MEASURING THE EFFECT OF CAPITAL STRUCTURE AND SEASONALITY ON EXPECTED RETURNS AND RISK: THE FRESH MARKET VEGETABLE CASE

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Abstract

The effect of capital structure and seasonality of fresh market vegetables was examined via the Target MOTAD model. The level of capital indebtedness and the selection of either a fall or spring season resulted in significantly different levels of enterprise mixes, expected returns, risk magnitudes, rates of change of risk magnitudes, and operating capital requirements. The fall season demonstrated larger initial levels of risk and larger increases in the level of risk due to increases in indebtedness. The spring season showed larger increases in risk between the minimum risk point and the maximum expected return point (linear programming solution) on the risk-efficient frontier. Operating capital requirements were substantially higher for the fall season than for the spring season. The operating capital requirements of the spring season were significantly affected by the level of indebtedness and the magnitude of risk selected by the grower, while the larger operating capital requirements of the fall season were only marginally affected.

Key words: alternative enterprises, decision-making, debt, operating capital, season, Target MOTAD

Fresh market vegetables have experienced increases in both demand and supply during the last two decades. The increase in demand has resulted largely from rising consumer income, population growth, and the changes in consumer taste and preference for fresh vegetables. Likewise, the supply of fresh vegetables has increased primarily due to technological production advances in improved varieties, refined cultural and management techniques, pest and weed management strategies, enhanced mechanical inputs, and innovative irrigation systems and practices.

In sharp contrast with many other agricultural enterprises, the fresh vegetable industry has not suffered from record acreage increases and continued excess supplies. However, while fresh vegetable acreage has remained somewhat steady, total production has increased. Readily adoptable technological production advances during the last two decades increased vegetable yields per acre that resulted in the increased supply of vegetables.

Unfortunately, the economic conditions of many other agricultural enterprises have not been favorable during most of the 1980s. Excess supplies, inflation, and diminished export markets have placed severe financial hardships on many agricultural producers. These conditions have spurred a great deal of interest in alternative agricultural enterprises, such as fresh vegetables. Numerous scientific research and trade publications consider fresh vegetable enterprises to be "alternative enterprises" that may have profit potential (Authur; Babb; Belmont; Colette; Estes; McGill; Rathwell; Wolfshohl).

As a result of the recent economic hardships encountered by numerous farmers engaged in other, less profitable, agricultural enterprises and some expansion-minded vegetable growers, many vegetable growers have experienced or fear lower profit levels resulting from increased competition due to expanded vegetable production. Consequently, vegetable growers are keenly interested in examining factors that affect vegetable enterprise profit levels and risk.

This analysis was developed to measure the expected return and risk associated with three levels of indebtedness and three alternative production scenarios for fresh market vegetables. The basic objective of this study was to analyze the maximum expected return from the production of fresh vegetable enterprises subject to a given minimum level of risk identified with a predetermined target level of return. Emphasis was given to examining and comparing the risk-efficient frontiers for the spring, fall, and annual scenarios and for the three target return levels for each season. In addition, the operating

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capital requirements for various levels of risk associated with each season and target return level were explored.

PROCEDURE

A typical fresh vegetable farm located in the coastal production area around Charleston, South Carolina, that possesses the usual type of land, improvements to land, and machinery and equipment associated with fresh vegetable production was assumed for this study. The planning horizon was the next year. A firm-level approach was taken to determine the fresh vegetable enterprises and their production levels that would maximize expected return, subject to a minimum level of risk associated with a given target return for a vegetable operation. A Target MOTAD model was developed to examine the expected returns and risk encountered by fresh market vegetable growers producing commercial quantities for shipment (Tauer). Risk was measured as the sum of deviations below the target return divided by the number of years in the study period. Numerous agricultural production and marketing applications have been made employing this technique (McKinnell; Zimet; Zwingli).

The activities of the Target MOTAD model included the production of the following five fresh vegetable crops: cantaloupe, cucumber, bell pepper, snap bean, and tomato. These enterprises are a part of the focus of a Tri-State research and extension study for North Carolina, South Carolina, and Georgia to evaluate vegetable production alternatives (Belmont). It was assumed that each crop may be planted during both the spring and fall seasons. In addition, three planting dates for each season were evaluated for each vegetable crop. The planting dates, staggered one week apart, were identified by research and extension workers of the Tri-State vegetable project as periods of favorable production conditions and resulted in 30 possible production activities. The activities of the model describe the type of vegetable crop and week of planting. The weeks were numbered beginning with the first week of January denoted as week 1 and ending with week 52 as the last week of December. For example, the code abbreviation TOMPLT10 specified a tomato production activity planted during week 10.

