Estimating Relative Sales Potential of Tilapia in Supermarkets

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Abstract: An experimental pricing study using a Latin square design was conducted to determine the relative sales potential of fresh, pond-raised tilapia (*Tilapia aurea*) in supermarkets in north Alabama. Six prices ranging from $3.06/kg to $4.61/kg were tested in 6 supermarkets during a 6-week period in September and October 1980. The effect of price on average sales of the sample of stores was estimated by simple linear regression. Sales potential varied from 4.11 to .97 kg liveweight/1,000 customers over the price range, or approximately 617 to 146 kg/week for the 4 city study region. Retail prices which yielded maximum net revenue to the retailer and farmer were estimated to be $2.84/kg and $4.83/kg respectively.

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Tilapia are receiving some attention in the United States as a food product. Certain species having efficient filter-feeding mechanisms and tolerance of relatively poor water quality (Stickney et al. 1977), can yield as much as 4,500 kg/ha in monoculture ponds (Nerrie 1979) or can contribute an extra 30% to total yields from polyculture ponds with channel catfish as the principal species (Dunseth 1977). Acceptance of tilapia for culture in the U.S. is impeded by their inability to tolerate low water temperatures (typically be-

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low 10°-13° C), precocious spawning which reduces marketable yields, and lack of established markets for tilapia as a food fish.

There are several factors which favor the consideration of tilapia for culture in the United States. Intolerance of tilapia to low water temperatures may make them attractive in those states which prohibit the importation of such eurythermal nonnative species as the Chinese carps. Overwintering of tilapia in warm water discharged from power plants may alleviate problems in acquiring replacement stocks each year (Behrends et al. in press, Nelson et al. in press). Because they can reach maturity in 4 months, producing and maintaining separate populations of large adult broodstock is unnecessary. Generation time for genetic selection work also is shorter than for most cultured food fish. Problems of excessive recruitment may be resolved by using cage culture or by production of all-male stocks using either hybridization or sex-reversal techniques (Galbreath 1979, Behrends and Smitherman 1981).

The decision to produce tilapia or to develop any other new enterprise should be made primarily on the basis of an evaluation of market potential. However, this evaluation is seldom undertaken by prospective producers of aquaculture products because of lack of product with which to test market acceptance, time and expense, and perceived lack of cooperation from wholesalers and retailers. Evaluation of market potential is essential to determine efficient allocation of resources to production of a new product. Thus, the preliminary study reported here was conducted to determine sales potential at various prices in 1 type of market (supermarkets) in a given area under certain base level conditions (particularly with regard to promotional activities) which might reasonably be expected to confront the first producer of tilapia in the study region. This type of information should give a prospective producer an indication of whether or not supermarkets in the area represent a large enough market by themselves to justify production. If the minimum level of potential sales in this type of market alone is not adequate, then other markets and marketing strategies need to be evaluated.

Sales potential alone does not indicate profitability of the enterprise, but it does provide the appropriate estimate of quantity from which unit revenue and cost can be extrapolated to total revenue and total cost. Estimates of quantity are often based on production capacity rather than sales potential, and this can lead to serious misrepresentations of the feasibility of an enterprise.

Another reason for conducting an evaluation of sales potential is to ensure efficient allocation of production and marketing resources once the decision to produce has been made. Location and size of facilities, such as overwintering accommodations, hatchery and production ponds, processing plants, and storage and delivery systems, depend on estimates of the quantity which can be sold. Scheduling of operations, such as stocking, production, harvest, processing, and transportation, are based on the rate of sales expected. Promotional inputs are assigned either to advertising or to sales personnel de-

pending on the potential of each for improving sales. Finally, the method of evaluation described in this study can also be used effectively to establish consumer awareness of the product, assess consumer responsiveness to changes in price, improve the product, identify specific consumer segments and market outlets, and monitor in-store activities such as storage, packaging, and display.

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Previous Studies

There is a lack of published material on the marketing of aquaculture products in general and even less concerning tilapia. Technological development of culture systems is moving far ahead of the known market capacity to absorb potential production, thus creating a bottleneck in the development of the industry.

