The Propensity to Excess Capacity in the Lettuce Subsector

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Commercial lettuce, grown principally in the West, is produced continuously throughout the year but in different areas with growing periods of various lengths. These various growing periods are due to different seasonal climatological patterns among producing areas. Weekly lettuce shipments are generally dominated by a few growers or grower-shippers with large acreages. Shippers have control over 85 percent of all lettuce planted for some harvesting periods and 65 percent for others, through coordination arrangements with growers. Due to the perishable (non-storable) nature of lettuce, the amount harvested is the amount shipped to consumption centers.

The lettuce subsector appears to behave in a coercive (predatory) manner. This conduct is evident in the long periods of relatively low prices and the short periods of high lettuce prices experienced in the subsector. Lettuce prices are characterized by wide intraseasonal variation largely because of an increasing overlap of harvest periods among producing areas, production expansion to new areas, and weather conditions. The outcomes are the short-run surpluses or deficits experienced by the subsector. This market instability in turn causes farmer and shipper income instability. The lack of adequate information about lettuce acreage planted each week contributes to additional uncertainty regarding the decision growers and shippers make about lettuce acreage to be planted at a given time in a particular area. Inadequate information on acres planted, compounded with the uncertainty of weather patterns, becomes a major problem in attempting to decrease the magnitude of the potential yield commodity-supply cycles. Uniquely for this subsector, potential yield exceeds the actual amount harvested. Does this indicate a misallocation of resources? The lettuce subsector problem of concern here is to achieve increased supply and demand harmony through vertical coordination.

This paper presents the important parameters affecting lettuce subsector behavior, stipulates an appropriate simulation model, and examines policy alternatives to achieve improved subsector coordination with weather remaining given throughout the period of study. The 1967-1968 period was selected for analysis on the basis of its stable market structure. Due to the wide price variation experienced at the farm level, it was decided that a seasonal-weekly model would yield most meaningful behavioral results.

The seasonal-weekly model of the United States lettuce subsector is represented in the flow diagram, figure 1.

The model was based on lettuce subsector characteristics for which parameters were estimated and tested for their statistical significance. The model is shown below:

