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COST AND RETURNS FOR MACROBRACHIUM GROW-OUT IN SOUTH CAROLINA

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Costs and Returns for *Macrobrachium* Grow-Out in South Carolina

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Abstract

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The costs and returns for the grow-out phase of producing Macrobrachium were estimated for South Carolina. The technical coefficients and yields were based on research results from experimental ponds. Estimates were made on a per pond basis assuming a module of ten ponds each being 0.41 ha (1 acre) in size.

Items of cost included feed, electricity, labor, fertilizer, repair and maintenance, interest on operating capital and on pond investment and depreciation. Total costs were estimated to be $984.14 per pond, 72 percent of which are variable in nature, and 28 percent are fixed. Feed made up 42 percent of the estimated total, labor comprised 16.5 percent, and depreciation amounted to almost 16 percent of the total. Based on 1976 yield data, net revenue per pond was -$62.16. The 1977 data resulted in an estimated net return of $312.74 per pond. The difference between the two years is the result of better feed conversion and improved size distribution in 1977.

Introduction

The climate of coastal South Carolina provides suitable conditions for the profitable growth of many agricultural crops. In 1972, the South Carolina Sea Grant Program initiated a small project to explore the technical feasibility of Macrobrachium culture in this temperate zone. The support focused on extensive grow-out. A parallel project funded by the Coastal Plains Regional Commission sought to develop the technology for efficient production of postlarvae via an indoor recirculating seawater system and high density rearing of juvenile prawns in a nursery system (Sea Grant, 1977). The development of the system has progressed to the point where four distinct phases are identifiable (Sandifer et al., 1976): (1) a late winter/early spring indoor hatchery phase yielding postlarvae; (2) a similar period of high density rearing of juveniles in a nursery phase; (3) a mid-spring through mid-fall pond production phase to produce marketable prawns; (4) maintenance of brood stock to provide postlarvae for the next growing season.

In 1977 the program entered a grow-out demonstration phase at Laurel Hill Plantation in Beaufort, South Carolina (Sea Grant, 1977). The experiments in the four ponds (0.113 - 0.376 ha) (0.28 - 0.93 acres) provided the initial opportunity to begin economic monitoring. Prawn culture in South Carolina has been viewed from inception as an alternative crop opportunity for food producers currently growing agricultural crops, catfish and/or eels. As such it must meet profitability and risk competition of other crops within an agriculturist's enterprise alternatives. The establishment of a prawn culture industry distinct from conventional food production systems in coastal South Carolina is not envisioned (Sea Grant, 1978). Consequently, the monitoring of the pond grow-out operation was conducted within the framework of a financial budget. Financial budgets exist for alternative crop options in South Carolina. A comparison of the pond grow-out phase with existing alternatives is thereby facilitated.

In addition, an economic snapshot of the pond grow-out phase was necessary prior to expending resources to determine the feasibility of hatchery and nursery phases. The conclusions drawn from the financial budget point to a near break even situation. Additional effort is required to determine the conditions necessary for cost effective delivery of stocking animals. The financial budget was prepared for a product module of ten pond of 0.41 ha (1 acre) each. The assumption made and technical coefficients used are based on observations and experience obtained in the management of ponds in coastal South Carolina. The production data is based on 1976 and 1977 yields from the ponds.

Technical Coefficients and Assumptions

The technical coefficients and assumptions identified in the appendix are the foundation of this analysis. Although some of these are briefly discussed in the narrative their origin and detail are reserved for the appendix. Costs of production are based on fall 1977 prices. Prices for use in calculating total revenue are based on a three year average (1975-1977) ex-vessel price for marine shrimp in South Carolina.

Variable Costs

Variable costs are those that vary with the amount of output produced. The variable costs for a 0.41 ha pond are presented in Table 1. The assumed yield of 500 kg gross weight per pond, or 255 kg of tails are based on the 1976 production trials.

Based on 1976 experimental data, a feed conversion rate of 2.5:1 was used. To produce 500 kg of biomass, 1250 kg of feed would be necessary. The cost of feed was based on an experimental marine ration. Delivered cost in the fall of 1977 was $.33 per kg. Given this base, the feed cost was estimated to be $412.50 per pond.

The electricity needs were estimated to be 442.4 kwhr for the initial filling of the pond, 151.3 kwhr to replace, net of average rainfall, the water lost by evaporation and seepage, and a maximum of 236.2 kwhr for aeration.

Discussions with power companies in the

coastal area of South Carolina indicate a representative rate of $.04 per kwhr. Therefore, the estimated total cost of the 829.9 kwhr is $33.20.