Data

Vegetable enterprise budgets were obtained from the South Carolina Extension Service (Rathwell, Luke, and Cook). The variable costs of each vegetable enterprise were used in this study. They include vegetable growing costs, overhead costs, and harvesting and packing costs. The 1988 variable costs were deflated using the index of prices paid by producers.

In the absence of consistent and continuous production data, Tri-State research yield data were used in this study. These data from plot research were adjusted by university research and extension personnel to reflect typical yields that may be obtained in a field setting. Vegetable yields for the spring season were assumed to be 65 percent of those obtained from Charleston research plot yields in the Tri-State vegetable project. Fall vegetable yields were assumed to be 90 percent of the spring yield level, except for snap beans for which spring yields were 90 percent of the fall yield level.

Fresh market vegetable prices were obtained from average weekly *New York City Fresh Fruit and Vegetable Wholesale Market Prices* (USDA 1980-88 (a)). The average weekly vegetable market prices during 1980-1988 were adjusted for container size, less 15 percent of wholesale market price for handling fees (Mook), and transportation round-trip fleet costs per mile from Charleston (USDA 1980-1988 (b)).

Vegetable returns were estimated using the adjusted fresh vegetable market prices and adjusted Tri-State vegetable yields for the Charleston area. The returns for each vegetable crop were reduced by the variable costs of the vegetable crop to obtain returns above variable costs. The returns above variable costs for the nine years were used to calculate the expected return for each activity. These expected return estimates were the objective function values for the activities used in the Target MOTAD model.

The only constraint placed on the model was limiting fresh vegetable production to 100 acres. Kittiampon reported that economies of size for vegetable production are realized between 60 and 100 acres. Land use for each activity was considered for an entire year.[1] An operating capital row was included as an unconstrained resource. The operating capital resource row was included to monitor the

[1] The consideration of a double or multiple cropping activity was not included in this study. The success of multiple cropping in the study area has been mixed and this practice is not widely used. However, the adoption of such a practice should prove to offer the possibility for a reduction in risk and perhaps some reduction in production costs from shared uses of land, plastic mulch, irrigation systems, site preparation, dolomite, and other inputs.

level of its use by production scenario and by level of indebtedness.

The target return was formulated by summing the operator's wage and debt payment. The operator's wage reflects the opportunity costs associated with the operator's labor and management skills. Debt payment is based on the investment cost for land, improvements to land, and machinery and equipment required for a 100-acre vegetable operation. The investment cost was assumed to be $500,000. The level of debt was set using 30, 60, and 90 percent of investment cost for target 1, 2, and 3 return levels, respectively. The debt levels were financed over 15 years using an annual rate of interest of 12 percent. The operator's wage was assumed to be $50,000. The target return estimates were rounded to $75,000 for target 1, $95,000 for target 2, and $120,000 for target 3.

RESULTS

The expected return and risk estimates for the three target return levels of three seasonal production scenarios were calculated and resulted in nine risk-efficient frontiers. The expected return and expected absolute negative deviations below a predetermined target level of return (risk) determine a point on the risk-efficient frontier. A locus of such points traces out the risk-efficient frontier. The risk-efficient frontier defines the set of feasible management plans.

The first point on the risk-efficient frontier represents the minimum level of risk and the last point represents the maximum expected return (LP solution). The interior points on the risk-efficient frontier represent solutions for which the basis of the algorithm has changed.

Table 1. Vegetable Activities, Acres, Expected Return, Risk, and Operating Capital for the Spring Season Scenario, $120,000 Target Return

Item	Point A	Point B	Point C
		acres	
CANPLT10	66.09	0.00	0.00
CANPLT12	19.53	0.00	0.00
CUCPLT13	0.00	50.00	0.00
PEPPLT11	14.38	0.00	0.00
TOMPLT10	0.00	50.00	100.00
Total	100.00	100.00	100.00
Expected return ($)	117,887	136,150	143,800
Expected return Change ($)		18,263	7,650
Risk ($)	7,228	29,082	69,797
Risk change ($)		21,855	40,715
Operating capital ($)	92,351	127,640	705,756
Return-risk ratio[a]		0.84	0.19

[a]Return-risk ratio is the dollar value increase in expected return for each additional dollar of risk incurred between the relevant points.