Preliminary market tests and consumer acceptance surveys of tilapia in the U.S. were conducted at Auburn University, Alabama (Crawford et al. 1978). Results showed that the form of the dressed product should be heads-off, since sales of heads-on tilapia were poor even though the price reflected the difference in dress-out percentage: $2.20/kg for heads-off versus $1.65/kg for heads-on. Also, in a telephone survey of tilapia buyers, 93% of the respondents preferred fresh fish to frozen fish. A substantial increase in sales was observed in the initial market study in the fall of 1976. In the fall of 1977, the demand was so high that the researchers were unable to achieve their objective of saturating demand at 2 supermarkets. Sales averaged about 18 kg/store/week in 1976 and increased to 79 kg/store/week in 1977. Retail prices for tilapia used in these studies were set by the stores themselves and ranged from $2.20 to $3.95/kg in 1976 and $2.84 to $3.06/kg in 1977.

Opportunities for market segmentation have been identified. A large proportion of tilapia buyers in the Auburn studies were black (43% to 57%) relative to their demographic representation in the area (23%). Also, tilapia buyers were heavy users of fish in general (67% bought fish at least twice per month) and preferred freshwater species to saltwater species (Crawford et al. 1978).

Galbreath and Barnes (1981) conducted a study of consumer preference for color and size of tilapia in supermarkets and found that consumers preferred gold-colored hybrid tilapia over the normal-colored tilapia (*Tilapia aurea*). Large tilapia (average liveweight = 0.35 kg) were preferred over small tilapia (average liveweight = 0.22 kg). However, premium prices com-

manded by gold and large tilapia do not appear to yield higher net revenues to the producer than can be achieved with normal-colored and smaller fish. The gold hybrid fingerling is more expensive to produce and exhibits higher mortality and slower growth than *T. aurea* (Behrends and Nelson 1982), and larger fish of either color incur higher costs in overwintering.

Since channel catfish (*Ictalurus punctatus*) are likely to be a major competing product for tilapia in supermarkets, market studies of catfish may provide some useful comparisons. In a study of farm-raised catfish in supermarkets in Little Rock, Arkansas, Pippin and Morrison (1975) found that sales to black customers were significantly greater than expected from their ratio in the population. They also noted that households with children under 12 years of age bought significantly less farm-raised catfish than did households with adult members only. They reported sales of 8.2 kg/1,000 customers at $2.84/kg and a frequency of 1 catfish buyer for every 128 store patrons.

Raulerson and Trotter (1973) conducted a study of farm-raised catfish in supermarkets in Atlanta, Georgia. At the then current retail price of $2.62/kg, they estimated sales to be about 5.9 kg/1,000 customers with 1 out of every 150 shoppers buying catfish at that price. The authors suggested that the market could be expanded if more consumers could be encouraged to try the product the first time and recommended further research in the areas of promotion and the nature of repeat business.

Procedure

Product

Tilapia used in the study were raised in cages anchored in ponds at the Agricultural Experiment Station, Auburn University, Auburn, Alabama. The fish had been fed commercial catfish feed either once or twice daily in an experiment designed to determine the effect of feeding frequency on feed conversion (Nathan Stone, Auburn University, pers. commun.). The species of tilapia used was *Tilapia aurea,* also known as the Blue Tilapia. Average size at harvest was 356 g.

The marketing study began in early September and continued until mid-October 1980. Each weekly harvest of tilapia was taken to a local processor to be dressed. The processing steps included electrocuting, scaling, deheading, gutting, brushing to remove the black peritoneal lining, and final washing. Scaling and gutting were done by hand; heads and pectoral fins were removed with a bandsaw. Dressout averaged 64%. Average dressed weight of the fish used in this study was 228 g. The fish were packed in ice and transported to the study area. The tilapia were packaged in overwrapped styrofoam traypacks with 2 to 4 fish in each traypack. Average weight of a traypack was about 600 g.