The labor needs are estimated on the basis of a 180 day production period for the ten pond operation. Stocking is estimated to require two hours per pond. The checking of water quality, i.e., temperature and dissolved oxygen, requires 0.1 hour per day or 18 hours per pond for the season. Likewise, feeding is estimated to require 0.1 hour per day for each pond. The labor associated with aeration and management is estimated to require an average of 15 minutes per day for all ten ponds, or 1.5 minutes per day per pond. This amounts to 4.5 hours per pond for the season. It is estimated that the total labor need for pond and equipment maintenance is 36 hours for ten ponds, or 3.6 hours per pond for the season.

It is assumed batch harvesting is employed and that it requires eight hours per pond. Labor cost for the total of 54.1 hours at $3 per hour is $162.30.

The equivalent of 45 kg of 10-10-10 fertilizer is used in each pond at the cost of $.15 per kg.

Repair and maintenance costs were estimated to be $55 per pond while miscellaneous costs were estimated to be $20 per pond.

These items total to $684.75 of operating costs. To estimate the average investment over the six month season, the total is divided by two. At an annual interest rate of 9%, the interest charge would be 4.5% for the season. The charge for interest on operating capital is therefore $15.52.

The total variable costs per pond are estimated to be $705.27 per pond, or $2.77 per kg of tail produced (Table 1). Not included is a cost for seed stock, postlarvae or juveniles. The climatic situation in South Carolina is such that the development will result into no more than a cottage industry. As such, it likely will be dependent on receiving seed stock from, for example, a state-owned hatchery similar to the present tree nurseries or trout and bass hatcheries. Progress is being made toward estimating the cost of a state-owned hatchery and developing a pricing strategy for seed stock.

The estimated fixed costs, those that are incurred regardless of production, are presented in Table 2.

Using the drainage system of harvesting, a harvest basin and drain is needed for each pond. This consists of an 0.20 m diameter corrugated metal barrel with a 0.4 m diameter flashboard riser, 2.1 m high riser and 12.2 m of 0.20 m pipe and with a 15.3 by 15.3 m drainage basin. This was estimated to cost $530. Useful life is 12 years so depreciation is 8 1/3% or $44.17 per year.

The pump and assembly for a 122 m deep well was estimated to cost $2,482. The assumed life is 12 years so the depreciation cost spread over ten ponds is 8 1/3% or $27.50 per pond per year.

It was estimated that about 24 m of .15 m distribution pipe would be necessary. At a cost of $6.55 per meter the estimated total cost is approximately $1,600. With a useful life of 12 years, the depreciation is 8 1/3% or $13.33 per pond per year.

A small four meter boat would cost approximately $330. With a useful life of ten years, the annual depreciation is 10%, or 1% for each of the ten ponds. Depreciation for a boat would therefore be $3.30 per pond per year.

A 1,600 pound capacity PTO feeder and 10 short tons of storage would cost $856 and $1,284 respectively. Each is assumed to have a useful life of 10 years, or depreciation of 10% per year. Therefore, depreciation is 1%, or $21.40 per pond per year.

The total cost of instruments necessary for testing water quality is estimated to be $510. These instruments are estimated to have a useful life of five years, so depreciation of 2% per pond per year would be $10.20.

A seine, with an expected life of five years, costs $400, so depreciation would be $8 per pond per year.

It is assumed an aerator would be needed for every two ponds, since it is unlikely that all ponds would have oxygen problems at the same time. A floating aerator and necessary power cord costs $350 and has an expected life of five years. The depreciation per pond would therefore be $35 per year.

The estimate of the necessary pond investment is based on a 10-pond module with each pond having water surface dimensions of 122 m by 33.5 m or approximately 0.41 ha. The levees have 3:1 slope. The total land needed for ponds, drainage, ditches, access, etc. was estimated to be 6.3 ha. The estimated total investment for pond construction and levee stabilization is $1535 per pond. Using 8% representative of returns from alternative investments, the annual fixed cost is $122.80 per pond.

The estimated total fixed costs are $278.87 or $1.09 per kg of tails produced in 1976 (Table 2).

Total Costs

The total costs per pond are $984.14. The cost per kg of tails produced in 1976 and the percentage breakdown by cost item are presented in Table 3. Variable costs comprise about 72 percent of total costs and fixed costs approximately 28 percent . The largest single item is feed, 42 percent of all costs, while labor and fixed costs items of depreciation and interest make up 16.5, 15.8 and 12.5 percent, respectively.

