Tilapia Farm Business Management and Economics:

A Training Manual

Carole R. