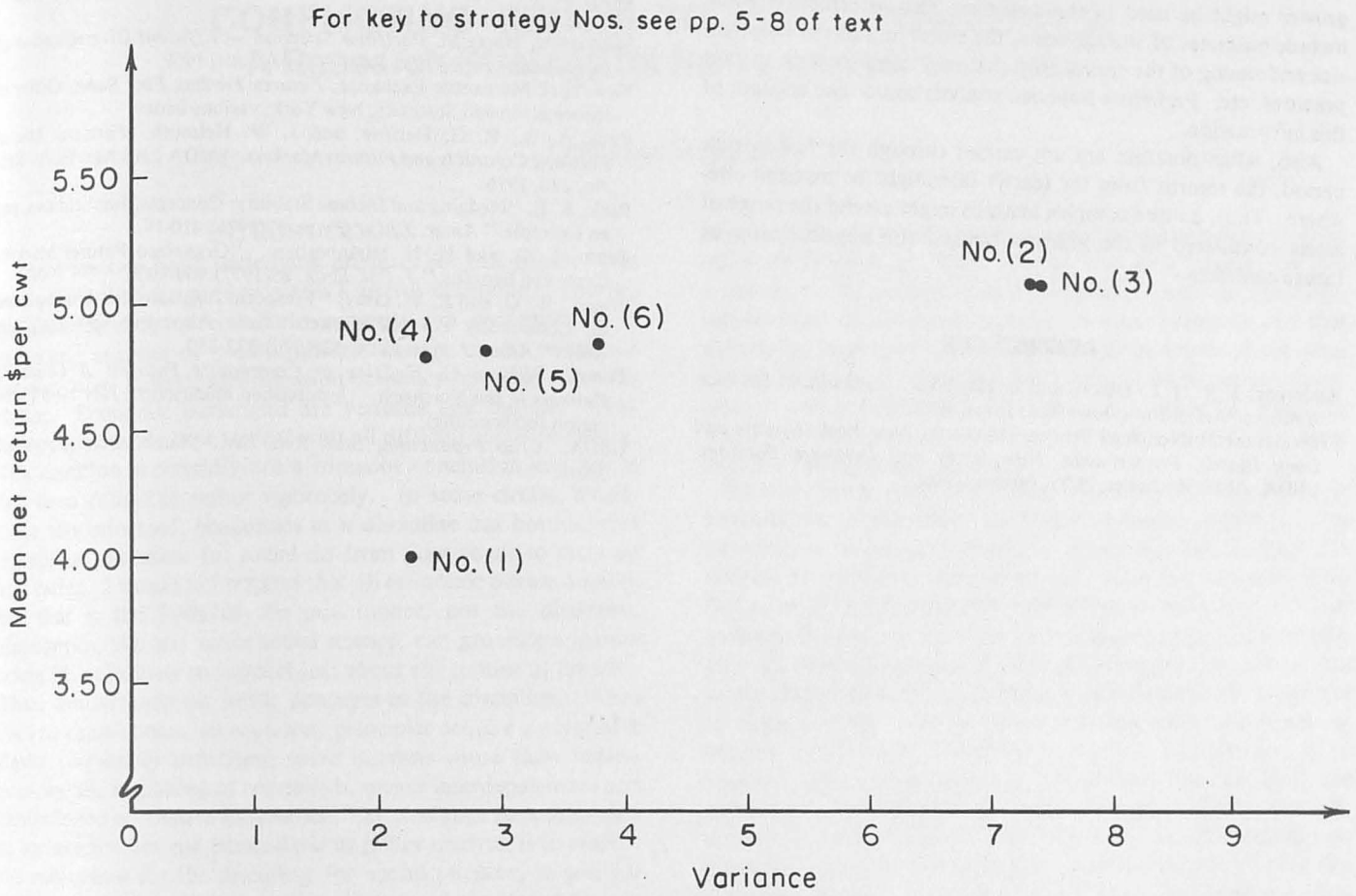

FIGURE 2.
Mean-Variance outcomes for selected marketing strategies 1967/8-1976/7.

(c) Routine hedging (alternative (4)) provides a mean return comparible to selective hedging (alternatives (5) and (6)) and with a slightly smaller risk.

(d) Storing the crop unhedged provides the greatest profit potential on the average because the effects of price increases in the storage period are not diluted by losses from hedging. Also, the decision rules for the selective hedging strategies resulted in the sale of potatoes at harvest in several instances where this proved to be an erroneous decision in light of subsequent price moves.

(e) For the selective hedges, as formulated here, there was little to choose between using the expected basis change and the price forecast as guides.

LIMITATIONS AND CONCLUSIONS

The generality of the results is probably limited by the rather rigidly defined alternatives used. A farmer would typically not market his entire crop at one point in time as is done in this study, nor would the farmer necessarily wait until October 31 to place hedges. The use of different assumptions and different decision rules would, no doubt, change the means and variances of returns from marketing potatoes.[7] But this does not mean that these different hedging strategies would necessarily have smaller average returns. Indeed a good manager may be able to place and lift hedges at more favorable prices than those considered here.

Another concern is that large means and variances for the unhedged storage alternatives are influenced by very large seasonal price increases in three of the 10 years (1972-73, 1973-74, and 1976-77). Nonetheless potato prices are extremely volatile, and similar price behavior could occur in the future.

Notwithstanding the limitations of the study, the results suggest that hedging can be useful even with a large basis risk. In comparison to selling the crop at harvest, storage with a routine hedge increased total returns about 60 cents per cwt. with essentially no change in the variance of returns. As indicated above, the increase in average returns from storing is almost twice as large without hedging, but this comes at the expense of a much larger variance of returns.

Another interesting conclusion is that the use of the expected change in basis as a guide to hedging performed as well as using a price forecasting model. This is an encouraging result in that potato farmers can make reasonable estimates of the change in the basis using historical data while price forecasting models would require more sophisticated analysis.

Obviously there is considerable scope for additional research. More realistic storage and hedging strategies need to be analyzed. Perhaps criteria other than the mean and variance of returns need to be used if the grower is more interested in avoiding loss than in stabilizing income.

Additional relevant information that may be available to the

7. Despite these limitations, subsequent work by Tomek is consistent with the results presented here. He uses a different rule for selecting the dates to place and lift hedges, but the mean-variance outcomes are reassuringly similar to the outcomes presented in this paper for strategies (1), (2), (4), and (5). Tomek did not develop results comparable to strategies (3) and (6).

grower might be used in the analysis. This information could include estimates of storage costs, the storability of the crop, the size and timing of the spring crop that may compete with storage potatoes, etc. Perhaps a Bayesian analysis could take account of this information.

Also, when potatoes are not carried through the full storage period, the returns from the (early) sale might be invested elsewhere. Thus, a more complex analysis might extend the range of assets considered in the analysis beyond the physical crop or future contracts.

REFERENCES

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

Federal-State Market News Service. *Marketing New York (Upstate and Long Island), Pennsylvania, New Jersey and Delaware Potatoes.* USDA, AMS, Rochester, N.Y., various issues.

Gray, R. W. "The Future Market for Maine Potatoes: An Appraisal." *Food Res. Inst. Stud.* 11(1972):313-41.

Markowitz, Harry M. *Portfolio Selection — Efficient Diversification of Investments.* New York: John Wiley & Sons, 1959.

New York Mercantile Exchange. *Futures Trading Fact Sheet.* Office of Information and Statistics, New York, various issues.

Paul, A. B., R. G. Heifner, and J. W. Helmuth. *Farmers' Use of Forward Contracts and Futures Markets.* USDA ERS Agr. Econ. Rep. No. 320, 1976.

Peck, A. E. "Hedging and Income Stability: Concepts, Implications, and an Example." *Amer. J. Agr. Econ.* 57(1975):410-19.

Telser, L. G. and H. N. Higinbotham. "Organized Futures Markets: Costs and Benefits." *J. Pol. Econ.* 85(1977):969-1000.

Tomek, W. G. and R. W. Gray. "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Role." *Amer. J. Agr. Econ.* 52(1970):372-380.

Tomek, William G. *Hedging in Commodity Futures: A Guide for Farmers in the Northeast.* Unpublished manuscript, July 1978 (publication forthcoming).

USDA. *Crop Production.* Stat. Rep. Ser., March, October, various years.