The spring season scenario for target 3 (target return of $120,000) is reported in Table 1. Points A, B, and C represent expected return and risk points on the risk-efficient frontier, as shown in Figure 1. The vegetable activities selected at point A include CANPLT10, CANPLT12, and PEPPLT11, out of a possible 15 production activities. There may be other combinations of vegetable activities with which risk is minimized, but the three production activities reported for point A result in the maximum expected return for the minimum level of risk.

The expected return at point A does not equal or exceed the target return of $120,000. The expected returns of points B and C do exceed the target 3 level, but in addition, incur significantly higher levels of risk. Furthermore, between points, the return-risk ratio measurements of 0.84 and 0.19 indicated that the selection of progressive points would contribute less than a dollar of expected return for each additional dollar of risk. The strongly risk-averse vegetable grower with a target return of $120,000 would select point A. A less risk-averse grower may chose either point B or C. In addition, the level of operating capital dramatically increases as expected returns increase, i.e., from $92,351 for point A to $207,756 for point C.

The fall season scenario for target 3 is reported in Table 2. Points A, B, and C represent the expected return and risk points on the risk-efficient frontier, as shown in Figure 1. Out of a possible 15 production activities, the two fresh vegetable enterprises se-

Table 2. Vegetable Activities, Acres, Expected Return, Risk, and Operating Capital for the Fall Season Scenario, $120,000 Target Return

Item	Point A	Point B	Point C
		acres	
TOMPLT27	26.55	33.62	100.00
TOMPLT28	73.45	66.38	0.00
Total	100.00	100.00	100.00
Expected return ($)	99,277	102,603	133,800
Expected return Change ($)		3,326	31,197
Risk ($)	46,656	47,062	54,246
Risk change ($)		406	7,184
Operating capital ($)	205,558	205,558	205,558
Return-risk ratio[a]		8.19	4.34

[a]Return-risk ratio is the dollar value increase in expected return for each additional dollar of risk incurred between the relevant points.