$$AC(i) = f\,(AC(i)_{t-1}; P(i)_{t-1})$$

$$Y(i) = f\,(P(i))$$

$$Q(i) = f\,(DI(i), M(i), P(i))^2$$

$$PR(i) = Y(i) \times AC(i)$$

$$P(i) = f\,(Q(i), PR(i))$$

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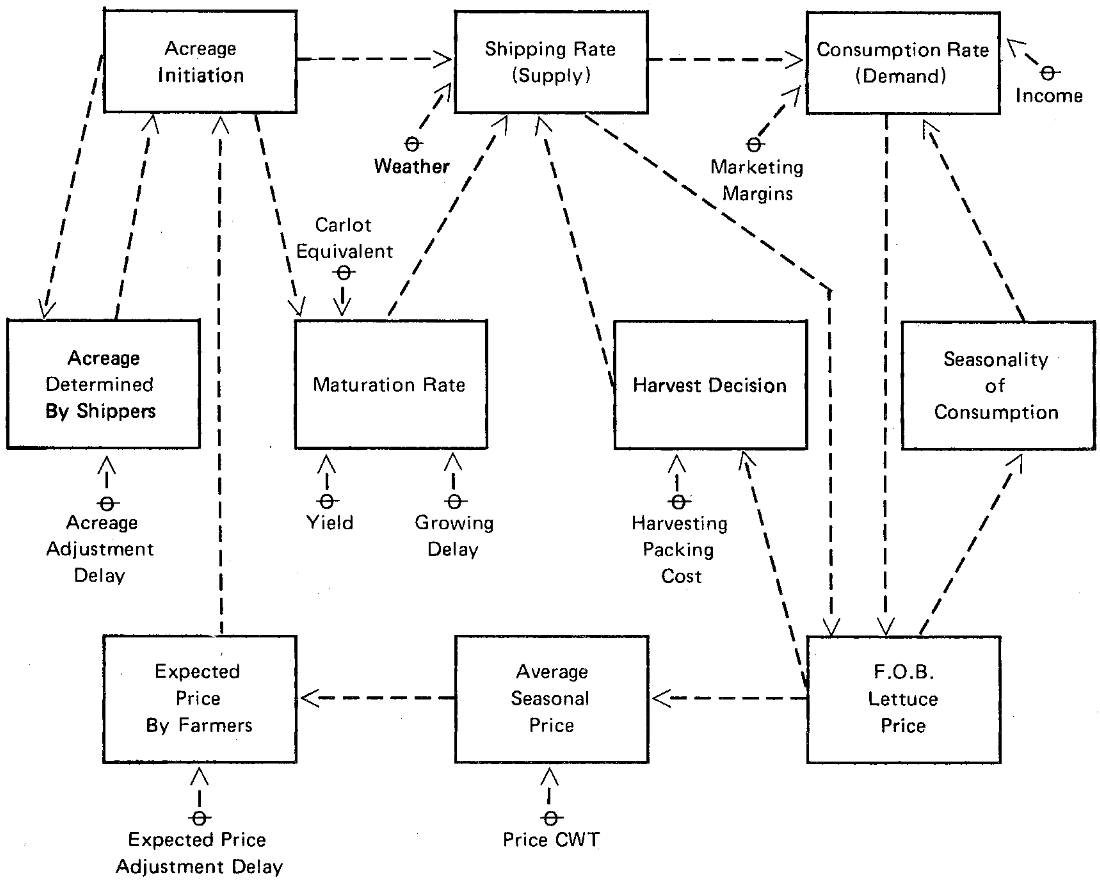
[1] The four seasonal demand functions were obtained from a previous study by Shelly. Disposable income and marketing margin were held constant for each season.

Fig. 1. Flow diagram of United States lettuce subsector



Where:

- AC(i) =seasonal lettuce acreage planted
- $AC(i)_{t-1}$ =seasonal lettuce acreage planted the previous year
- $P(i)_{t-1}$ =seasonal lettuce FOB price the previous year
- Y(i) =seasonal marketed yield
- P(i) =seasonal lettuce FOB price
- Q(i) =seasonal demand for lettuce
- DI(i) =seasonal consumer disposable income
- M(i) =seasonal marketing margin
- PR(i) =supply of lettuce
- i =w, s, su, f season; winter, spring, summer, and fall, respectively

The estimated results for the seasonal lettuce acreage planted and seasonal yield equations were based on seasonal data for the period 1960-74; the price equation is a seasonal-weekly price function based on weekly data for the period 1966-70.[2]

$$AC = 2802.2597 + 0.8535\ AC_{t-1} + 1140.6475\ P_{t-1}$$
(11.94)** (2.29)*
F = 73.08** R^2 = 71.94%

$$Yw = 127.1510 + 10.1179\ Pw$$
(3.17)* F = 10.06* R^2 = 43.62%

$$Ys = 116.8755\ Ps^{0.2617}$$
F = 9.54* R^2 = 42.32%

$$Ysu = 17.9437 + 87.8513\ Psu - 7.8900\ P^2su$$
(4.59)* (-4.01)*
F = 23.27** R^2 = 79.50%

$$Yf = 131.9377\ Pf^{0.1765}$$
(2.71)* F = 7.34* R^2 36.08%

$$P = 5.6820 - 0.00062\ Q - 0.00101\ PR$$
(-12.51)** (-6.84)**
F = 109.71** R^2 = 46.15%

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[2]Numbers in parentheses are t-values, * means 90% confidence level and ** means above 90% confidence level. Data used in the analyses were obtained from the four USDA source references.

The weekly simulation output is obtained by dividing the seasonal results by 13 (weeks in a season). These results are inputs into the price equation as weekly supply and demand; in turn, the weekly prices are used in the seasonal equations to complete the systems cycle.