Distribution

Six grocery stores participated in the study. They were chosen from 4 cities in northwest Alabama—Florence, Muscle Shoals, Tuscumbia, and Sheffield. A stratified random sample was not used since some of the contacted stores declined to participate, and others could not provide a weekly customer count. However, the combined customer population from these 6 stores was believed to adequately represent a cross section of the general population of supermarket shoppers in the area. The stores were located in several areas including downtown, suburban, and mall locations and served customers from predominantly black, predominantly white, and mixed populations. Three stores could be classified as small (<5,000 customers/week), one as medium (5,000 to 10,000 customers/week), and two as large (>10,000 customers/week).

Fish were harvested and processed on Tuesdays, delivered on Wednesdays, and were available for sale Thursday mornings. The stores placed an appropriate amount of fish in their fresh meat cases and stored the remainder in their walk-in coolers. Fish left unsold from the previous week were removed with each new delivery so that shelf time never exceeded nine days. Periodic checks on quality were made throughout the week. Packages of fish which no longer had a fresh odor, good color, or firm texture were removed.

Advertising

Since the supply of tilapia was limited and demand unknown, advertising was minimized. A stockout at any store during the study would have required a missing value be assigned to that data point since consumers had to be able to buy as much fish as they desired at any given price. Also, stores were asked not to promote or merchandise tilapia any more than specified so as to equalize the effects of these variables among stores.

At the request of several meat market managers, the fish were introduced to shoppers by using a small poster (28 cm × 18 cm) placed at the head of the section of the meat case containing the fish. The poster boldly displayed the name "Tilapia", the price, and a brief description of the history and origin of tilapia. It also indicated that they were "farm-raised"—a significant promotional point in this area.

Although other names for the product have been suggested, including "African Perch," "St. Peter's Fish," "Southern Panfish," and "Kariba Bream," it was decided that potential problems in labeling (Miller 1980) would be avoided by using the original generic name from the outset of market development.

Price

Prices used in the study were $3.06, $3.51, $3.73, $3.95, $4.17, and $4.61/kg. Prices received for fresh tilapia (Crawford et al. 1978) and fresh

catfish were considered in establishing the price range. The lowest price was calculated to be the break-even price based on estimated costs of production (Galbreath 1979). The highest price was competitive with local prices for fresh, farm-raised channel catfish. The range of prices also included local prices for fresh, river-caught catfish.

Experimental Design

Sales of tilapia in the U.S. are relatively small in volume and restricted to areas in Florida, Colorado, Alabama, Idaho, and Oklahoma (Engle 1978). Records on sales volume and prices in these markets are unavailable. Without such secondary information, traditional approaches to estimating demand, such as time-series or cross-sectional studies, could not be used. Instead, a controlled pricing experiment using a Latin square design was devised (Raulerson and Trotter 1973).

The treatment variable was price, and the 2 independent variables subject to control were time ("weeks") and market characteristics ("stores"). The objective was to determine the relation between price and average quantity of tilapia sold in a sample of stores in the region.

Experimental units were arranged with stores as row variables, weeks as column variables, and prices as treatments (Table 1). The dependent variable was defined as "kg of fish sold/1,000 customers". It was necessary to divide the quantity sold by the weekly customer count to equalize the effect of

Table 1. Individual sales by store and week (first row, in kg/thousand customers) and prices (second row, in dollars/kg) and average sales for tilapia marketing study.

	Sales and price at store					
Week	A	B	C	D	E	F
1	1.41	2.86	5.44	6.93	1.68	3.38
	$4.61	$4.17	$3.73	$3.51	$3.95	$3.06
2	1.64	2.70	3.25	4.43[a]	1.23	1.47
	$3.51	$3.06	$4.61	$4.17	$3.73	$3.95
3	2.45	1.67	1.28	5.11	0.94	0.61
	$3.06	$3.73	$4.17	$3.95	$3.51	$4.61
4	1.44	0.43	3.37	4.76	0.54	2.07
	$3.95	$4.61	$3.06	$3.73	$4.17	$3.51
5	1.22	1.07	2.26	2.27	1.49	1.17
	$3.73	$3.51	$3.95	$4.61	$3.06	$4.17
6	0.65	1.96	1.51	4.49	0.48	1.57
	$4.17	$3.95	$3.51	$3.06	$4.61	$3.73
	Prices ($/kg)					
	$3.06	$3.51	$3.73	$3.95	$4.17	$4.61
Average sales	2.65	2.03	2.12	2.04	1.01[b]	1.22

[a] Missing value. Estimate in parentheses (Snedecor and Cochran 1967: 317–320).
[b] Due to missing value, this is an average of only 5 data points.

differences in customer populations among stores. Analysis of variance was used to test for significance of effects attributable to stores, weeks, or prices (Snedecor and Cochran 1967).

A survey of the general customer population at each store and the characteristics of the buyers of tilapia was not attempted. However, observations on in-store activities were made routinely, and meat market managers participating in the study were interviewed at the end of the 6-week period to get their impressions and opinions of the product and the study.

Results and Discussion

Pricing Experiment

A total of 464 kg of dressed tilapia was sold during the 6-week study. Combined customer counts for the 6 stores showed that about 41,500 shoppers had an opportunity to buy tilapia each week. Sales data from the pricing experiment are shown in Table 1. Sales are listed in units of kg/1,000 customers for each store in each week. Failure by 1 of the stores to display tilapia during the second week resulted in a missing value for that point. Sales ranged from 0.43 to 6.93 kg/1,000 customers. Average sales at each price were calculated as total weight sold in all stores divided by total customer count.

At any particular price there was considerable variation in sales between stores. This was anticipated in designing the experiment, and this source of variation, together with that of the time (weeks) variable, was partitioned separately from the price effect. This study was not concerned with causes of this variation, but there are several possibilities. Previous studies have shown that at supermarkets black customers are more likely to buy tilapia than are white customers (Crawford et al. 1978). If some supermarkets have a higher proportion of black customers than others, there is an obvious opportunity for market segmentation. Other criteria for segmenting supermarkets, such as average income of customers, average store sales, and sales of fresh seafood may have potential, but less is known about the influence of these factors, and the information is of a more proprietary nature.

Average sales/1,000 customers were highest in the first week of the study. This was probably the major contributor to the variation in sales over time. When asked about the reasons for the drop in sales, market managers attributed it to a "wearing-off" of the novelty of the product and to initial consumer reaction to fluctuating prices.

Analysis of variance for the price variable was subdivided into variation attributable to the effect of linear regression and to deviations from the linear effect. Of the 2, only linear regression was found to be significant, indicating no curvilinearity in the relationship.

The equation for the linear regression was $Q = 5.713 - 1.008\ P$ where

Q is quantity in kg (dressed weight)/1,000 customers and p is price, in dollars/kg. The coefficient of determination (r^2) was 0.78. The F value for the linear regression was significant at the 0.05 level.

Survey of Meat Market Managers

At the end of the study, most of the meat market managers said that if supplies continued to be available they would order about 23 kg of tilapia per week. Others said they would order as little as 9 kg/week and as much as 45 kg/week. Most of the store managers said they would price tilapia in the range of $3.51 to $3.73/kg. The other managers suggested prices from $3.73 to $4.17/kg. None of the managers reported unfavorable customer comments even though a few packages were returned due to spoilage.

A markup of 30% from wholesale to retail seemed to be standard among the stores for relatively perishable meat products. During the study, some stores periodically had catfish for sale at prices ranging from $3.28 to $4.39/kg for river catfish and $5.05 to $5.49/kg for farm-raised catfish. When river catfish were available, store managers said they could sell from 14 to 45 kg/week.

None of the managers responded favorably to the idea of a frozen tilapia product. They said this was primarily because their customers wanted a fresh product and that there was heavy competition for shelf space from other frozen foods.

Under conditions of the study which included minimal promotion, fluctuating price, and consistent supply, tilapia sales were at least as good as sales of river catfish, according to market managers. Customers and market managers commented favorably on product attributes, such as uniform size, regular supply, and perceived quality of farm-raised fish. Most managers believed that aggressive promotion of these qualities and a stable price would increase base level sales substantially.

Shelf Life

Deterioration in product quality occurred in some stores during the study. This was attributed to lack of familiarity in handling and storing fresh fish products rather than an inherently short shelf life. Records showed that the frequency of lower quality packages at the end of each week was consistently high for certain stores and nonexistent for others. This problem could be attributed to temperatures in meat lockers and display cases which, while adequate for other meats, were not maintained low enough to keep tilapia fresh for 7 days after delivery. This problem could be alleviated by making Wednesday or Thursday deliveries of only enough fish to sell through Saturday. Since grocery sales are low on Monday, Tuesday, and Wednesday, store managers suggested that sales lost on those days would be outweighed by advantages of improved product quality and consistency.

Estimation of Sales Potential

The regression equation may be used to estimate the total quantity which could be sold in the region at a given price. For example, if the average retail price is $4.39/kg, the average quantity which could be sold in supermarkets in the region would be about 1.3 kg/1,000 customers. In this study, an estimate of the number of customers in the area was derived by categorizing each supermarket as small, medium, or large and assuming that the number of customers/week for each category was about 3,000, 6,000, and 10,000, respectively. Thus, the total for 24 supermarkets in the region was estimated to be 150,000 customers/week. This figure multiplied by 1.3 kg/1,000 customers yielded an estimate of 195 kg (dressed)/week distributed among these supermarkets. These estimates would, of course, be different if a different price were used. For example, a price of $3.28/kg would correspond to a market potential of 361 kg (dressed)/week in the region.

Given the retail price, the farm price can be estimated from information on retail markup, wholesale markup, cost of processing, and dress-out percentage. For example, assume that retail price is $4.39/kg, retail markup is 30 percent, wholesale markup is 15 percent, processing cost is 64 cents/kg (dressed weight), and dress-out is 64 percent. The farm price would thus be $1.47/kg (liveweight). Therefore, if the farmer sells his tilapia for $1.47/kg, and the other assumptions hold, then he could expect to sell 195 kg/week of dressed tilapia or 305 kg/week liveweight through supermarkets in the region. Obviously, it is important to have reliable estimates of these other components used in calculating the farm price.

Optimum Prices

The relationship between price and quantity can be used to estimate price levels which give the highest net returns to the retailer and to the fish farmer (Table 2). The quantity demanded is calculated from the regression equation. Price elasticity, which measures the percentage change in quantity demanded resulting from a 1% change in price, is calculated from the formula: $\epsilon = bP/Q$, where b is the regression coefficient, and P and Q are the levels of price and quantity in question. Gross revenue is simply the quantity demanded multiplied by the price. Cost of goods sold was determined by dividing retail price by 1.3, i.e., retail price is marked up 30% over wholesale price. Net revenue is defined here as the difference between gross revenue and cost of goods sold. Since in this case costs are a constant percentage of gross revenue, net revenue is maximized at the same price as gross revenue. From Table 2, this occurs at about $2.84/kg. Higher or lower prices only reduce net revenue from the maximum of $1.86/1,000 customers. These figures are approximations since the regression equation only estimates aggregate relationships for stores in the area. Also, the estimated optimum price is not strictly within the range of prices examined in this study.

Table 2. Effect of retail price on quantity sold, total revenue, and net revenue at retail level.

Retail price ($/kg)	Quantity demanded[a] (kg dressed/ 1,000 customers)	Price elasticity	Gross store revenue[b]	Wholesale cost[b, c]	Net store revenue[b, d]
2.62[e]	3.07	−0.86	8.04	6.19	1.85
2.84[e]	2.85	−1.00	8.09	6.23	1.86
3.06	2.63	−1.17	8.05	6.19	1.86
3.28	2.41	−1.37	7.90	6.08	1.82
3.51	2.18	−1.62	7.65	5.89	1.76
3.73	1.95	−1.93	7.27	5.59	1.68
3.95	1.73	−2.30	6.83	5.26	1.57
4.17	1.51	−2.78	6.30	4.84	1.46
4.39	1.29	−3.43	5.66	4.36	1.30
4.61	1.07	−4.34	4.93	3.79	1.14
4.83[e]	0.85	−5.73	4.11	3.16	0.95

[a] Estimated with the regression equation: Quantity = 5.71 − 1.01 (Price).
[b] Units in dollars/thousand customers.
[c] Wholesale cost = $\frac{\text{retail price}}{1.3}$ × quantity demanded.
[d] Net revenue here represents only gross revenue less cost of goods sold. It does not account for other costs of retailing (which are assumed to be relatively constant in this range).
[e] These prices are outside of the range examined in the study but are included here for purposes of discussion.