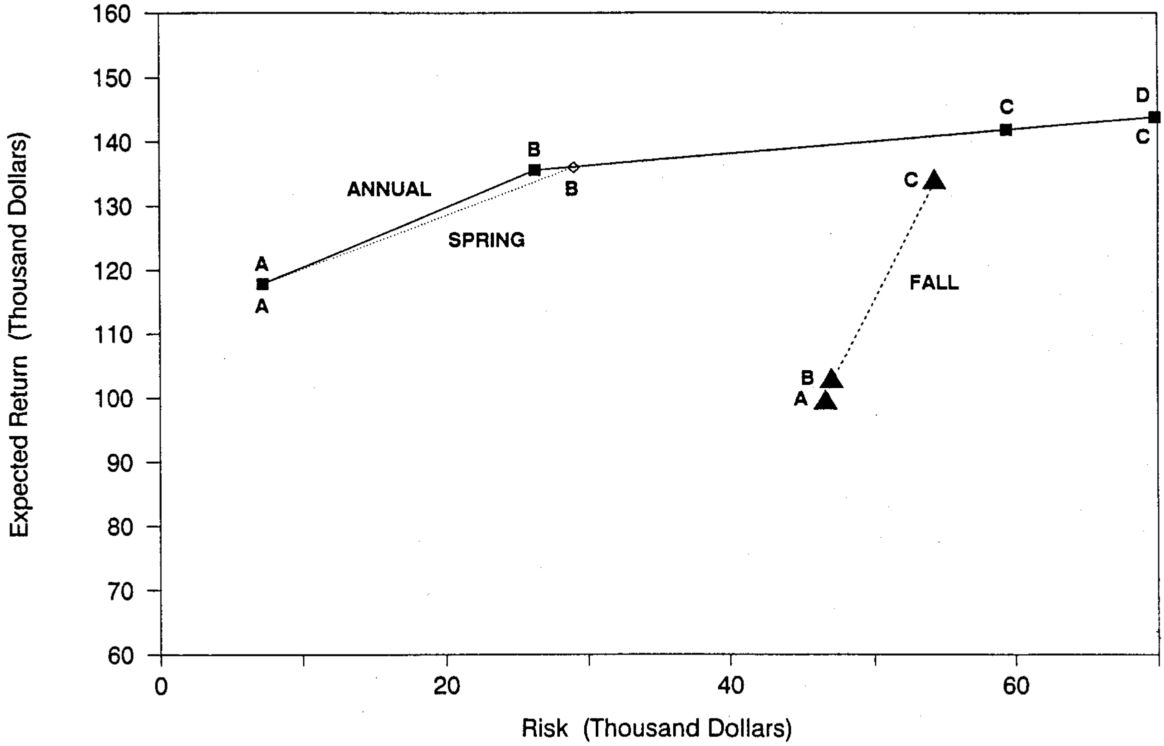

Figure 1. Return-Risk Seasonal Comparison Target 3

lected were TOMPLT27 and TOMPLT28. Points A and B included both of these vegetable production activities, but in each case, the largest acreage was allotted to the production of TOMPLT28. However, TOMPLT27 was the only vegetable production activity at point C.

The target 3 return level was attained only at point C. The expected return associated with point C was $133,800 and the expected risk $54,246. The return-risk ratio measurements of 8.19 and 4.34 indicate that the selection of progressive points would contribute greater than a dollar of expected return for each additional dollar of risk between the relevant points. The less risk-averse vegetable grower with a target of $120,000 would select point C. The level of operating capital was constant at $205,558.

The annual scenario for target 3 is reported in Table 3. Points A, B, C, and D represent the expected return

Table 3. Vegetable Activities, Acres, Expected Return, Risk, and Operating Capital for the Annual Scenario, $120,000 Target Return

Item	Point A	Point B	Point C	Point D
	acres			
CANPLT10	66.09	0.00	0.00	0.00
CANPLT12	19.53	0.00	0.00	0.00
CUCPLT13	0.00	45.39	0.00	0.00
PEPPLT11	14.38	0.00	0.00	0.00
TOMPLT10	0.00	42.89	81.25	100.00
TOMPLT27	0.00	11.72	18.75	0.00
Total	100.00	100.00	100.00	100.00
Expected return ($)	117,887	135,684	141,925	143,800
Expected return change ($)		17,797	6,241	1,875
Risk ($)	7,228	26,320	59,368	69,797
Risk change ($)		19,092	33,048	10,429
Operating capital ($)	92,351	143,769	207,344	207,756
Return-risk ratio[a]		0.93	0.19	0.18

and risk points on the risk-efficient frontier, as shown in Figure 1. Point A production activities, associated with the minimum level of risk for target 3, consisted of CANPLT10, CANPLT12, and PEPPLT11 out of a possible 30 production activities. Point B specified three production activities, CUCPLT13, TOMPLT10, and TOMPLT27. Point C included production activities of tomatoes only, TOMPLT10 and TOMPLT27. Point D, the maximum expected return for target 3, included the sole vegetable production activity of TOMPLT10.

The expected return at point A for target 3 does not exceed or equal the target return of $120,000. The expected returns for points B, C, and D do exceed the target 3 return level, but they also incur significantly higher levels of risk. Furthermore, the return-risk ratio measurements of 0.93, 0.19, and 0.18 indicate that the selection of progressive points would contribute less than a dollar of expected return for each additional dollar of risk. The strongly risk-averse vegetable grower would select point A production activities. Significant increases in the level of operating capital were required between points.

The return-risk target comparison is illustrated in Figure 2. The return-risk target comparison evaluates the risk-efficient frontiers of the three target levels for the spring and fall scenarios. The risk-efficient frontiers for targets 1, 2, and 3 of the spring scenario lie in descending order, indicating a lower level of utility for each successive target level, assuming the decision-maker is risk-averse. However, if the decision-maker exhibits the risk-preferring characteristic, the maximum level of utility will be attained at the point farthest from the origin. In general, risk-efficient frontiers shift slightly downward and to the right for progressively higher target levels (i.e. higher levels of indebtedness).

The risk-efficient frontiers for targets 1, 2, and 3 of the fall scenario lie in numerical order left to right. The shifts to the right are significantly larger in comparison to those associated with the spring scenario. A lower level of utility may be realized for each successive target return level, assuming the decision-maker is risk-averse. However, if the decision-maker exhibits the risk-preferring characteristic, the maximum level of utility will be attained at the point farthest from the origin.