The system simulation model is a translation of the mathematical model into a computer language using Industrial Dyamics as the methodology. Production initiation begins with the acres planted to lettuce. This decision is made on the basis of how many acres growers can forward contract with shippers, who in turn make their decisions based on past experience, and lettuce prices paid to farmers lagged one year. The initial lettuce acreage planted is slightly decreased prior to harvesting due to weather, insect, and disease factors.

The acres planted do not reach maturity all at one time, but the bulk matures at an average of 100 days (called a growing delay). Growing delays are affected by climatological conditions among and within producing areas. In the basic run of the model, growing delay was assumed constant.

The system simulation model incorporated the difference between potential and marketed yield with an average potential yield of 900 cartons per acre, and a marketed yield determined by economic factors at the time of harvest. Price at the time of harvest is the factor which affects the amount of lettuce to be shipped to the consumption centers. Marketed yields in the model have an upper limit set by the average potential yield and a lower limit of no harvesting resulting from lettuce prices below the variable costs of harvesting, packing, cooling, and selling. The shipping arrivals were assumed to have a one week delay for lettuce reaching the consumption centers.

The system simulation model was used to estimate 104 weekly periods. Adjustment delay to consumer's response to change in lettuce price was assumed to be non-existent. The weekly FOB lettuce price is determined by the interaction of total weekly lettuce shipments and weekly consumption rates. These prices are determined in the model by the continuous interaction of supply and demand at the shipper-retailer and retailer-consumer levels. The role of wholesalers is assumed to be insignificant, because direct retail store buying has increased in volume leaving only a small portion handled by terminal markets [Bohall:1].

Model Validation

The validity of the system simulation model was evaluated through sensitivity analyses and a comparison of the actual and generated data. These two elements of model validation were simultaneously considered to provide an overall test of the model validity.

The sensitivity analyses were designed, by varying growing delay, to detect logical errors in the system simulation model. Growing delay was not known with a high degree of confidence; the average growing time for lettuce is between 90 and 100 days and the limits are 70-150 days. Thus, the sensitivity analyses were performed by varying growing delay, using 13 weeks for the basic run, 10 and 18 weeks in subsequent runs for comparison.

The expected behavior of the lettuce subsector follows: Given that lettuce shippers have control over a large percent of the total lettuce acreage planted, a shorter growing time would tend to diminish barriers to entry and exit. There would be more frequent opportunity to enter or exit from the lettuce subsector. With a shorter growing delay, shippers and growers would be even more responsive to economic factors, resulting in greater week-to-week price variation within the overall price cycle. Given the apparent coercive (predatory) conduct among shippers, a decrease in barriers to entry will increase competition. As a result, simulated FOB lettuce prices, with a shorter growing delay, are expected to average higher than prices generated by the basic run. With a longer growing delay, the expected subsector behavior will increase barriers to entry and exit and consequently, decrease average FOB lettuce price, assuming present conduct continues.

By comparing the generated results of the simulation model basic run with the runs of 10 and 18 weeks growing delay, the model was found to behave in accordance with expected behavior of the lettuce subsector.

A comparison was conducted between results generated by the simulation model basic run and historical data (weekly FOB lettuce price and total U.S. shipments for the period 1967-1968) to determine the major turning point errors. The few major discrepancies between generated and historical data were partially due to climatological conditions and labor strikes which occurred during the period of study. The model generated a data series which followed the historical data pattern.

In a combined view of the two approaches to model validation, it can be said that the system simulation model generally follows the subsector dynamics considering that climatological factors were held constant in the model.

Policy Alternatives

Policy in the context of this paper refers to changes which could be introduced in the model's operating rules or its structure. Policies investigated dealt with altering lettuce supplies through restricting acreage planted. This might be achieved, for example, through grower or shipper group action.

