

**SUPPORT OF THE GROWTH OF THE U.S. RECIRCULATING AQUACULTURE  
INDUSTRY THROUGH ANALYSIS OF PROCESSING COSTS AND MARKET  
VIABILITY FOR VARIOUS TILAPIA PRODUCTS  
FY 2009**

Worldwide increases in population and standards of living, accompanied by a growing understanding of the health benefits of eating seafood, have resulted in a steadily increasing demand for fish. Unfortunately, it is widely agreed that the world's major fishing grounds have either reached or exceeded their natural limits for producing fish. Therefore, any increase in per capita seafood availability must come from aquacultured products, not the wild catch. The U.S. aquaculture industry has the knowledge and capability to increase domestic production through use of recirculating aquaculture systems, but economically-viable market forms and the potential consumer demand for value-added products are unknown.

The primary goal of this research was to support expansion of the U.S. recirculating aquaculture industry, specifically tilapia producers, by determining costs to process both fillets and other value-added products and estimating the value of those products in various markets. The three objectives were to:

- 1) Estimate the cost to fillet tilapia. Three avenues for filleting tilapia were explored: custom cutting by existing processing facilities; construction of a hand cutting facility specific to tilapia; and construction of an automated filleting line;
- 2) Investigate processing options for other value-added tilapia products, including hot smoked whole fish, smoked fish salads, dips, and ready-to-eat soups; and
- 3) Analyze the market potential of U.S. grown tilapia fillets and value-added tilapia products made from U.S. grown tilapia by interviewing representatives of major market sectors and survey seafood prices at different types of retail grocery outlets, yielding additional information on currently available products.

## **FINAL REPORT**

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**Supporting the Growth of the  
U.S. Recirculating Aquaculture Industry  
Through Analysis of Processing Costs and Market Viability  
for Various Tilapia Products**

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## **I. Issue Addressed**

Worldwide increases in population and standards of living, accompanied by a growing understanding of the health benefits of eating seafood, have resulted in a steadily increasing demand for fish. Unfortunately, it is widely agreed that the world's major fishing grounds have either reached or exceeded their natural limits for producing fish. Therefore, any increase in per capita seafood availability must come from aquacultured products, not the wild catch.

In 2006, aquaculture supplied approximately 36% of the worldwide demand for seafood. Approximately 90% of this production occurred in Asia, with China topping the list at 66% of total aquaculture production. Less than one percent of the world's aquaculture production occurred in the United States. This situation contributes significantly to the U.S. trade deficit; seafood is by far the largest category of foodstuffs imported into the U.S. (exceeding \$1 trillion in 2010). In addition, the quality and safety of foreign products is difficult to control. As demand for seafood increases in Asia, even the availability of these exports may become limited. To assure the continued supply of safe, healthy seafood for Americans, it is imperative that the U.S. develops its aquaculture industry.

Due to land, water, and environmental constraints, the only viable avenue for expansion of the U.S. aquaculture industry is through indoor, recirculating aquaculture systems. The technology for these systems has been developing in the U.S. for over 30 years, and is reaching maturity. Currently, there are approximately 40 commercial recirculating aquaculture operations in production in the U.S. The greatest barrier to expansion of the U.S. recirculating aquaculture industry is stiff competition with low-cost seafood imports.

The U.S. aquaculture industry has the knowledge and capability to increase domestic production through use of recirculating aquaculture systems, but economically-viable market forms and the potential consumer demand for value-added products are unknown. Existing recirculating aquaculture facilities currently rely on specialty or niche markets, where producers can command a high price. For example, U.S. tilapia producers currently rely on the live market for profitability. While these markets have made development of the industry possible, it is unlikely that they can support further industry expansion.

The goals of this project are threefold: to determine the facilities and associated costs required to fillet tilapia; investigate processing requirements and costs to generate value-added products from tilapia including hot smoked fish, smoked fish salads, dips, and ready-to-eat soups; and to define new markets for the processed products. The information gained in these three areas will serve industry, paving the way for expansion of the U.S. tilapia industry.

## II. Approach Taken to Address the Problem

The primary goal of this research was to support expansion of the U.S. recirculating aquaculture industry, specifically tilapia producers, by determining costs to process both fillets and other value-added products and estimating the value of those products in various markets.

The *first objective* was to estimate the cost to fillet tilapia. Three avenues for filleting tilapia were explored: custom cutting by existing processing facilities; construction of a hand cutting facility specific to tilapia; and construction of an automated filleting line.

The *second objective* was to investigate processing options for other value-added tilapia products, including hot smoked whole fish, smoked fish salads, dips, and ready-to-eat soups. The equipment required and associated costs of production were determined. As part of this project, five value-added products were developed and tested for acceptability by a taste panel.

The *third objective* was to analyze the market potential of U.S. grown tilapia fillets and value-added tilapia products made from U.S. grown tilapia by interviewing representatives of major market sectors: chain restaurants, white-tablecloth restaurants, institutional food service, and grocery stores. In addition, seafood prices were surveyed at different types of retail grocery outlets, yielding additional information on currently available products.

### III. Cooperators and Partners, work performed

#### A. Virginia Tech (VT)

1. **Dr. Lori Marsh**, Associate Professor of Food Science & Technology, assisted in conducting interviews to determine the existing capacity and cost of custom filleting of tilapia, and the market potential of tilapia fillets.
2. **Dr. George Flick**, Professor of Food Science & Technology, assisted in the design and costing of both tilapia filleting facilities presented in this document.
3. **Dr. Denise Mainville**, Assistant Professor, Agricultural & Applied Economics Department, designed the survey instrument used to evaluate the market potential of tilapia fillets, and helped to analyze survey results.
4. **Ms. Angela Correa**, Public Information Officer, Department of Food Science and Technology, assisted with market research, and completion of the final report.

#### B. Blue Ridge Aquaculture (BRA)

1. **Mr. Martin Gardner**, Marketing Director, assisted in conducting interviews and analyzing data to determine the market potential of tilapia fillets.
2. **Mr. Haze Harris**, assisted in development of our research plan and provided drawings for the hand filleting facility.

#### C. North Carolina State University (NCSU) Seafood Laboratory

1. **Mr. Hannon Fry**, President, Outer Banks Fisheries, Inc. worked with the NCSU Seafood Laboratory to investigate processing options for value-added products made from tilapia.
2. **Mr. Barry Nash**, Seafood Technology & Marketing Specialist, and **Ms. Joyce Taylor**, Consumer Education Spec., North Carolina Sea Grant, helped to develop and test products, and determine equipment and labor costs.
3. **Dr. David Green**, Professor and Extension Specialist, Department of Food, Bioprocessing and Nutrition Sciences, helped to develop and test products and estimate equipment and labor costs.

#### D. Virginia Department of Agriculture and Consumer Services (VDACS)

1. **Mr. T. Robins Buck**, Project Manager, assisted in product testing of value-added products through the Virginia Food and Beverage Exposition, held in Richmond, Virginia.

## IV. Summary of Results

### **A. Objective One. Determine the cost to fillet tilapia at existing facilities, existing capacity for filleting, and projected costs of equipping and staffing a new facility for hand-cutting or automated cutting of fillets**

#### 1. Determination of the current capacity and cost of custom filleting of tilapia in the Mid-Atlantic region of the United States

Prior to designing a tilapia filleting facility, an attempt was made to identify custom cutters operating in the Mid-Atlantic United States. To accomplish this, Cooperative Extension Specialists in North Carolina, Maryland, and Virginia with expertise in the seafood industry were contacted. Each provided a list of custom cutters in their state. Every company identified was interviewed by phone. The results of the phone interviews are shown in Table 1.

Many of the companies interviewed indicated that they were not interested in filleting tilapia. Several of the companies stated that they did not have experience cutting tilapia and were unwilling to estimate a cost without a trial, using fish of a representative size. Two custom cutting firms indicated that they would be willing to increase their cutting volume to meet a guaranteed demand. The least expensive price quoted was \$1.56 per pound of fillet, excluding packaging. This quote was received in the fall of 2009 and would most likely be higher today. It is difficult to compare the various prices quoted (some include packaging while others do not, one could only produce a skin-on fillet, and one company provided an estimate of labor costs only). Prices quoted per pound of fillet packaged in bulk ranged from a high of \$3.90 to a low of \$2.16/lb.

The script that was used for the interview is included in Appendix A.

Table 1. Custom fish cutters in the Mid-Atlantic Region<sup>1</sup>

<b>Location</b>	<b>Capacity (Live weight)</b>	<b>Estimated Cost (\$/lb)</b>	<b>Comments</b>
VA - 1	Could gear up as needed using H2 Visa workers	\$2.40/lb fillet, including packaging	Currently purchase gutted tilapia from FL for \$0.80/lb and sell to a food chain in NC
VA - 2	Currently full	Does not believe it would be cost effective to cut tilapia	Believes labor costs too high to compete with

<sup>1</sup> This table is not intended to be inclusive of all fish cutters in the region, but rather a representative sampling.

			imported fillets
VA - 3	Currently 500-1000 lbs live wt per day	\$1 to \$1.25/lb Live Wt cut and packaged. Note: at 32% yield = \$3.125-\$3.90/lb fillet wt	Willing to increase cutting capacity for guaranteed product stream
VA - 4	1000 lb/wk	\$0.50/lb live wt or \$1.56/lb fillet (32% yield). Additional cost to package	Willing to increase cutting capacity for guaranteed product stream
VA - 5	5000 lb/wk	\$0.69/lb live wt to cut and package in bulk; \$2.16/fillet @ 32% yield	Doubt concept is feasible. Said 70% of the tilapia they sell is frozen and inexpensive
NC - 1	5,000-7,000lbs/wk	Not equipped to skin fish; could scale and fillet for \$0.50/lb dressed weight into a fresh bulk pack	
NC - 2	0. Regulations prevent them from having tilapia in their facility		
NC - 3	0		Not interested in cutting tilapia
MD - 1	0		Only cut HACCP certified fish. Not interested in cutting tilapia.
MD - 2	0		Only cut summer flounder. No interest in tilapia.
MD - 3	25,000 to 35,000 lbs/wk	No experience cutting tilapia; unwilling to estimate cost to cut	
MD - 4	500 lbs/day	No experience cutting tilapia; unwilling to estimate cost to cut	Noted that labor cost is \$10/hr
DC -1 (Profish*)	10,000 lbs/wk	\$1.41/lb fillet weight LABOR COST ONLY	Cost of labor is \$19.33/hr including benefits

\*Profish conducted a cutting trial on behalf of Blue Ridge Aquaculture (BRA). BRA shipped them 1000 lbs of live tilapia. Using six skilled cutters, it took 3 hours and 55 minutes to cut the fish, which resulted in 320 lbs of skinless, boneless fillets - a 32% yield. This translates into a labor cost of \$1.41/lb of fillet based on their labor rate of \$19.33/hr. This figure does not include any costs beyond labor.