Total Revenue

The ponds in South Carolina would likely be harvested by draining rather than selective seining. Estimated production, based on 1976 pond production data, is presented in Table 4, along with percentage breakdowns by size classes of production and value. The estimated total revenue from 255 kg of tails is $921.98.

Gross receipts could be increased if the size distribution were improved. This would have a more beneficial impact on total revenue than would a yield increase with the size distribution in Table 4. Research on increasing size as well as on selective harvesting is continuing.

Net Revenue

Net revenue is presented in Table 5. The net revenue per pond for 1976 was estimated to be $-62.16, or $-.243 per kg of tails. As have been mentioned, the estimates do not include the cost of seed stock nor a land charge. The *Macrobrachium* enterprise is considered as an alternative for South Carolina farmers already in the food producing business with land resources available. The net revenue can be compared to the returns to land and management from other crops and enterprises making use of land.

1977 Pond Grow-Out Results

The 1977 grow-out tests conducted on a pilot scale level yielded two results which have a beneficial impact on the previous financial analysis. The size distribution of prawns at harvest shifted significantly to the larger market classes (Table 6). Estimated total revenue increased from $921.20 to $1,184.50 per pond. To achieve the increase in total revenue per pond of $263.30 with the percentage size distribution from 1976 (Table 4), an increase in yield of 30 percent or 149 kg would be required. Increased feed efficiency was also achieved in 1977. The feed conversion was 1.83:1 as compared to the 2.5:1 in 1976. The combined influence of larger average prawn size on total revenue and the reduced feed conversion on costs results in a positive net revenue of $312.74 per pond or $1.28 per kg of tail (Table 7).

This indicates that *Macrobrachium* culture experiments in South Carolina are producing results favorable to continued pond grow-out development.

Summary and Conclusions

The estimates of costs presented here are based on experience with several experimental ponds in the coastal area of South Carolina. The estimates of gross receipts presented here are based on harvest data from 1976 to 1977. The 1976 data indicate a negative net return, $-62.16 per .41 ha pond. This is based on a 2.5:1 feed conversion ratio. In 1977, the estimated net returns were $312.74 per pond. This is based on an indicated improvement in the feed conversion ratio to 1.83:1, and on an improvement in the size distribution, i.e., even though the total tail production decreased a greater number of larger animals were produced which would sell for a higher price and thereby increase total revenue. Both of these changes have a positive effect on net revenue. It was assumed all the costs, except for feed, would be the same in both years.

The cost estimates include no charge for land, therefore the net revenue is a return to land and management. Also, no cost was included for seed stock.

It would be premature to predict economic feasibility on the basis of these results. As will all enterprises, *Macrobrachium* culture must yield competitive returns with comparable risk in order to attract investment capital. Additional grow-out trials over the next few years will be necessary to establish the range of variability in yield, prawn size at harvest, and feed conversion. The availability of such information will allow an entrepreneur to make an investment decision based on the risks and returns from *Macrobrachium* in comparison with other enterprises.

Appendix

A. Feed and yield

Feed conversion:
2.50:1 in 1976
1.83:1 in 1977

Yield:

500 kg/pond, 255 kg of tails in 1976
500 kg/pond, 244 kg of tails in 1977

Feed cost:

$.33/kg

B. Ponds and levees

Ponds are "dug type" pond 0.41 ha in size. Type A levees have 3.6 m tops and are 1.8 m high. Type B levees have 2.4 m tops and are 1.8 m high. Both levees have 3:1 slopes. The levees of each pond are to be constructed via excavation of an average of 1.2 m. The charge used in the budget for excavating and shaping the soil was 0.79 per m^3. Type A and B levees require 9.02 and 7.5 m^3 per m of levee respectively. The total cost of establishing the levees containing 18,243 m^3 of excavated soil was estimated to be $14,412.

C. Levee Stabilization

The 221 m of levee to be surfaced with 55 m^3 of crushed limestone at $15.20 per m^3 results in a cost of $836.00. Vegetative stabilization of levee slopes requires establishment of grass cover through seeding and fertilization. The 1,211 m of type A levee involve covering 993 m to a width of 5 m and 2221 m to a width of 2.5 m. The 976 m of type B levee involve covering all 976 m to a width of 2.5 m. The total 0.80 ha which requires vegetative cover results in a total cost of $98.31 when the establishment cost is $122.89 per ha.

D. Water use factors

Filling:

The pond is assumed to be 0.41 ha with an average depth of 1.15 m, i.e., it contains 4715 m^3 of water. At 1000 liters per m^3, the capacity of the pond is 4,715,000 liters.

A 20 horsepower pump with a capacity of 2650 liters per minute would require 29.65 hours to fill the pond. One English horsepower is by definition equivalent to 746 watts, so a 20 horsepower motor would use 14,920 watts per hour. The total for 29.65 hours would be 442,378 watt hours or 442.4 wkhr.

Replacement:

Based on information in the National Climatic Atlas estimated evaporation in the coastal area of South Carolina would be 117 cm per year. Data from the National Weather Service Office at the Charleston, South Carolina Airport indicate an average annual evaporation-precipitation deficit of 13.10 cm (Appendix Table 1). For a 0.41 ha pond this amounts to 537.1 m^3 for 537,100 liters. The 2650 liter per minute pump would require 3.38 hours over the year for replacing water, or approximately 50.43 kwhr.

It is assumed that the water lost by seepage is twice the amount lost by evaporation; therefore, the total electricity to replace water lost by evaporation and seepage is three times 50.43 or 151.3.

Aeration:

It is assumed that the maximum aeration needs would be 8 hours per day for 120 days. Aeration is to be accomplished with 1/3 horsepower floating aerators with a capacity of 1,330 liters per minute. When equipped for floating operation and a 45 m power cord, the cost is approximately $350. With a 1/3 horsepower motor, 246 watts per hour would be used. The total usage would therefore be 236.2 kwhr.

E. Water requirements can be met by use of surface supplies from waterways in the state's coastal region.

The cost of drilling and casing a well to meet water supplies was estimated. For this reason well costs are included in the appendix in the event subsurface water must be used. However, the use of a well will not necessarily require modification of the financial budget. The reason that depreciation of the well's cost would not be included in the fixed cost section of the budget has to do with the United States Internal Revenue Service regulations relating to water wells. Internal Revenue regulations 1.67 (a)-6(b) permit a reasonable deduction for depreciation of water wells only if it can be demonstrated that the well has a limited useful life. Useful life must be demonstrated on a case by case basis. Water wells are routinely treated as capital improvements to land. As such the cost must be capitalized into estimating the basis of the land upon sale. For an instance where the well could be demonstrated to be of limited life, the authors utilized a 25 year life to provide insight to the depreciation charge which would be experienced. A well of 122 m depth in a location where the water table is 30.5 m was estimated to cost $21.66 per m for drilling and $21.66 per m for casing. The total cost of $3,303 depreciated over 25 years results in an annual depreciation charge of $132 for the 10 pond module or $13.20 per pond.

The cost of establishing the pond and levee system as previously estimated in part B of the appendix was used to serve as the base for calculation of a charge for interest and pond investment. This method was chosen due to the complexity of the United States Internal Revenue Service regulations regarding deductions for nondepreciable earthern structures such as dikes and levees. Regulations 1.182-1, 1.182-2 and 1.182-3 deal with tax treatment of expenditures for nondepreciable items. A deduction for construction costs of levees is allowed in the tax year of the expenditure subject to a limit of the lesser of $5,000 or 25 percent of the taxable income derived from farming during the tax year. Expenditures in excess of this amount for the tax year must be treated as capital expenditures and shall constitute an adjustment to the basis of the land. An aquaculture operation as a separate entity will likely not have sufficient taxable income in the first year of operation from which to deduct levee expenditures under these regulations. This points to treatment of the expenditure as an item to be capitalized into the purchase price of land. Thus, interest on the expenditure would remain the correct economic cost to include. A culturist combining prawn culture with existing farm enterprises may have taxable income from conventional farm crops to which the above deduction limits can be applied. There being no method by which to identify an acceptable target figure, the authors proceeded as identified in the budget.

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Table 1. Variable production costs for *Macrobrachium*, .41 ha pond, 500 kg. gross production, 255 kg tail production, South Carolina.

Item	Unit	Price per unit	Quantity	Cost per pond	Cost per tail weight
		$		$	($/kg)
Feed	kg.	.33	1250	412.50	1.618
Electricity	kwhr.	.04			
Fill			442.4	17.70	.069
Replacement			151.3	6.05	.024
Aeration			236.2	9.45	.037
Labor	hr.	3			
Stocking			2	6.00	.024
Water quality			18	54.00	.212
Feeding			18	54.00	.212
Aeration & management			4.5	13.50	.053
Pond & equip. maint.			3.6	10.80	.042
Harvest			8	24.00	.094
Fertilizer	kg	.15	45	6.75	.026
Repair & maintenance	$	1	55	55.00	.216
Miscellaneous	$	1	20	20.00	.078
Interest on op. cap.	$	.045	344.88	15.52	.061
				705.27	2.766

Table 2. Fixed costs of production for *Macrobrachium*, .41 ha pond, 500 kg gross production, 255 kg tail production, South Carolina.

Item	Unit	Price per unit	Quantity	Cost per pond	Cost per tail weight
				$	($/kg)
Depreciation					
Harvest basin and drain	$	.083	530	44.16	.173
Pump and assembly	$	.0083	2482	20.68	.081
Pipe	$	.0083	1600	13.33	.052
Boat	$	.01	330	3.30	.013
Feeder and bulk storage	$	.01	2140	21.40	.084
Instruments	$	.02	510	10.20	.040
Seine	$	.02	400	8.00	.031
Aerator	$	.01	350	35.00	.137
Interest on pond investment	$	.08	1535	122.80	.482
Total Fixed Costs				278.87	1.093

Table 3. Total cost items per unit of *Macrobrachium* tail produced, percentage break-down, .41 ha pond, 255 kg tail produced, South Carolina.

Item	Cost per tail weight	Percent of total cost
	($/kg)	%
Feed	1.618	41.9
Electricity	.130	3.4
Labor	.637	16.5
Fertilizer	.026	.7
Repair and maintenance	.216	5.6
Miscellaneous	.078	2.0
Interest on operating capital	.061	1.6
Total Variable Costs	2.766	71.7
Depreciation	.611	15.8
Interest on pond investment	.482	12.5
Total Fixed Costs	1.093	28.3
Total Costs	3.859	100.0

Table 4. Composition of total revenue from *Macrobrachium*, 500 kg per pond, 255 kg tails, South Carolina, 1976.

Market class	Tail count/kg	Tail production	Percent of product	Price	Value	Percent of value	Cumulative percent of value
		(kg)	(%)	($/kg)	($)	(%)	(%)
Micros	154	55	21.6	2.07	113.85	12.3	12.3
Small	112-154	117	45.9	2.95	345.15	37.4	49.7
Medium	79-112	28	11.0	4.45	124.60	13.5	63.2
Large	57-79	34	13.3	5.60	190.40	20.7	83.9
Jumbo	35-57	16	6.3	6.68	106.88	11.6	95.5
Whopper	35	5	2.0	8.22	41.10	4.5	100.0
Total		255			921.98		

Table 5. Net revenue per .41 ha pond, 500 kg gross production, 255 kg of tails, South Carolina, 1976.

		$/Pond		$/kg
Total Revenue		921.98		3.616
Costs				
Variable	705.27		2.766	
Fixed	278.87		1.093	
Total Costs		984.14		3.859
Net Revenue		- 62.16		- .243

Table 6. Composition of total revenue from *Macrobrachium*, 500 kg yield per pond, 244 kg yield per pond, 244 kg tails, South Carolina, 1977.

Market class	Tail count/kg	Tail production	Percent of product	Price	Value	Percent of value	Cumulative percent of value
Micros	154	18	7.4	2.07	37.26	3.1	3.1
Small	112-154	28	11.5	2.95	82.60	7.0	10.1
Medium	79-111	91	37.3	4.45	404.95	34.1	44.2
Large	57-78	55	22.5	5.60	308.00	26.0	70.2
Jumbo	35-56	48	19.7	6.68	320.64	27.0	97.2
Whopper	35	4	1.6	8.22	32.88	2.8	100.0
Total		244			1,186.33		

Table 7. Net revenue per .41 ha pond, 500 kg gross production, (244 kg of tails), 1977 pilot scale harvest results, South Carolina.

		$/Pond		$/kg
Total revenue		1,186.33		4.862
Costs				
Variable*	594.72		2.437	
Fixed	278.87		1.143	
		873.59		3.580
Net revenue		312.74		1.282

* Includes a reduction of feed costs to reflect a 1.83:1 feed conversion.

Appendix Table 1. Average annual precipitation, evaporation, and deficit, by month, coastal South Carolina

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
precipitation (cm)	7.62	8.41	9.25	6.96	8.94	13.49	18.34	17.25	12.73	8.05	5.74	7.26	124.04
evaporation (% of annual)	5	5	9	10	12	12	13	12	9	8	5	0	
evaporation (cm)	5.84	5.84	10.67	11.68	13.97	13.97	15.24	13.97	10.67	9.40	5.84	0	117.09
deficit (cm)	-	-	1.42	4.72	5.03	.48	-	-	-	1.35	.10	-	13.10