Policy I was to restrict acreage planted by 20 percent throughout the year. The results show that shipments and FOB lettuce prices each maintain their respective pattern, as if no policy had been implemented. The existing potential to increase market yield is because there are indications that there exists a large percentage of unharvested lettuce production, making it possible to increase producer net revenues. Prices maintain the same pattern because total lettuce quantity marketed remains the same and acreage planted decreases, resulting in lower total costs. Thus, Policy I would increase net revenues to lettuce growers given that growing, harvesting, and climatological patterns remain unchanged.

Policy II was to restrict acreage planted for summer harvest by 20 percent. Lettuce FOB prices are lowest during summer months when the bulk of lettuce is available. As a result of Policy II, FOB lettuce prices for the summer season increased, smoothing out the seasonal cycles exhibited by FOB prices in the basic run. The price increases resulting from such a policy are much greater than the decrease in lettuce shipments, thus indicating an inelastic demand for summer lettuce. The results do not agree with some studies which indicate that price elasticity of demand for summer lettuce is elastic [McGlothlin; Shelly].[3] Total revenues received by lettuce growers increased as a result of the increase in price. Total cost decreased because of less acreage planted; thus, net revenues for producers increased.

[3]The price elasticity of demand for lettuce is -0.0245, calculated as an arc elasticity. The disagreement between the result of this study and previous ones is apparently due to the two year period of the data used in calculating this price elasticity; elasticities based on long-time series yield more elastic results than the elasticities based on shorter periods.

Conclusions

It is appropriate to try to draw conclusions concerning the stage of development reached in constructing the lettuce system simulation model. The model follows the dynamic behavior of the lettuce subsector. This is not to state that the model is complete. The model is an economic model which indicates the likely economic consequences of alternative policies in the context of the model's structure.

The model did not explain all of the variation observed in the historical data for shipment and FOB lettuce price as it does not include certain parameters such as weather which affect potential yield, marketed yield, and growing delays. As a consequence, the inclusion of weather in subsequent models might improve the simulator.

After analyzing the two alternative control policies, it was concluded that lettuce growers can increase their net revenues by restricting acreage devoted to lettuce and allowing marketed yield per acre to increase in view of the potential availability of lettuce now abandoned in the fields.

Lettuce planting information on a weekly basis would help the lettuce subsector to coordinate the acreage planted, to diminish harvest overlaps considering that lettuce growing delay varies among production areas and the season that lettuce is planted. By diminishing harvest overlaps, the production cycles and price variation could be decreased. These results, of course, assume that the excess capacity or abandoned production do not represent an allowance for weather risk involved in lettuce growing.

References

Bohall, Robert W., *Pricing Performance in Marketing Fresh Winter Lettuce,* Marketing Research Report No. 956, USDA, ARS, May 1972.

McGlothlin, R. S., *Price Relationship in the Western Lettuce Industry,* Arizona Agricultural Experiment Station Bulletin No. 287, Tucson, Arizona, 1957.

Shelly, William Vernon, "A Simulation-Equation Analysis of the United States Demand and Supply, 1949-1970," unpublished Master's thesis, New Mexico State University, Las Cruces, New Mexico, 1971.

United States Department of Agriculture, *Agricultural Statistics,* United States Printing Office, Washington, D.C., 1960-1974.

United States Department of Agriculture, Consumer and Marketing Service and Arizona Fruit and Vegetable Standardization Service, Bureau of Market News, *Marketing Central and Eastern Arizona Lettuce,* Phoenix, Arizona, 1965-1970.

United States Department of Agriculture, Fruit and Vegetable Division, Market News Branch and California Department of Agriculture Division of Marketing Services, Bureau of Market News, *Marketing Lettuce from Imperial Valley and Blythe Districts,* Sacramento, California, 1965-1970.

United States Department of Agriculture, Fruit and Vegetable Division, Market News Branch and California Department of Agriculture Division of Marketing Services, Bureau of Market News, *Marketing Lettuce from Salinas-Watsonville and other Central California Districts,* Sacramento, California, 1965-1970.