## 2. Processing Tilapia to produce a skinless, boneless fillet

While some capacity exists for tilapia growers to have their fish custom cut, large-scale growers or a cooperative of growers may wish to establish their own cutting facilities. This section outlines the facilities needed to cut tilapia. Two arrangements are considered. The first relies on hand labor to cut the fish, while the second uses automated equipment. The volume of fish cut dictates which option is most attractive.

For this study, the cost per pound of tilapia fillet produced was calculated for both a hand-cut and an automated facility. In both cases, it was assumed that the fish were owned by the processing facility, and that no cost was ascribed to the whole fish. Also, it was assumed that costs associated with bookkeeping at the processing facility were handled by the fish production facility, and that no accountant was needed at the processing facility.

### ***Facility for hand cutting***

Appendix B shows a layout for a filleting facility based on hand labor. This design includes a receiving area where fish are bled, an area for cutting and packing, a cold storage area for finished product, and a freezer for storing fish offal prior to disposal. In addition, there are rest room facilities, a break room for employees, and office space for the facilities manager. The facility shown covers 3,360 ft<sup>2</sup>.

With the exception of office, restrooms, and break room, all areas must be constructed of materials that are easily cleaned to prevent bacterial growth. Cement floors should slope towards a center trough drain in each room. Walls and ceilings should be constructed of a smooth, scrubbable material. Sinks for employee hand washing must be readily available in both the cutting room and the bleeding room. Other considerations include adequate area for a forklift to deliver product in and out of the storage areas, and a shipping/cargo door through which fish can be received and fillets can be shipped.

This facility is designed to receive whole tilapia in batches of up to 1,000 lbs. Fish will be bled by cutting the gills and expiring them in a chilled bleeding tank. This operation is generally accepted to produce a high quality product because it removes the blood that could produce off-flavors. Once the fish have expired, they are weighed and delivered to the cutting room in small batches. The cutting room provides stations

for eight cutters. Each cutter is responsible for the entire filleting process, including skinning and removing pin-bones.

After cutting, fillets are weighed, inspected, and brought down to temperature in a fillet chill tank. Fillets are packed in 10lb lots and placed in waxed cardboard boxes, on ice. The boxes should be stored no more than four days before shipping.

To calculate the cost to produce a fillet from a whole fish, many assumptions are required.

The following assumptions were used to estimate the cost to hand cut tilapia:

- Labor costs and cutting capacity: Labor is expected to be the largest contributing expense to the cost of filleting. The salary required to maintain a skilled workforce will vary from location to location. Also, as with most tasks, a cutter's ability (speed and yield efficiency) increases with practice. Starting workers on an hourly wage during a training phase and then moving to an incentive pay scale, where the employee is paid as a function of both the rate at which fish are cut and the resulting yield should help develop a skilled and motivated workforce capable of a high level of performance. It is anticipated that an experienced and motivated cutter can process 1.25 lbs of tilapia (whole weight) per minute while achieving a 30% yield (a fillet weight that is 30% of the whole fish weight). Assuming an 8-hour workday and 50 minutes of work/hour, this corresponds to 500 lbs live weight per cutter per day. Based on a 30% yield, the resulting fillet weight would be 150 lb per cutter per day. These conditions (cutting rate 1.25 lb/min at an efficiency of 0.30 lb fillet/lb whole fish) are considered the median or baseline conditions for this analysis.
- Number of employees. Eight cutters are required for the cutting operation. Three additional employees are responsible for receiving and bleeding fish, packaging fillets, and cleaning the facility.
- Compensation rate for employees. The median or baseline compensation rate was set at \$13/hr for trained cutters and \$12/hr for the other three employees. The "high" labor rate was set at \$15/hour for cutters and \$13/hr for the other employees. The "low" labor rate was set at \$10/hr for cutters and \$8/hr for the additional labor. All employees at all labor rates were assumed to receive a benefits package equaling 24% of their wage.
- The operating schedule is assumed to be 8 hours/day, 5 days a week, plus a 2-hour cleaning each day. This would correspond to processing one million pounds of tilapia (whole weight) per year assuming a cutting rate of 1.25 lb whole fish/min. If the cutting rate is reduced to 1lb/minute, the facility would handle 800,000 lbs of tilapia per year. At a cutting rate of 1.5 lbs/minute, 1,200,000 lbs tilapia could be processed annually.

- Estimated equipment costs. The required equipment for the facility and the associated costs are presented in Table 2.
- Building cost for this analysis was assumed to be \$250,000 (\$74.40/sq ft).
- Useful life was assumed to be 20 years for both building and equipment.
- Financing cost for both building and equipment is 5% annually.
- Utility costs were assumed to be \$500/month for electric; \$500/mo for water and sewer, and \$100/mo for phone.
- Insurance costs were assumed to be \$6000/year for general liability and \$6000/year for workman’s compensation)
- Property taxes \$1000/yr
- Waste disposal, consisting of offal pick up by a rendering service once a week were estimated at \$300/mo.
- Packing costs. Fillets will be packaged in 10 lb boxes, which are assumed to cost \$2.50 per box. This is the only cost that fluctuated depending on the number of fish cut per day (determined by the cutting rate).
- Cleaning and miscellaneous supplies are estimated at \$400/month.

*Table 2. Anticipated equipment costs for a hand-cutting fillet facility*

<b>Item</b>	<b>Number required</b>	<b>Cost (\$)</b>
Ice Machine, Flake 2,000 #	1	9,800.00
Freezer Room 10’x12’	1	7,500.00
Cold Storage Room 16’x19’	1	5,025.00
Cutting Tables, 72’’x30’’	6	1,800.00
Three Bay Sink w/ Sideboards	1	900.00
Two Bay Sink w/o Sideboards	1	500.00
Pre-rinse Faucets	6	800.00
Hand Sink	1	450.00
Receiving Tanks	3	2,000.00
Bleeding Tanks	3	2,000.00
Knife Sharpener	1	825.00
Scales	2	800.00
Pallet Jack	2	600.00
Additional equipment		2,000.00
Other Supplies		1,000.00
Computer	1	1,500.00
Handling Bins	20	100.00
Trolleys	4	800.00
Bug Killers	2	200.00
<b>TOTAL</b>		<b>38,600.00</b>

While all assumptions regarding input costs will affect the calculated cost to produce a fillet, the analysis is most sensitive to three variables: labor costs, the rate at which fish are cut (lbs of whole fish/min) and the cutting efficiency (lbs of fillet/lb of whole fish). To characterize the sensitivity of cost to these three variables, a baseline case was calculated (based on median labor costs, cutting rate and cutting efficiency, Table 3) and then the analysis was repeated for all possible combinations (high, medium and low) of the three variables (Table 4). Cutting rates of 1.00, 1.25, and 1.50 lbs/hr and fillet yield efficiencies of 0.28, 0.30, and 0.32 lb fillet/lb whole fish were considered. It was assumed that these variables only affect the cost of production in terms of packing costs, and that no other costs are affected by the number of pounds of fillets produced. Cutting efficiency and cutting rate affect the cost to produce a fillet because these factors directly affect the number of fillets produced, spreading the cost of production over a varying number of fillets. The monthly production costs assuming the “average” labor costs, a cutting rate of 1.25lbs whole fish/min and a cutting efficiency of 30% are shown in Table 3. With these assumptions, the filleting costs are \$1.62/lb. It should be noted that this does not include the cost of the fish - it represents the cost to cut a tilapia to produce a boneless, skinless fillet.

*Table 3. Baseline monthly production costs for tilapia fillets, assuming a cutting rate of 1.25 lb/min and a yield efficiency of 0.30 lb fillet per lb whole fish*

<b>Cost Item</b>	<b>Monthly Cost</b>
Labor--8 cutters @ 13/hr	\$17,333.00
Fringe on cutters	\$4,160.00
Labor--3 additional @ 12/hr	\$6,000.00
Fringe on additional labor	\$1,440.00
<b>Total Labor + Fringe</b>	<b>\$28,933.00</b>
packing costs	\$6,250.00
cleaning/misc supplies	\$400.00
<b>Total Cost of Labor + Goods</b>	<b>\$35,583.00</b>
Loan payment principal	\$1,202.50
Loan payment interest	\$1,202.50
Utilities	\$1,100.00
Insurance	\$1,000.00
Waste disposal	\$300.00
Property taxes	\$83.33
<b>Total Overhead</b>	<b>\$4,888.33</b>
<b>TOTAL MONTHLY COSTS</b>	<b>\$40,471.00</b>
<b>Monthly Production (lbs fillet)</b>	<b>25,000.00</b>
<b>Cutting Cost/lb fillet</b>	<b>\$1.62</b>

Table 4 presents the cost to cut a tilapia fillet assuming various labor rates, cutting rates and cutting efficiencies. The cost ranges from a low of \$1.09 for the lowest labor and highest cutting rate and efficiency to \$2.30 for the highest labor rate and lowest cutting rate and efficiency. Clearly these factors have a large influence on fillet costs.

*Table 4. Cost per pound of fillet produced for various yields (28, 30, 32%), cutting rates (1, 1.25, 1.5 lb/min) and labor rates (high, medium, low).*

Fillet Production (lbs/mo)	Yield (%)	Cutting Rate (lb/min)	Cost/lb Fillet for 3 Labor Rates		
			High	Medium	Low
18,667	28	1.00	\$2.30	\$2.08	\$1.68
20,000	30	1.00	\$2.16	\$1.96	\$1.59
21,333	32	1.00	\$2.04	\$1.85	\$1.51
23,333	28	1.25	\$1.89	\$1.72	\$1.40
25,000	30	1.25	\$1.78	\$1.62	\$1.32
26,667	32	1.25	\$1.68	\$1.53	\$1.25
28,000	28	1.50	\$1.61	\$1.47	\$1.21
30,000	30	1.50	\$1.52	\$1.39	\$1.14
32,000	32	1.50	\$1.44	\$1.32	\$1.09

#### ***Facility for automated cutting***

The hand-cutting facility described in this report is sized to handle approximately one million pounds of whole tilapia annually, assuming a cutting rate of 1.25 lb whole fish/min and operation of one, eight-hour shift, five days a week. Annual production could be doubled by operating two shifts. An automated cutting line, by comparison, processes a much larger quantity of fish. In general, because of the high cost of equipment, an automated facility must be operated more than a hand-cut facility in order to distribute equipment costs across a larger volume of finished product.

Pisces Fish Machinery, Inc (Wells, MN, USA) manufactures an automated tilapia processing line. An analysis was conducted to estimate the cost to cut tilapia fillets using Pisces equipment. Pisces is not the only manufacturer of filleting equipment and this analysis is not intended to serve as an endorsement of their equipment. Pisces equipment was chosen for example purposes only to provide an estimate of the cost to fillet with automated equipment.

The Pisces Fish Machinery processing line considered consists of the following:

- 1) receive/chill/stun tank
- 2) weigh-in platform
- 3) feed table to collect and store fish after weigh-in
- 4) bleed/cut machine
- 5) infeed chute from bleed/cut machine to dry bleed system

- 6) dry bleed system
- 7) collection hopper/feed conveyor for collection of product and delivery into the scaler
- 8) drum scaling machine
- 9) drop bottom holding hopper
- 10) scale basket
- 11) collection hopper/outfeed conveyor
- 12) Heading and filleting system
- 13) intermediate storage table
- 14) skinning machine
- 15) twenty station trim system
- 16) chill/wash system
- 17) fillet takeaway conveyor
- 18) fillet auto feeder
- 19) electronic grading system
- 20) six station packing system
- 21) vacuum system

A schematic of this equipment line is shown in Appendix C. More information on Pisces Fish Machinery, Inc. equipment can be found on the company website at [www.pisces-ind.com](http://www.pisces-ind.com).

The price for the 21 pieces of equipment listed (quoted January, 2011) is \$635,500. The floor space occupied by the machinery and worktables for pin bone removal and packing is roughly 120' by 46'. Additional space would be required for refrigerating finished product, holding offal, restrooms, break rooms, and office space.

The following assumptions were made for this analysis:

- Equipment costs: \$635,500 for the cutting and packaging line plus \$20,000 for an ice machine, \$15,000 for two freezer rooms (10' x 12' each), and \$10,000 for two cold storage rooms for product for a total equipment cost of \$680,500.
- Production capacity: The line is operated 24-hours a day, six days a week, fifty weeks a year. The line is designed to handle 40 fish per minute and it is assumed that tilapia are harvested at 1.5 lbs each. With a down time of 40 min per eight-hour shift, the facility capacity is 15,940,000 lbs/yr of whole fish. Assuming a yield of 32%, this represents 5,100,800 lbs of fillet/yr.
- Labor requirements: For each eight-hour shift, twenty people are required to remove pin bones from the fillets. An additional seven employees are required to operate the line and six employees are required for packing finished product. The machinery is cleaned once a day after the two shifts (20 hours filleting, 4 hours cleaning/day).

Two full-time positions are needed for the daily cleaning. One additional position is assumed to manage the entire operation.

- Compensation rate for employees. As in the hand-cut analysis, three different labor-rate scenarios are considered. For the average pay rate scenario, cutters, line employees, cleaners, and packers are compensated at \$13/hr and the facility manager receives \$40,000/yr. For the high rate, hourly employees receive \$15/hr and the manager receives \$50,000/yr. For the low rate, hourly employees receive \$12/hr and the manager receives \$30,000/yr. All employees receive a benefits package of 24% of wages.
- Building cost for this analysis was assumed to be \$750,000 (7,500 sq ft @ \$100/sq ft).
- Useful life was assumed to be 20 years for the building and seven years for the equipment.
- Maintenance costs were assumed to be 5% of equipment purchase cost per year (\$31,780/yr).
- Financing cost for both building and equipment is 5% annually.
- Utility costs were assumed to be \$3000/month for electric; \$3000/mo for water and sewer, and \$100/mo for phone.
- Insurance costs were assumed to be \$10,000/year for general liability and \$35,000/year for workman's compensation.
- Property taxes \$2000/yr.
- Waste disposal, consisting of offal pick up by a rendering service once a day, \$24,000/yr.
- Packing costs. As in the hand-cutting analysis, fillets will be packed into boxes in 10 lb lots. Box cost is assumed at \$2.50 each. This corresponds to a cost of \$106,267/mo for boxes.
- Cleaning and miscellaneous supplies are estimated at \$30,000/yr.

Table 5 presents the results of the cost analysis.

*Table 5. Cost to produce a tilapia fillet for the medium labor cost assumption described above, using an automated processing line.*

<b>Cost Item</b>	<b>Monthly Cost</b>
56 employees/day @ \$13/hr	\$145,600
fringe	\$34,944
manager (\$40,000/yr)	\$3,333
fringe on manager	\$800
<b>Total Labor + Fringe</b>	<b>\$184,677</b>
packing costs	\$106,256
cleaning/misc supplies	\$2,500
<b>Total Cost of Goods</b>	<b>\$293,433</b>
Loan payment, principal on building	\$3,125
Loan payment, interest on building	\$3,125
Loan payment, principal on equipment	\$8,102
Loan payment, interest on equipment	\$2,836
utilities	\$6,100
insurance	\$3,750
maintenance	\$2,835
waste disposal	\$2,000
property taxes	\$167
<b>Total Overhead</b>	<b>\$32,040</b>
Total Monthly Costs	\$325,473
Total Monthly Production lbs fillet/mo	425,023
<b>Cutting cost/lb fillet</b>	<b>\$0.77</b>

Repeating the cost analysis, but assuming the high and low labor costs described in the section on hand cutting facilities, resulted in a cost per pound of fillet produced of \$0.83 and \$0.73. As was the case with hand cutting, labor costs represent a much greater expense than overhead costs (\$293,433 versus \$32,040). However, the cost per pound of fillet produced with an automated cutting system is not as sensitive to changes in labor cost (\$0.84/lb with “high” labor costs and \$0.73/lb with “low” labor costs) as it is with a hand cutting line (\$1.78/lb with “high” labor and \$1.32/lb with “low” labor with other variables at baseline conditions).

***B. Objective Two. Investigate value-added processing options for tilapia in the high-end retail and wholesale foodservice markets; determine equipment requirements and related costs to product value-added products***

1. Background

To investigate potential value-added products made using domestic tilapia fillets, personnel from Outer Banks Fisheries, LLC, working cooperatively with Virginia Tech and North Carolina State University, referenced more than twenty years of experience in the manufacture of smoked fish products. The goal of objective two was to determine the manufacturing costs associated with production of hot smoked tilapia fillets and further processed smoked tilapia salads, dips, and spreads. A cost analysis was performed based on product formulations, manufacturing steps, and break-even point sales. Prototype value-added products were evaluated for their sensory attributes, and samples were provided for use in demonstrations to determine consumer acceptability.

NC State University provided access to the Meats Processing Pilot Plant (Raleigh, NC), equipped with commercial-scale smoking and vacuum-packaging equipment. NC State University Seafood Laboratory (Morehead City, NC) provided access to the Seafood Products Test Kitchen and Pilot Processing Plant equipped with walk-in cooler and freezer storage. Smoked tilapia was manufactured in Raleigh and value-added smoked tilapia products were manufactured in Morehead City for sensory evaluation and market survey analysis.

Blue Ridge Aquaculture (Martinsville, VA) provided fresh tilapia. The whole fish were filleted at Southern Foods (Greensboro, NC) and hot-smoked, vacuum-packed and frozen in the Meats Processing Pilot Plant at NC State University. The smoked fillets were used in a series of three product development sessions in the Seafood Processing Laboratory at Morehead City, NC. These sessions resulted in the development of several value-added smoked tilapia salads, dips, and spreads. Selected prototypes were provided to Virginia Tech for use in taste tests and market surveys conducted in conjunction with the Virginia Food and Beverage Expo in Richmond, Virginia.

2. Smoked tilapia production

Skin-on fillets (114.5 lbs) were placed in a brine solution comprised of 167 lbs water, 73 lbs ice, 10 lbs salt, 5 lbs sugar, and 2 lbs lemon juice. The brine temperature was approximately 32°F and was mechanically agitated for 30 minutes to allow salt and sugar to dissolve completely. The fresh fillets were placed in the brine solution and allowed to marinate for 12.5 hours at 37°F. The

brined fillets were removed from the brine, rinsed with fresh tap water, and placed on racks for smoking.

The smoked fish process schedule had three stages: 25 minutes at 120°F, 0% humidity and damper open; 45 minutes at 145°F, 0% humidity, damper shut; and finally 175°F, until the thickest fillets reached an internal temperature of 145°F and remained at 145°F for 30 minutes. The full smoking process cycle was 3 hours, 22 minutes.

The smoked tilapia fillets (77 lbs) were cooled, vacuum-packed, and frozen prior to transport to the NC State University Seafood Laboratory. The finished smoked fish yields were 67%.

### 3. Value-added product development

Smoked fillets were skinned and flaked for use in smoked tilapia salads and spreads; yields were 73-74%. The flaked smoked fish was used in several recipes provided by the Nutrition Leaders Group at the Seafood Laboratory and Outer Banks Fisheries, which had been commercially developed for use with smoked salmon.

The smoked fish spread was prepared in approximately 8 lb batches according to the following formulation on a percent weight basis. Cream cheese (41.65), smoked fish (27.77), mayonnaise (27.77) lemon juice (1.52), spice blend (0.92), chives (0.15), black pepper (0.12), and potassium sorbate (0.1).

The spicy smoked fish spread was prepared in approximately 8 lb batches according to the following formulation on a percent weight basis. Cream cheese (36.0), smoked fish (24.0), mayonnaise (24.0), pasteurized imitation cheddar cheese (12.0), lemon juice (1.32), chopped onion (1.48), spice blend (0.78), cayenne pepper (0.18), chives (0.13), and potassium sorbate (0.1).

Smoked fish spreads were packed in plastic containers with snap on lids and held on ice. Samples were allowed to mature overnight before taste test runs. Samples were provided to Virginia Tech. The recipes used are provided in Appendix E.

The prototypes were used in market research at the Virginia specialty trade show, at Virginia Tech, and at the NC State University Seafood Laboratory. Products received good reviews and potential consumers showed interest in purchasing smoked tilapia products if they became available, depending on price in relation to similar processed food items on the market at the grocery store or specialty retailer.

#### 4. Determine equipment requirements and related costs

##### ***Gather cost numbers on equipment, packaging, labor costs for smoked fish.***

Basic processing equipment required for hot-smoking of tilapia includes weighing scales, brine tanks, drying racks, a smoking kiln, smoke trucks, a smoke generator, smoke sticks, Teflon screen overlays, a vacuum-packing machine, refrigerated and frozen storage, and various expendable supplies and ingredients. Appendix E shows a sample diagram of a fish smoking and processing facility.

The hot smoked fish processed in the Meats Processing Pilot Plant was smoked using an Enviro-Pack oven with two truck capacity and an in-line configuration. The estimated costs to set up the Enviro-Pack smoking oven with accessories is \$80,000 based on figures provided by NC State University. Detailed information, can be found at <http://www.enviro-pak.com/>.

Another equipment manufacturer that has provided smokehouse equipment and accessories for Outer Banks Fisheries in the past is Friedrich Metal Products Inc. in Greensboro, NC. The company custom builds smoking kilns according to customer needs. Based on a continuous batch production model, a double-chamber smoking kiln was recommended in order to process 4-6 production runs at 300 pounds of smoked tilapia each per 8-10 hour work day. Estimated equipment costs, including accessories total \$120,000. More information can be found at <http://www.friedrichproducts.com/smokehouse.htm>.

There are also a number of international firms who supply fish processing equipment including fish smoking kilns. Others of interest are AFOD Ltd. (<http://www.afogroup.com/food/index.htm>) in England and Traust Know How Ltd. (<http://www.traust.is/solutions/smoking-plants>) in Iceland.

A number of suppliers like Koch Equipment (<http://www.kochequipment.com/>) offer double-chamber vacuum-packing machines that allow for packaging of smoked fillets. The double chamber units handle small and large packaged fish. Other suppliers include Gem Pack (<http://www.gemppack.org/>) and TechnoPACK (<http://www.technopackcorp.com/>). Costs range from \$6,000 to \$20,000.

Other related costs include labor and cleaning supplies needed to process fish into value-added smoked products. These costs are estimated at 2 full-time employees and 1 part-time cleaning crewmember per production day. Estimated costs are \$50-\$60 per hour for a 10-hour production day.

##### ***Compare actual and projected costs of production of smoked tilapia fillets.***

The actual cost of processing smoked tilapia fillets depends greatly on the fillet price paid by the processor. For our cost analyses, we assumed a cost of \$5.50/lb

for a skin-on fillet. This is based on a cost to produce whole fish of \$1.25/lb live weight, a cost to fillet of \$1.62/lb, and a fillet yield of 32%.

In projecting costs for the smoked tilapia spreads, we used the yield data determined in this study. At 33% loss during smoking and 25% loss in skinning, the yield of smoked tilapia meat was 50% of the fresh fillet, effectively doubling the price, from \$5.50 per pound to \$11.00 per pound when using skin-on fresh fillets. Adding costs for labor, ingredients, and packaging drives the price per pound still higher. We conservatively estimated the price to produce a smoked tilapia spread at \$13.00 per pound, equal to \$0.81 per ounce. This estimate is \$0.23 per ounce over the breakeven point determined from current products in retail distribution. Therefore, the actual and projected costs do not favor making further processed smoked tilapia products from fresh fillets with skin-on and bone-in. Production costs from skinless, boneless fillets would be greater.

***Compile prepared product costs to determine break-even point for processing.***

A survey of prices at three local foodservice distributors was conducted to determine the average retail prices in the market at high end retailers. Prices for boneless, smoked salmon fillets ranged from \$5-8 per 4 ounces (\$4.99, \$5.49 \$7.99 in 4 ounce containers), to \$9.99 for an 8 ounce container. Prices for a smoked salmon and cheese spread were \$3.50 for 7 ounces and \$5.99 for 6 ounces. A smoked whitefish salad was priced at \$4.99 for 6 ounces and a smoked salmon pate was priced at \$6.99 for 6 ounces.

The average price for all commercial products surveyed in the market was \$1.16 per ounce. Generally retail prices are expected to be two times the wholesale price making the break point in processing smoked tilapia products to be \$0.58 per ounce.

## 5. Conclusions

Hot smoked tilapia loins were featured at the 2011 Seafood Prix d'Elite new products competition in Brussels, Belgium. The product is boneless, deep-skinned, mild in flavor, and high in protein. Smoked tilapia has a mild, sweet taste and a firm, flaky texture. The products can be smoked and marinated with different flavors, including curry, pepper, and honey. According to the manufacturers, smoked tilapia is very rich in protein and low in calories, total fat, saturated fat, and carbohydrates. The information gathered here on the manufacture of value-added products from smoked tilapia will be beneficial as price of producing tilapia fillets declines, and manufacture of smoked tilapia meat increases.

The brining process used for this study should serve as an example only. Brining time, strength of solution, temperature, brine-to-fish ratio, fish thickness, texture,

fat content, quality, and fish species all affect the needed water phase salt concentration. Also, variables within the smoking process, which include drying time, input/output air temperature, humidity, air velocity; smoke density, and drier load also impact water phase salt content. Packaging also affects the final product. For example, if an aerobic packaging material is used (an oxygen transmission rate of 10,000 cc oxygen/m<sup>2</sup> at standard temperature and pressure), a water phase salt content of 2.5% or greater can be used. If an anaerobic packaging material is employed instead, the water phase salt content must be no lower than 3.5%. In some permitted fish species, a water phase salt content of 3% and not less than 100 ppm nitrite can be used.

Design of a processing facility should include sufficient space for smoking and value-added processing, in order to diversify the product forms beyond fresh whole fish, and filleted products (fresh and/or frozen). The merits of tilapia are strong, and further work to inform consumers on the value, flavor, texture, versatility, and nutritional benefits of tilapia would be a worthwhile endeavor.

The primary outcome of this project is the finding that the cost of production of boneless fillets makes smoked fillets and value-added products based on smoked tilapia cost prohibitive at the present time, at least using the current parameters.

Based on this price point data and commercial experience, we suggest that smoking whole tilapia (gutted) for sale in ethnic markets and processing whole (gutted) smoked tilapia through a meat recovery operation (deboning machine) for recovery of smoked tilapia mince may provide a feasible alternative in the manufacture of value-added smoked tilapia products such as dips and spreads. Details of this process would have to be determined through further research.

### ***C. Objective Three. Surveys to determine potential market for a U.S. grown tilapia fillet***

#### **1. Interviews with representatives from different market sectors**

A survey was conducted to gather information from various market sectors regarding their demand for tilapia. The goal was to understand what the various market outlets prefer, and the requirements and potential for U.S. tilapia producers to meet that demand. The sectors interviewed included:

- 1) Chain restaurants;
- 2) White tablecloth restaurants;
- 3) Institutional food services including a seafood distributor and dining services at both a large state-supported educational institution and a public school system within a large city; and

4) Retail and specialty shops, including an independent grocery specializing in local/health foods; a large chain grocery that includes an up-scale seafood department; a cooperative grocery store specializing in locally produced foods, where members receive a discount; and the U.S. Commissary System, which sells groceries to military families at bases throughout the world.

The survey (Appendix F) was designed to capture the following information from each of the four market sectors interviewed:

- 1) Forms of tilapia currently being sold;
- 2) Interest in expanding tilapia sales;
- 3) Attributes/characteristics of the fillet considered important and the associated value of each of these characteristics;
- 4) If there were market forms besides fillets of interest;
- 5) Requirements the vendor has of the supplier of tilapia products;
- 6) Perceived benefit (if any) of fish reared in recirculating systems over pond production;
- 7) Price they would be willing to pay for the various products;
- 8) Company's procurement process;
- 9) Any value-added products (spreads, salads, dips) that they see a market for.

In all cases but one, interviews were conducted face-to-face. A researcher from Virginia Tech, accompanied by the marketing representative from Blue Ridge Aquaculture, conducted the interviews. The interviewees did not have access to the survey prior to the meeting. In general, meetings lasted about one hour. Answers were recorded by hand, then transcribed within 24 hours by the Virginia Tech researcher, and checked for accuracy by the marketing specialist. The following summarizes the lessons learned from each sector.

### **Chain restaurants**

Chain restaurants generally aim to provide their products at a high volume and at the lowest possible cost. Chain restaurants, by definition, operate numerous outlets that are all consistent in terms of menu, atmosphere and quality attributes. Cooks at chain restaurants have little to no authority to select their menu items; decisions are typically made by the top administration so that changes are reflected in all outlets. Customers of chain restaurants are normally price conscious, desiring to obtain the best possible price and value while dining at the chain.

The first person interviewed representing chain restaurants owns ten family style seafood restaurants, all located within two states in the mid-Atlantic region. His company also sources fish for distribution to U.S. Foods service. In this role, he

was able to give us some sense of the enormity of this market and a sense of what the chain restaurant market is looking for in a tilapia product. His survey answers were echoed by the other respondent in this sector.

In his restaurants he handles only frozen fillets. He said demand for tilapia has increased significantly in the past decade, due primarily to the low price. He believes people want an inexpensive, mild fish. He indicated that his restaurants sold 80,000 lbs of tilapia in the first quarter of 2010. He mentioned one large chain of buffet-style restaurants (with almost 500 locations in 40+ states) that consumes approximately five million pounds of frozen fillets each year. He added that the Asian wholesaler that he purchases from brings roughly 60 containers (80,000 lbs each) into Los Angeles each month.

When asked about the attributes he and his customers consider important, the response was that the concerns/desires of the firm and its customers were the same - they want a fresh, wholesome product with no surprises, at a low cost. The customer trusts the restaurant to deliver a high-quality product. Beyond that, they are looking for low cost. Occasionally a customer will inquire about the source of a fish, but not often. Basically, the restaurants do not educate the customer regarding any of the attributes of the products, with the exception of an occasional special on a local product. The goal of the restaurant is to promote seafood that is in season and locally produced, and hence they will occasionally run a special on these products; however, price is the primary driver. In the case of a special, the origin of the product would be included on the menu as part of the description of the entree. He said 75% of the patrons on a given day will typically order the special if it is at a good price. When asked if a patron would pay a premium for a local product, or one with other "special" attributes (such as "aquacultured without fishmeal feed" or "containing omega-3's"), he indicated that they would not, primarily because they were not being informed of the attribute and hence would have no reason to want to pay a premium. He did not believe his customers came to a restaurant to be educated about their food.

The second interview within the chain restaurant sector was conducted with a seafood buyer for a large, national restaurant chain that has several different restaurants within its network, including steak houses and seafood restaurants. The seafood buyer indicated that they currently offer tilapia fillets on their menu, from both frozen and fresh fillets. She declined to provide either current volume sold or the number of suppliers they use for their products. She did indicate that all tilapia fillets were currently sourced from South and Central America and Asia. When asked what attributes are important for tilapia fillets, the response was that quality was most important and non-negotiable. After quality, the second most important criterion was price. Consistent availability is also important, but it was noted that this has never been an issue with tilapia.

When asked if any special attributes such as local, environmentally sustainable production/harvest, nutritionally enhanced, etc. would command a premium price, the buyer indicated that the decision would be up to the marketing team for each individual restaurant brand. In general, she echoed the information gathered in the previous interview--there is no mechanism in place to inform the customer about the attributes of the food they are being served, and hence, there would be no reason for a patron to want to pay a premium. An online review of the menus from the various restaurants owned by the company represented in the second interview revealed descriptors such as “fresh never frozen” and “flown in or sourced from nearby waters.” It should be noted that these descriptors referred to entire sections in the menu, not an individual offering. In this sense, they served to impart the *feeling* of informing the customer, without actually giving any details as to the sourcing of the fish on the menu.

Regarding requirements of suppliers, the buyer indicated that the company conducts a facility audit and looks for good manufacturing practices (GMP's), HACCP plans (Hazard Analysis Critical Control Point), and any other food safety aspects. All frozen shipments are checked for quality including microbiological checks. Fresh product is spot-checked (not possible to test all fresh product due to short shelf life). They require Best Aquaculture Practices certification from all suppliers. Packaging requirements vary by product. Frozen product must have a bar code for traceability. Regarding the procurement process, if a supplier is interested in selling to the company, they would arrange to make a presentation to the purchasing team.

### **Sector Summary – Chain Restaurants**

The clear message from this sector is that while quality is important, price is critical. Since there is little-to-no consumer education occurring in the restaurant regarding details of the food served, there is no room for a price premium for a U.S. grown product. The one price point that was shared was a current price (2010) of \$1.65/lb for an entire container of frozen fillets of mixed sizes (3 oz, 5 oz, 7 oz and greater than 7 oz) delivered to the mid-Atlantic region. It is very unlikely that a U.S. producer could ever compete with frozen fillets at this price, since the cost of filleting alone will likely exceed \$1.65/lb.

Our interviews did not reveal the current price for fresh fillets; however, the FAO reported the average wholesale price of fresh tilapia fillets in the U.S. wholesale market at \$3.60/lb in 2010. This price was down from \$4.00/lb in 2009. Even \$4.00/lb represents a challenging price point for a U.S. grower to produce a boneless tilapia fillet.

The chain restaurant sector represents a tremendous volume of sales, but due to the focus on low cost and the lack of interest in educating the consumer on the specifics of the food products being served, it does not appear that any price

premiums are available to the U.S. producer. Without premiums, this will be a very challenging market for U.S. producers.

### **Independent, White Table Cloth Restaurants**

In this sector we focused on local, independently owned restaurants. These venues attract a higher income customer, who is willing to pay a higher price for specialty products. Typically, chefs in this sector are directly involved in purchasing decisions. Restaurants in this sector are not purchasing high volumes of product at a time, due to storage space limitations and the desire for a very fresh product. Hence, they will likely require small volumes of product with frequent delivery.

Three chefs representing white table cloth restaurants were interviewed. One of the chefs owns and operates two restaurants in North Carolina - one specializing in seafood, and the other with a Mexican theme. The second chef interviewed cooks for one, large, well-established restaurant in the Raleigh, North Carolina area that is known primarily as a steakhouse, with a seating capacity of 650. The third chef works for a large country club in Virginia, with patronage limited to members and their guests. The country club has seven different venues in which it offers food, and the menus are quite varied. Across all seven venues, approximately 850,000 meals were served in 2010. All three of the interviewees indicated that they were intimately involved in making menu decisions.

Two of the three chefs reported that they have offered tilapia on their menu; one indicated that tilapia is a regular menu item and the other said tilapia had been on the menu for the past six months, and had just rotated off. The third chef said he had not tried tilapia, but was not opposed to trying it if he found a high-quality source. When asked if they felt demand for tilapia had increased in the past few years, all three indicated that tilapia was now known to the American public, whereas a decade ago it was not.

Regarding the product forms they currently serve or would be interested in serving, all three were most interested in fresh fillets. The chef representing the Mexican restaurant indicated he might have use for “bits” or trim pieces, if they were one to two inches in diameter. These could be used in fish tacos. He had no interest in a value-added product such as a spread, dip or chowder. However the other two indicated they would be willing to try an appetizer at their bar area.

All three chefs indicated that quality was critically important, and that cost, while important, is secondary to quality. As an example of this principle, one chef indicated that he is willing to pay 20 cents per shrimp for a fresh product from the U.S., versus 11 cents for a frozen, foreign product. One chef said he believes a high quality product, while costing more per pound, often translates into a better value because quality can translate into more portions (this may not hold

true for a boneless fish fillet). All three indicated that their customers expect the highest quality available. One chef did acknowledge that if quality was the same from different sources, he would go with the least expensive option.

All three indicated that their customers are interested in the source of the food served and that there is some interest/concern that the food be produced in an environmentally sustainable manner. All three indicated that they source food locally, to the extent that it is possible to do so and achieve the requisite quality. Two of the three indicated that they educate their customers through their wait staff, who are expected to be knowledgeable about the items on the menu. The third chef has a more direct relationship with his customers and talks to them personally. One indicated that he trusts federal guidelines to ensure that fishing practices are sustainable and does not feel it is necessary to advertise that he utilizes sustainable sources. He felt that there is disagreement on what is sustainable and that to describe his selection practices would just create unnecessary disagreements.

Regarding the importance of other attributes to the customer (beyond local and environmentally sustainable), the response was varied. The country club chef felt that omega-3-enhanced would be a positive attribute for his “athletic” audience, while the others did not feel that they would advertise this attribute. All agreed that there is a limit to how much information the customer in a restaurant setting wants to receive, and none indicated that they would educate their customers regarding production in recirculating aquaculture systems versus other methods of aquaculture. Two mentioned they do indicate that their farmed fish are antibiotic and hormone free.

When asked what they expect from a supplier, again quality was the first thing mentioned, and all expect the product to be very fresh - one mentioned he expects products to be less than 48 hours from processing when he receives them. Two of the three expressed an interest in seeing where the product was raised and processed. One indicated that the owner insists on seeing that the animal products he sells are produced in a humane manner and that all fish harvested from the wild are line caught. Product consistency and availability were also mentioned as critical; however, one chef mentioned that his menu changes every three days so consistent availability isn't critical. Another mentioned that he follows an “80% rule”, which implied an expectation that a supplier would be able to fulfill requests for a specific seafood product 80% of the time. All expect to build a trusting relationship with their suppliers. Regarding packaging and labeling requirements, all indicated that the product must arrive in good shape and be labeled indicating date and place processed and sourced.

## **Sector Summary - White Table Cloth**

It is clear that this sector places a high premium on quality and is willing to pay more for it. They do “educate” their customer to some extent, especially regarding sourcing, with local products being highly desired. All three indicated that fresh tilapia fillets were of the most interest to them, and had little to no interest in a frozen fillet. The price point given was in the \$4 to \$6/lb range. The one chef who indicated that “bits” would be of interest suggested a price point of \$3/lb. No prices were suggested for any of the value-added products.

The challenge this sector represents from a marketing perspective is that the restaurants require a relatively small volume, delivered frequently. Hence, the supplier would most likely need to work with a distributor to assure frequent, timely delivery. Use of a distributor would add another cost, reducing the profit available to the tilapia producer.

## **Institutional Food Services**

Three entities were interviewed representing this sector: a large, kindergarten-through-12<sup>th</sup>-grade public school system, a food service unit within a large public university, and a seafood distributor in North Carolina.

The interview with the K-12 school system was conducted with the Director of School Nutrition Services. She is responsible for making purchasing decisions for her school system, which serves approximately 17,000 students. She indicated that their menu items must meet strict regulations and standards set by state and federal government and that all price points must fall within a formula, which is currently between \$0.75 and \$0.90 per 4oz portion (\$3.00 to \$3.60 per pound). Within these constraints, another important consideration is ease of preparation. They do not currently serve tilapia products, but would be interested in a frozen, ready-to-heat, breaded fillet or fish stick. When asked what attributes would be important (locally produced, hormone-free, omega-3 enhanced, etc), she indicated all were important, but the school system could not pay a premium for any of these attributes due to the price points mentioned above.

The situation described by the chef of one food venue within the large university system was markedly different from the K-12 system. In this university setting, students have several options for dining on campus. The chef we interviewed worked in one venue—which consists of a food court, offering a variety of food options at each meal. The cost varies from one entrée to another. Students purchase a food plan, and the cost of each meal is deducted from their dining card. In this food court venue, students purchased an average of 7,000 meals per day at a total cost of \$40,000, which represents an average meal cost of \$5.71. The chef indicated that a fish entry is offered every day and that they rotate through the species they serve (salmon, tuna, and mahi-mahi). Tilapia is not

currently sold in this venue. When asked why not, he replied, “It hasn’t crossed my path.” He indicated he would be interested in offering tilapia fillets (probably fresh, but a quality frozen fillet might be acceptable). He noted that the university had a policy that only allowed him to purchase fish approved by the Monterey Bay Seafood Watch as being environmentally friendly (farmed tilapia meets this criterion). The university also allowed premiums necessary to procure environmentally-sustainable products to be passed on to students. When asked if he felt students would pay a premium for attributes such as omega-3 or locally sourced, he indicated that he felt students generally were price conscious and would not want to cover a premium price. Finally, he offered a possible price point of \$5 to \$8 per pound for fresh boneless fillets.

### **Retail sector**

We spoke with managers of several retail grocery outlets: one upscale traditional grocery store, one health food cooperative, one high-end sustainable/gourmet retailer, and one regional hub for military commissaries in the Eastern U.S.

#### ***Upscale traditional grocery store***

This store currently sources tilapia from South China and 2 areas in Panama, and has 3 seafood suppliers for the seafood counter. The store philosophy is to give consumers a range of choices; some customers would be willing to pay more for special attributes while others are more price driven. They would prefer to source their products from the U.S., but price and availability are definitely an issue. When asked about the value of “local” sourcing, he said that to him, “local” means U.S. He said to some customers, “local” would merit a premium of 20-25%, as would a claim of “high Omega-3” content. Fish raised without animal-based feeds would also open up the possibility of a 20-25% premium. This distributor indicated that “Environmentally sustainable” was not considered to be an important distinction. He mentioned a survey at the Boston Seafood Show that rated this attribute as 6<sup>th</sup> out of 10 in considerations made by the public.

#### ***Cooperative Grocery Store***

Local, sustainable foods are what this company is about. These two characteristics are worth an estimated 30% premium. They deal with an educated client and have a substantial platform to provide further information on product attributes to their customers; to maximize this, they have recently hired an in-store demonstrator to further market certain products. They currently sell about 70 lbs/wk of fresh tilapia from Costa Rica.

#### ***High-end sustainable/gourmet retailer***

This natural foods store has a strong marketing program, which includes social media and a website. Their customers are vocal, and store managers have direct communication with customers. There is extensive signage in the store to engage and inform the consumer. Most customers believe themselves to be very aware

of their food, in terms of sourcing, sustainability, and health. They are aware of the Monterey Bay Seafood Watch, and many carry the card put out by the group to help identify fish that is safe and sustainable. Customers value local and domestic sourcing, but consider environmental sustainability as the most important attribute. Omega-3 enhanced products are viewed in a positive light, as long as they come from a natural source. The vendor thought that with the right attributes and marketing, tilapia fillets could sell for \$9.99/lb. However when asked later what price range he thought we should expect for a tilapia fillet, he said \$5.57 to \$6.25/lb for fresh fillet. The prices we observed in this store: Tilapia “fresh farm-raised” \$6.99/lb; catfish \$4.99/lb Smoked salmon \$8.99/lb (I asked how this could be so cheap and was told they got a really good deal and that it was typically \$12.99/lb). Scottish Salmon \$12.99/lb.

### **U.S. Commissaries**

Commissaries represent about 1.6% of all U.S. grocery sales. Authorized patrons are active duty, retired military, or medal of honor recipients; approximately 12 million eligible patrons. There are 257 commissaries worldwide, selling products at cost, with an estimated savings to patrons of 31% over average retail pricing. Savings on seafood are higher, about 40%.

All food sold is inspected by the U.S. Army veterinary corps. Vendors must be DOD-approved, and source labeling and large suppliers that can provide good customer service are preferred. Suppliers are expected to stock their own products in the commissaries.

Annual sales of comestibles are \$6 billion, representing about 1.6% of U.S. grocery sales. Most commissaries currently sell an IQF tilapia fillet, and many stores also have an arrangement with independent contractors to manage and sell fresh seafood within the commissaries.

Many commissary patrons are young, and shopping in the commissary is their first experience purchasing their own food. Hence they are often looking for ready-to-eat foods or foods that are very simple to prepare.

Commissary patrons value food that is produced in the U.S., but probably place a lower value on “local” sourcing.

Environmental sustainability is valued by DOD, which is tasked by congress to have a low environmental impact in terms of their carbon footprint, energy input, and solid waste generated. However, these measurements reflect policies at the store level more than the inherent properties of the products sold. He did say that Congress can impact their purchasing practices.

## 2. Results of Price Survey of Five Grocery Retailers

A review of pricing for value-added seafood offerings at five grocery retailers in Southwest Virginia indicated some areas of high potential for product development. The five retailers were chosen to represent different sectors of the retail market, appealing to consumers of differing socioeconomic levels, and with different interests. The researcher visited these retailers without any prior contact with store management, and recorded prices observed for fresh fish, frozen fish, and a variety of value-added products, including spreads, dips, salads, and sauced or crusted fillets. Data collected is presented in Appendix G.

### **Customer assumptions based on store type**

There were five stores reviewed: one low-price big box retailer, two traditional grocery retailers, one “health-food” cooperative, and one high-end specialty grocer. It can be assumed that pricing pressures are significantly stronger at the low end of the retail outlets surveyed, and that the average education level of consumers increases as you go up the scale. These factors exert a strong influence on whether a consumer will respond to product attributes beyond price and convenience. Claims tied to health benefits, sustainable farming practices, enhanced freshness and product quality, or local/domestic sourcing have a much higher chance of being considered and valued at the cooperative and high-end specialty stores.

### **Findings**

***Low-Price Big Box Retailer*** – the prices observed at the low-price retail outlet clearly indicated little or no room for a domestic tilapia fillet. The only potential niche would be the sale of a whole smoked tilapia fillet, which would offer an alternative to the standard smoked salmon. It is uncertain, however, if a smoked tilapia product would have the market appeal that is typically associated with smoked salmon products.

***Traditional Grocery Retailer*** (2 stores sampled) – Here too, there was little or no room for a domestic tilapia fillet. Prices observed for fresh tilapia would barely meet the base costs of raising the fish, not to mention processing, packaging, and distribution. As with the low-price retailer, only the whole smoked products reached the pricing that would be needed for the enterprise to be sustainable.

***Natural Foods Cooperative*** – Here, there was no seafood counter or frozen seafood section. The only seafood items available were two wild-harvested salmon products, one a fresh, full-slab fillet, and the other a cold-smoked product. Only the smoked product met our pricing requirements. However, it should be noted that cooperatives such as this one do offer an opportunity for niche marketing. They function as the starting point for many new trends, and

may be considered fertile ground for testing a domestic, farmed tilapia fillet, especially if it is demonstrably safe, healthy, and environmentally sustainable.

*High-End Specialty Grocer* – The most promising options for marketing a domestic tilapia fillet were found at this venue. They had a wide variety of fresh, ready-to-eat, and frozen products, but also had a small selection of fresh, value-added fillets that offered an intriguing possibility. They were offering a parmesan-crusting tilapia fillet for \$9.00 each – a fillet that was roughly 7oz by weight. This translates to a per pound cost of \$20.57. There would be some costs associated with the ingredients for the breading, but it seems likely that there would still be sufficient room for profitable marketing of a domestically-produced fillet.

## V. OVERALL CONCLUSION

Given the current condition of ocean-based fisheries, there is wide agreement that increases in per capita seafood availability will require a concomitant increase in aquaculture-based production. In the U.S., the greatest barrier to expansion is strong competition from low-priced seafood imports. U.S. tilapia producers currently rely solely on the live market for profitability, but these markets are fully exploited, and are unlikely to generate further industry expansion.

In an effort to explore possibilities for expansion into new areas of the seafood marketplace, this study pursued three objectives. The first objective was to estimate the costs of filleting tilapia. Three avenues were explored; custom cutting by existing processing facilities, construction of a hand cutting facility specific to tilapia, and construction of an automated filleting line. Custom cutting yielded a 32% yield, with a labor cost of \$1.41/lb of fillets. The dedicated tilapia processing facilities resulted in a cost of \$1.62/lb for the hand cutting facility, compared with \$0.77 for the automated cutting facility. For the hand-cutting facility, the analysis is most sensitive to three variables: labor costs, the rate at which fish are cut, and the cutting efficiency. For the automated cutting line, cutting rate and filleting efficiency are fixed; the analysis is most sensitive to labor rate, followed by the number of hours per year that the facility is operated. While the automated line represents significantly lower filleting costs, it requires a much larger quantity of product throughput (16 million lbs of whole fish per year versus 1 million). Unless a large growing cooperative was established, it is likely that a filleting operation would have to start out with manual cutting, despite the higher cost per pound of finished product.

The second objective was to investigate processing options for value-added tilapia products. This section focused on production of smoked tilapia, which was used in salads, dips, and spreads. The products received good reviews, and buyers indicated an interest in purchasing these products, if they became available. However, with a 33% loss in smoking and 25% loss in skinning, the yield of smoked tilapia meat was only

50% of the fresh fillet, effectively doubling the price from \$5.50 per pound to \$11.00 per pound when using the skin-on fresh fresh fillets. This proved prohibitive.

The third objective was to analyze the market potential of U.S. grown tilapia fillets and value-added tilapia products made from U.S. grown tilapia by interviewing representatives from chain restaurants, white-tablecloth restaurants, institutional food service, and grocery stores; in addition, prices were surveyed at five different retail outlets. The results of this analysis were clear: there is some opportunity for a high-quality, locally-sourced, environmentally sustainable filleted tilapia product within two venues: the white-tablecloth restaurants, and the high-end specialty and health food markets. In these venues, more-educated, more affluent consumers are willing to pay domestic prices for an attractive, fresh, delicious product. Another opportunity is seen in the production of smoked tilapia, either as planks or whole (head-on, gutted). Across the board, smoked salmon was sold at prices which often exceeded \$20/lb. If similar pricing could be obtained for smoked tilapia, it could be sufficient to cover the costs of production. The brightest possibility for fresh, U.S. produced tilapia fillets appears to be in finding ways to meet the low volume, high frequency demand from individual professional chefs and restaurateurs, and in careful exploration of value-added options in the high-end specialty grocery marketplace.

## **Appendices**

Appendix A – Sample script used in calls to fish cutting firms

Appendix B – Hand Cutting Facility diagram

Appendix C – Automated Cutting Facility diagram

Appendix D – Smoking/Processing facility diagram

Appendix E – Recipes

Appendix F – Tilapia market survey instrument

Appendix G – Virginia store data

**Appendix A - Tilapia Niche Marketing Project**  
**Sample Script Used in Calls to Fish Cutting Firms**

*Hello, my name is Lori Marsh. I work for Dr. George Flick in the Food Science and Technology Department at Virginia Tech. I got your name from (insert as appropriate).*

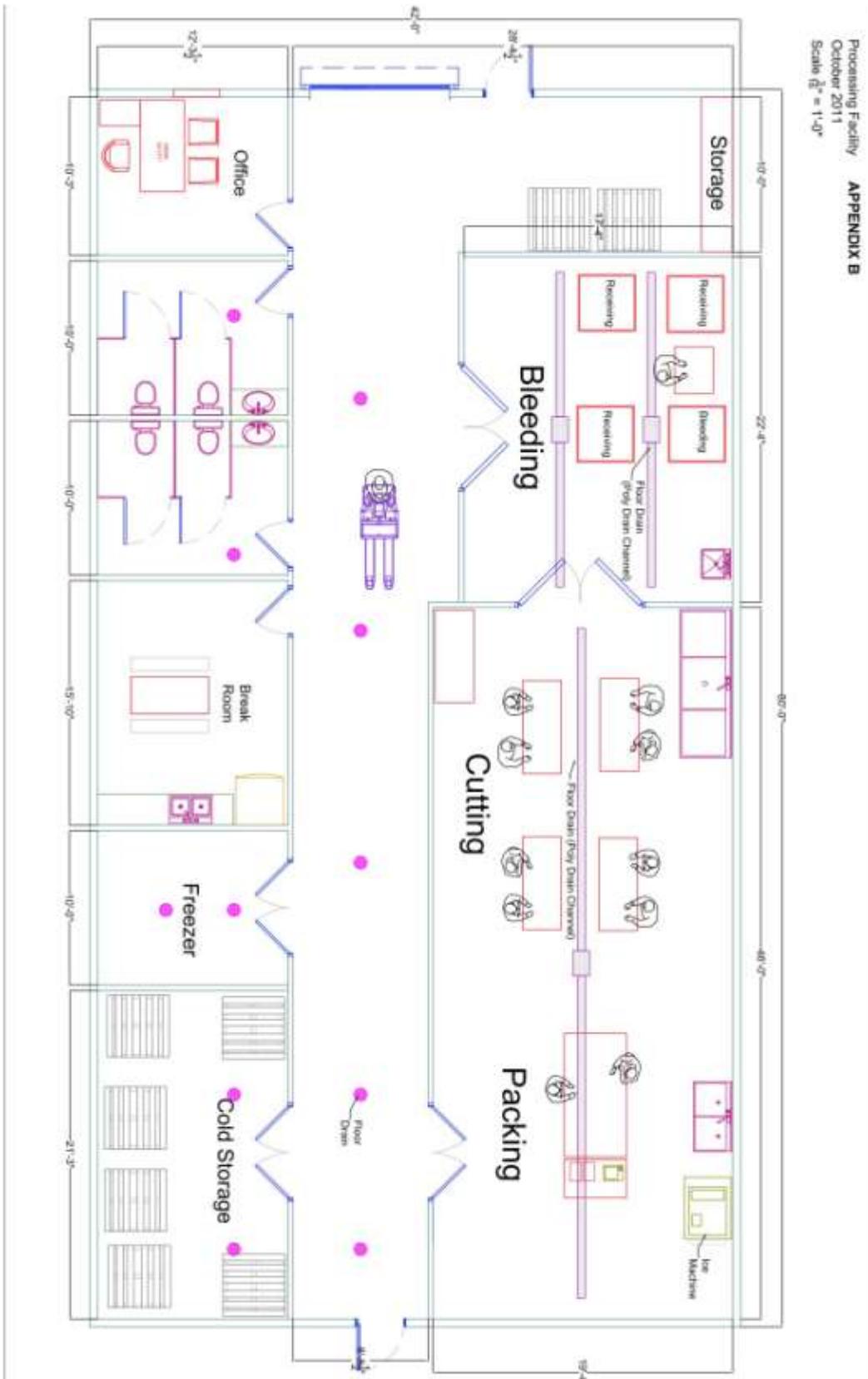
*Dr. Flick received a marketing grant from the United States Department of Agriculture to determine the potential for tilapia producers in the United States to compete against imported tilapia fillets. Through this grant, we wish to determine the cost to process tilapia into skinless, boneless fillets and also to explore the price that a U.S. grown tilapia can fetch in the market.*

*I'm trying to determine how much capacity currently exists for custom filleting and also, get some idea of the cost to the tilapia producer to have their fish filleted. That's why I'm calling you.*

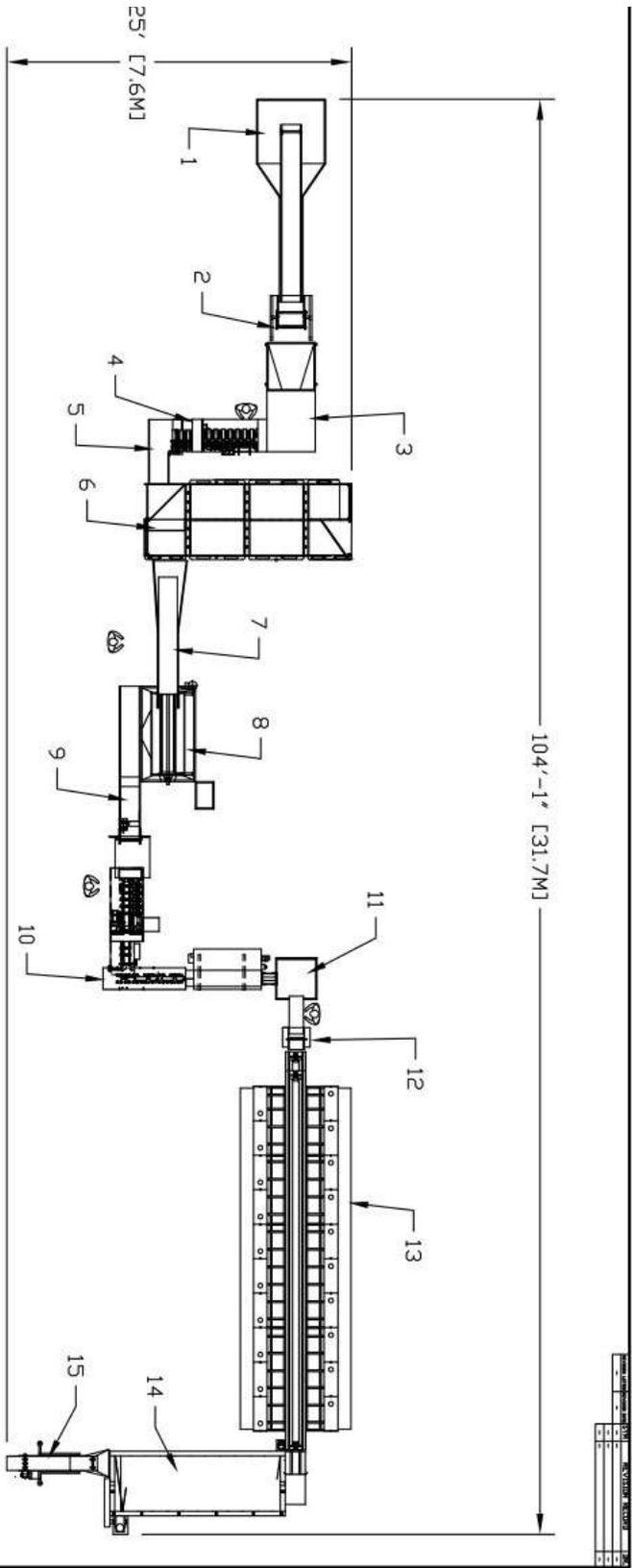
*Do you currently accept custom fillet orders? If so, what capacity can you handle on a weekly basis? I understand you can't give me an exact quote, but could you suggest a range in which the cost might fall?*

*Thank you for your time.*

APPENDIX B

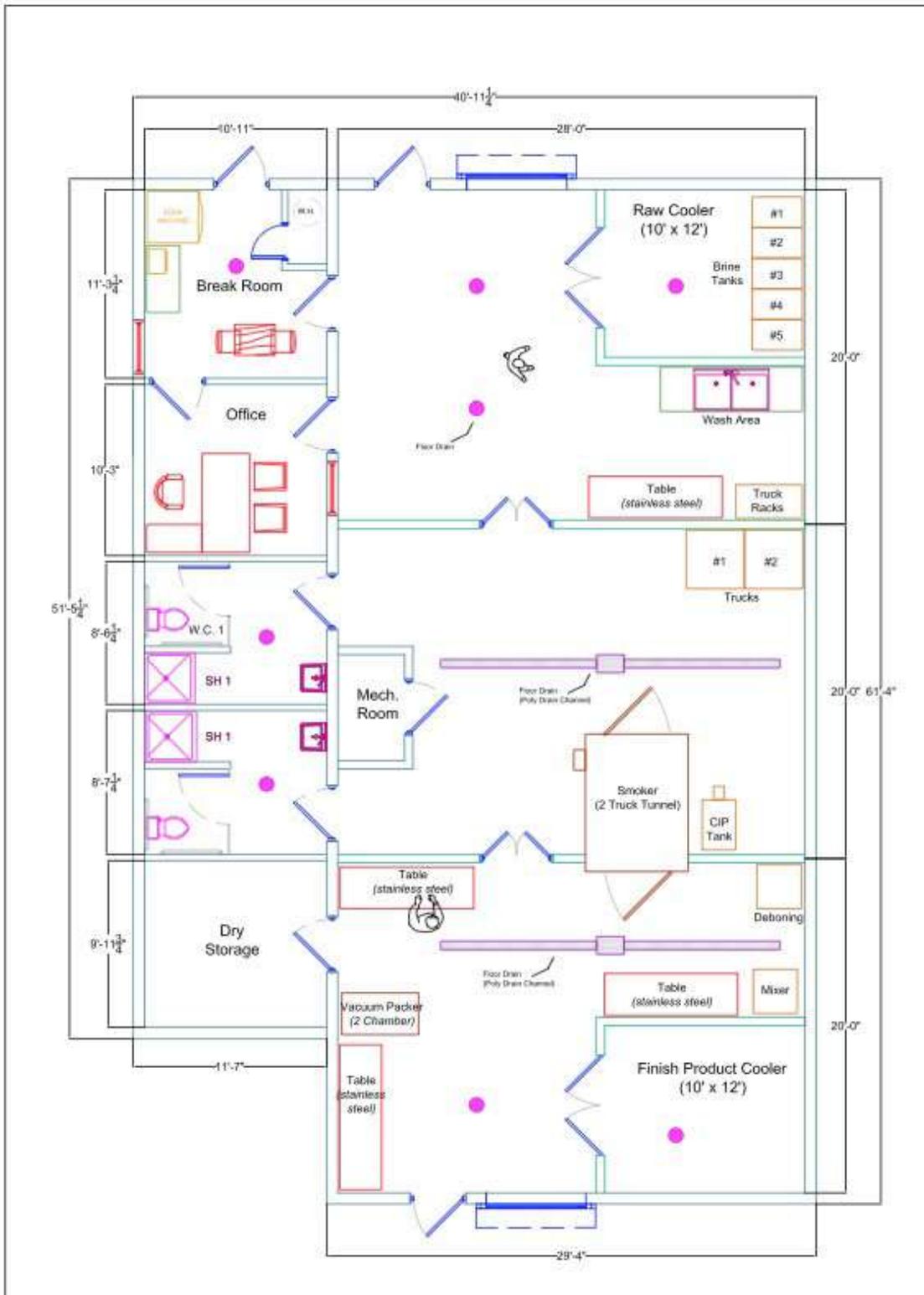


# APPENDIX C



NO.	DESCRIPTION	QTY	UNIT	REMARKS
1	HOPPER	1	PC	
2	CONVEYOR	1	PC	
3	CUTTING STATION	1	PC	
4	BLADE	1	PC	
5	SUPPORT	1	PC	
6	STORAGE TABLE	1	PC	
7	FILLETING TABLE	1	PC	
8	KNIFE	1	PC	
9	SUPPORT	1	PC	
10	CUTTING STATION	1	PC	
11	BLADE	1	PC	
12	SUPPORT	1	PC	
13	CONVEYOR	1	PC	
14	COLLECTION AREA	1	PC	
15	SUPPORT STRUCTURE	1	PC	

**APPENDIX D**



## **Appendix E - Tilapia Niche Marketing Project**

### **Smoked Tilapia Recipes**

#### **Smoked Tilapia Salad #1**

1 pound flaked smoked tilapia  
¾ cup mayonnaise  
½ cup chopped celery  
¼ cup chopped red onion  
2 tablespoons chopped green pepper  
1/3 cup finely chopped fresh parsley  
4 teaspoons fresh lemon juice  
¼ teaspoon freshly ground black pepper  
¼ teaspoon salt  
(lettuce leaves)  
(cherry tomatoes)

In medium bowl, combine mayonnaise, celery, onion, green pepper, parsley, lemon juice, black pepper and salt. Mix thoroughly. Gently blend in fish, being careful not to break flakes apart. Chill thoroughly. Serve on lettuce leaves. Garnish with cherry tomatoes.

---

#### **Smoked Tilapia Salad #2**

2 cups flaked smoked tilapia  
½ cup mayonnaise  
1 tablespoon Dijon mustard  
½ cup finely chopped celery  
¼ cup thinly sliced green onions, including tops  
1/3 cup slivered almonds  
1 tablespoon fresh lemon juice  
¼ teaspoon freshly ground black pepper  
¼ teaspoon salt  
(lettuce leaves)  
(lemon wedges)

Place mayonnaise in medium bowl. Stir in mustard. Add celery, onions, almonds, lemon juice and pepper. Gently blend in flaked fish, being careful not to break flakes apart. Chill thoroughly. Serve on lettuce leaves. Garnish with lemon wedges.

---

**Smoked Tilapia Dip #1**

2 cups smoked flaked tilapia  
2 ounces cream cheese, softened  
4 tablespoons mayonnaise  
4 tablespoons sour cream  
½ teaspoon Tabasco sauce  
½ teaspoon Worcestershire sauce  
¼ teaspoon freshly ground black pepper  
¼ teaspoon salt

In medium bowl, combine cream cheese, mayonnaise, sour cream, Tabasco, Worcestershire, pepper and salt. Gently mix in fish, being careful not to break flakes apart. Chill thoroughly. Place in serving bowl. Serve with assorted vegetables and chips.