The return-risk target comparison of the annual scenario was excluded in Figure 2 because the expected return and risk points identified were identical or in close proximity to those found in the spring scenario. If included, they would detract from the visual interpretation of the graph. In general, the annual scenario was quite similar to the spring scenario where risk-efficient frontiers shifted slightly to the right, implying larger levels of risk.

The levels of operating capital used for targets 1, 2, and 3 of the spring, fall, and annual scenarios,

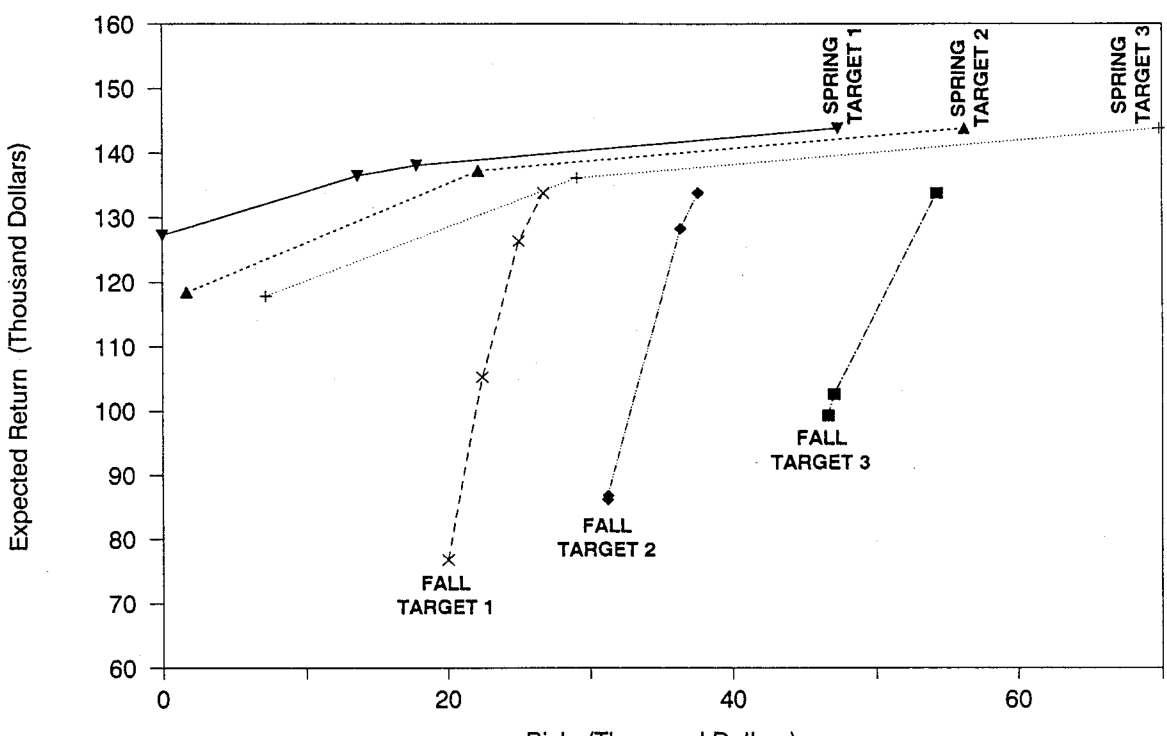

Figure 2. Return-Risk Target Comparison Spring vs. Fall

respectively, are illustrated in Figure 3. The different bar heights for a given season and target return level are associated with the points on the individual risk-efficient frontier. Hence, higher levels of risk resulted in larger operating capital requirements.

The spring and annual scenarios required similar levels of operating capital. Large increases in operating capital were required between risk-efficient points for all target return levels of the spring and annual scenarios except for the last two points of the target 3 annual scenario. The level of operating capital for the fall season scenario, however, was basically constant. The operating capital requirement for the minimum risk point associated with target 1 of the fall season was the only exception.

In general, higher levels of operating capital for a given target level were associated with higher levels of risk. Also, the minimum risk point of successive target return levels required more operating capital.

SUMMARY AND CONCLUSIONS

The fresh vegetable industry has enjoyed profitable market conditions during a period when most agricultural enterprises have experienced excess supplies or reduced demand resulting in depressed product market prices. Consequently, many agricultural entrepreneurs have attempted to enter or further expand into fresh vegetable enterprises. Hence, the volatility of fresh vegetable markets and prices in recent years has resulted in a planning environment that is increasingly uncertain.