Table 3 presents these associations at the farm level. Farm prices were calculated the same way as the example in the previous section. Note that farm prices and quantities are expressed as liveweight rather than as dressed weight. Cost of production ($1.23/kg) was calculated from enterprise budgets for tilapia cage culture (Galbreath 1979), assuming 10% inflation/year for 2 years. In this example, net farm revenue was maximized at a retail price of about $4.83/kg. Thus, the retailer and the fish farmer will conflict over the best price at which to sell tilapia. Clearly, the producer cannot afford to have his fish sold at a retail price of $2.84/kg since the equivalent farm price is below his cost of production. The retailer, however, would not be willing to forego nearly 45% of his potential gain to accommodate the producer. He might accept the producer's price if he had no other choice, but competition for shelf space from other products would probably force the producer to accept a lower price. Also, competition from other tilapia producers entering the market would decrease the price eventually. But early producers could probably command premium prices and above-normal profits for at least a short time. These profits serve an important function in that they compensate early producers for their efforts in developing new enterprises, such as tilapia culture.

Marketing Strategy

Under the conditions of this study, it is apparent that supermarkets in the region could not absorb a significant amount of production from even a

Table 3. Effect of retail price on quantity sold, total revenue, and net revenue at farm level.

Retail price ($/kg dressed)	Farm price[a] ($/kg liveweight)	Quantity demanded[b] (kg liveweight)	Gross farm revenue[c]	Cost of production[c, d]	Net farm revenue[c]
3.06	0.90	4.11	3.70	5.06	−1.36
3.28	0.99	3.77	3.73	4.64	−0.91
3.51	1.09	3.41	3.72	4.19	−0.47
3.73	1.19	3.05	3.63	3.75	−0.12
3.95	1.28	2.70	3.46	3.32	0.14
4.17	1.38	2.36	3.26	2.90	0.36
4.39	1.47	2.02	2.97	2.48	0.49
4.61	1.56	1.67	2.61	2.05	0.56
4.83[e]	1.66	1.33	2.21	1.64	0.57
5.05[e]	1.75	0.97	1.70	1.19	0.51

[a] Farm price = $\left[\frac{\text{retail price}}{1.3 \times 1.15}\right]$ 0.64 0.64.

[b] Estimated with the regression equation: Quantity = 5.71 − 1.01 (Price).

[c] Units in dollars/thousand customers.

[d] Cost of production (cage culture) = $1.23/kg liveweight (from Galbreath 1979, plus 2 years of inflation at 10%/yr).

[e] These prices are outside of the range examined in the study but are included here for purposes of discussion.

small operation during a harvest season characteristic of temperate climates (August to December). At $3.95/kg, the lowest price the producer could accept, about 8,100 kg liveweight could be sold to the 24 supermarkets in the region over a 5-month harvest period. This would be equivalent to only about 2 ha of production ponds.

These projections are not intended to discourage prospective producers but rather to direct attention to the necessity of considering other marketing strategies.

Other markets and marketing channels would certainly increase sales potential beyond that of supermarkets alone. Seafood brokers offer considerable opportunity for sales in metropolitan areas although increased costs of distribution would presumably increase the wholesale markup. Restaurants, cafeterias, and fish markets also have potential in both metropolitan and non-metropolitan areas.

Increased promotional efforts would increase sales over the "minimal level" established in the study. Some added costs, particularly advertising at the point-of-sale, might be borne by the retailer, while others, such as distribution of free samples or recipes, would be the responsibility of either the wholesaler or of the producer should he adopt the role of the wholesaler.

Fresh tilapia in the form sold in this study is not the only product which could be offered to consumers. While frozen tilapia was not recommended for supermarkets, this form may be desired by restaurants and institutional

customers. Different methods of processing, such as filleting or deboning, may attract other market segments.

Finally, lowering costs of production, processing, or distribution would lead to a lower retail price and greater sales. A combination of several of these options would probably be the optimum marketing strategy.

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