---

**Smoked Tilapia Dip #2**

1 cup flaked smoked tilapia  
8 ounces cream cheese, softened  
1 tablespoon mayonnaise  
1 teaspoon grated onion  
½ teaspoon pressed garlic  
1 teaspoon Worcestershire sauce  
¼ teaspoon Tabasco sauce  
1 teaspoon fresh lemon juice  
¼ cup chopped fresh chives  
½ teaspoon salt  
¼ teaspoon freshly ground black pepper

In medium bowl, combine cream cheese, mayonnaise, onion, garlic, Worcestershire, Tabasco, lemon juice, chives, salt and pepper. Gently mix in fish, being careful not to break flakes apart. Chill thoroughly. Place in serving bowl. Serve with chips and assorted vegetables.

---

**Smoked Tilapia Spread #1**

2 cups flaked smoked tilapia  
8 ounces cream cheese, softened  
1 tablespoon mayonnaise  
2 tablespoons sour cream  
1 tablespoon Worcestershire sauce  
2 teaspoons Old Bay seasoning  
½ cup finely chopped green onion, including tops  
¼ teaspoon freshly ground black pepper  
¼ teaspoon salt

In medium bowl, combine cream cheese, mayonnaise, sour cream, Worcestershire, Old Bay, onion, pepper and salt. Gently mix in fish, being careful not to break flakes apart. Chill thoroughly. Place in serving bowl. Serve with assorted crackers.

---

**Smoked Tilapia Spread #2**

2 cups flaked smoked tilapia  
8 ounces cream cheese  
3 tablespoons mayonnaise  
¼ teaspoon salt  
¼ teaspoon freshly ground white pepper  
¼ teaspoon cayenne pepper  
½ teaspoon minced fresh garlic  
1 tablespoon chopped fresh chives  
4 ounces grated medium cheddar cheese

In medium bowl, combine cream cheese, mayonnaise, salt, white pepper, cayenne, garlic and chives. Gently mix in fish and cheese, being careful not to break fish flakes apart. Chill thoroughly. Place in serving bowl. Serve with assorted crackers.

**Appendix F - Tilapia Niche Marketing Project**  
**Tilapia Market Survey Instrument**

1. Date \_\_\_\_\_
2. Name of interviewee, position
3. Company name
4. Type of business (retailer, restaurant, institutional)
5. Who makes menu/merchandising decisions at your company?
6. Who makes purchase decisions?
7. Do you currently serve/sell Tilapia products? Y/N
8. If no, have you ever served/sold them?
  - a. If yes, why did you stop?
  - b. If no
    - i. is there a specific reason you haven't?
    - ii. do you sell any similar products (mild fish—catfish? Trout? Etc.)
    - iii. are you interested in selling Tilapia products?

For those who sell/serve Tilapia products or those who don't sell but are interested in selling them:

9. Are you aware of any change to demand for tilapia from your customers over the past few years (increasing, decreasing, change in types of product sought)? If so, please describe.

10. Multi-part Question	Fillet	Mince	Value-added	Other
What tilapia products do you sell or would you be interested in selling?				
What approximate volume do you sell or think you could sell of each type of product (specify unit and per week/year, etc.)				
Is the product you sell or would be interested in selling fresh or frozen?				
Where do you current source Tilapia (domestic or import, specific country/state if possible)				
How many suppliers do you have per type of product What is the nature of the supplier per type of product (producer, wholesaler, etc.)				

11. What quality attributes are most important to the firm? To the customer?

12. For each type of supplier, what are strengths/weaknesses of this source of Tilapia?  
Please explain

Supplier 1: \_\_\_\_\_

	Strength/ weakness	Explanation
Quality		
Price		
Consistent availability		
Availability of services		
Other		
Other		
Other		

Supplier 2: \_\_\_\_\_

	Strength/ weakness	Explanation
Quality		
Price		
Consistent availability		
Availability of services		
Other		
Other		
Other		

13. Do you see any customer interest in the following product attributes? If so, would customers be willing to pay a premium for the products and if so what premium do you think you could charge? Does demand relate to any product type (fillet, value-added, etc.)

Attribute	Demand? (y/n)	Premium? (Y/N)	% premium (5%, 10%, 15%, other?)	Specific product?
Local				
Produced in U.S.				
Environmentally sustainable (ex. Monterrey Bay Watch certified)				
Nutritionally enhanced (e.g. high Omega-3 content)				
Organic				
Guaranteed “safe”				
Other: _____				
Other: _____				

Tilapia is generally produced using either pond or recirculating aquaculture systems. Pond production is less expensive, but due to the inability to control temperatures, has a limited geographic range. Problems with off flavors, pollution, and predation can also affect product quality, reliability, and volume.

Recirculating systems allow for greater consistency in terms of quality, size, and availability; as well as full control of attributes including feed inputs, environmental impacts, and presence of contaminants. However, tilapia products grown in recirculating systems cost more to produce than they do with pond systems.

14. Would you/your customers be willing to pay more for tilapia from a recirculating system if the following attributes were assured?

	I would pay more	Customer would pay more	Specific products, comments
High quality			
Consistent quality			
Consistent availability			

Raised without animal feed inputs (no fish oil, fish meal, etc.)...			
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15. What do you require of your suppliers with respect to:

	Yes/No	Detail
Minimum volume of supply		
Food safety certification/GAPs, GMPs, Haccp, etc.		
Other certification		
Delivery		
Packaging		
Labeling		
Other requirements?		

16. What price range should a potential supplier expect to adhere to?

17. What is the procurement process utilized by your company? How should a potential supplier go about approaching you if s/he were interested in supplying Tilapia to your outlet?

18. What is the demand for specific value-added aquaculture products (spreads, salads, smoked, ready-to-eat soups). Could there be an unmet demand for these products? What do you base your answer on (current sales of product, customer requests, sales of similar products, etc.) ?

**Appendix G - Tilapia Niche Marketing Project**  
**Data from Five Virginia Grocery Stores, surveyed 19 October 2011**

**Value-priced big box grocery store**

***RTE Products***

Hot smoked salmon, vacuum pack \$5.00/4oz pkg	\$20.00/lb
Cold smoked salmon, vacuum pack \$5.88/4oz pkg	\$23.52/lb

***Previously frozen, thawed fillets***

Gutted tilapia, head-on, 2 fish/pack	\$2.48/lb
Tilapia fillets, skinned	\$3.98/lb

***Frozen products***

Parmesan-crusted tilapia, 1 lb pack	\$4.98/lb
Shrimp cakes, \$5.98/12oz	\$7.97/lb
Crab cakes,\$5.00/lb pack	\$5.00/lb

**Market-standard grocery store #1**

***RTE Products***

Hot smoked salmon, vacuum pack \$4.99/4oz pkg	\$19.96/lb
Cold smoked salmon, vacuum pack \$3.49/3oz pkg	\$18.61/lb
Seafood salad, tub \$2.00/12oz	\$2.66/lb
Smoked salmon dip, tub \$2.50/7.5oz	\$5.33/lb
Crab spinach dip, tub \$2.50/7.5oz	\$5.33/lb
Surimi products, vacuum pack \$2.50/8oz	\$5.00/lb

***Fresh fillets***

Farmed Atlantic salmon	\$8.99/lb
Wild Swordfish, prev frz	\$8.99/lb
Wild Cod, prev frz	\$4.99/lb
Farmed Tilapia (Honduras)	\$5.99/lb
Farmed Rainbow Trout	\$8.99/lb

***Frozen products (plain)***

Farmed flounder fillets \$3.99/12oz	\$5.32/lb
Farmed Tilapia fillets \$9.99/2.5 lbs	\$4.00/lb
Farmed Tilapia fillets \$3.99/12oz	\$5.32/lb
Wild Cod \$9.99/2.5 lbs	\$4.00/lb
Pink Salmon \$9.99/2.5 lbs	\$4.00/lb
Farmed Atlantic salmon \$7.99/12oz	\$10.65/lb
Haddock \$7.99/12oz	\$10.65/lb

## **Market-standard grocery store #2**

### ***Value-added frozen products***

Coconut-crusted Tilapia (High Liner brand) \$4.99/two fillets (10oz)	\$7.98/lb
Tortilla-crusted Tilapia (High Liner brand) \$4.99/two fillets (10oz)	\$7.98/lb
Asian Glazed Tilapia fillets (Inland Market brand) \$6.99/two fillets (12oz)	\$9.32/lb

### ***RTE Products***

Smoked salmon dip, tub \$2.50/7.5oz	\$5.33/lb
Cold smoked salmon, vacuum pack \$5.99/4oz pkg	\$23.96/lb
Crab spinach dip, tub \$2.50/7.5oz	\$5.33/lb
Hot smoked salmon, vacuum pack \$4.79/4oz pkg	\$19.16/lb

### ***Fresh fillets***

Farmed Tilapia (Honduras)	\$5.99/lb
Wild Cod, prev frz	\$5.99/lb
Wild Perch	\$5.99/lb
Farmed Rainbow Trout	\$6.99/lb
Flounder	\$8.99/lb
Yellowfin tuna	\$8.99/lb
Farmed Atlantic salmon	\$8.99/lb
Sockeye salmon	\$7.99/lb
Steelhead trout	\$7.99/lb
Swai, prev frz	\$3.99/lb

## **High-end specialty grocer**

### ***Fresh fillets***

Grouper	\$20.00/lb
Turbot	\$12.99/lb
Farmed Tilapia (Honduras)	\$7.99/lb
Swordfish	\$14.99/lb
Chilean Sea Bass	\$26.99/lb
Wild Cod	\$11.99/lb
Farmed Atlantic salmon	\$11.99/lb
Rainbow trout	\$11.99/lb
Catfish	\$6.99/lb
Sashimi-grade tuna	\$12.99/lb

***Fresh, value-added fillets***

Pistachio-crusted flounder	\$12.99/lb
Parmesan-crusted tilapia \$9.00/7oz	\$20.57/lb

***RTE Products***

Lobster and Shrimp salad	\$9.99/lb
Krab Dip (surimi)	\$4.99/lb
Cold-smoked salmon	\$19.99/lb
Hot smoked salmon, vacuum pack \$5.99/4oz pkg	\$23.96/lb
Crab Dip, tub \$3.99/8oz	\$7.98/lb
Clam chowder, tub (16oz)	\$5.49/lb
Lobster chowder, tub (16oz)	\$6.99/lb

***Frozen products***

Flounder	\$9.99/lb
Salmon	\$9.99/lb

**Mid-sized, membership-based natural grocer**

***Refrigerated Products***

Wild Sockeye Salmon, vacuum-packed fillet \$20.84/1.71lbs	\$12.19/lb
Wild Cold-smoked Salmon, vacuum packed \$8.19/4oz	\$32.76/lb

No seafood counter, dips/spreads/soups, or frozen seafood products