Based on the results of this analysis, several conclusions may be drawn regarding production mix, season, target return level, and operating capital. These conclusions are firm-specific and should not be extended to other firms with differing resources, technology, markets, and debt.

The production mix of vegetable enterprises revealed that at the minimum levels of risk, more vegetable enterprises entered the optimal solution. Conversely, with higher levels of risk and expected return, fewer vegetable enterprises entered the optimal solution. Accordingly, production of only one vegetable enterprise resulted in the highest level of risk.

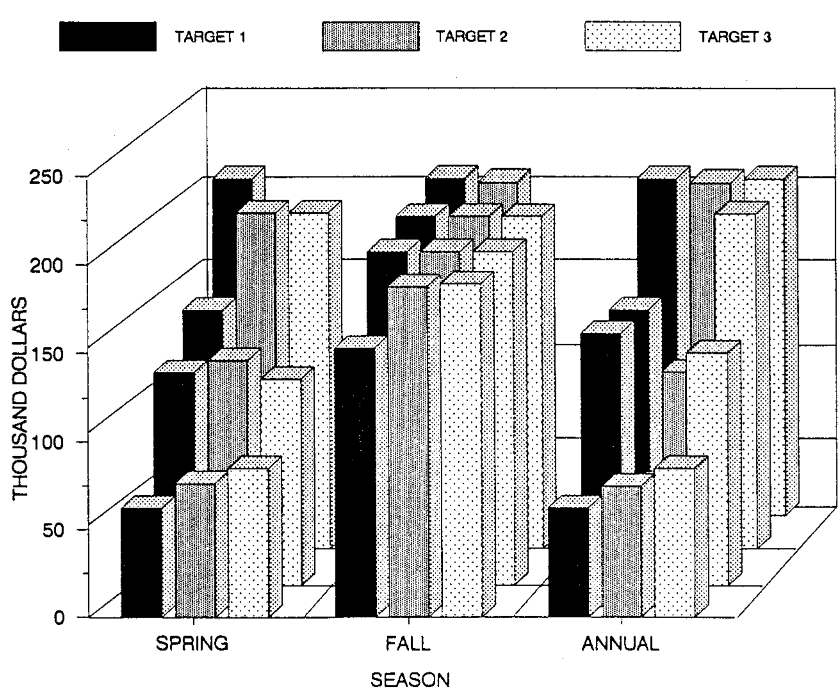

Figure 3. Operating Capital Requirements

The return-risk season comparison showed that the spring season resulted in larger values of expected return and smaller values of risk in comparison to the fall season for points at the minimum level of risk. The results of the annual scenario were identical to those of the spring scenario for the points of minimum risk and maximum expected return with only minor improvements of expected return over the spring season for the interior points on the risk-efficient frontier. A fall crop was selected but only for interior points with the annual scenario.

Many vegetable growers in the Charleston growing area were observed to produce over the entire range of the risk-efficient frontiers during the 1980s. This evidence suggests that either grower attitudes toward risk change over time or other factors, such as crop insurance, income taxes, and market conditions, affect the production mix decision.

The return-risk target comparison illustrated that large rightward shifts of risk-efficient frontiers occurred for the fall season due to the higher levels of risk associated with fall vegetable enterprises, while smaller shifts of the risk-efficient frontiers for the spring season were also observed. However, the spring season had larger increases in risk between the minimum risk point and the maximum expected return point (linear programming solution) on the risk-efficient frontier. The return-risk ratio for the spring scenario was consistently less than one for each target return level, while this measurement was always greater than one for the fall scenario. This implies that the less risk-averse vegetable grower during the fall period may move to successive points on the risk-efficient frontier and engage in fewer or only one production activity. Finally, higher levels of operating capital were associated with higher target return levels (increasing levels of debt) for the minimum risk points. In addition, higher levels of operating capital were generally associated with higher levels of risk for a given target return level.

Future research efforts should consider incorporating policy and crop insurance programs in the model. Specific attention should be given to the formulation of the target return level. In addition, the inclusion of financial instruments such as certificates of deposit and stock activities merit thorough investigation. With these and other refinements, additional detailed information can be provided at the firm level for more informed decision-making. Hopefully, this additional information will allow vegetable growers to make more efficient decisions.

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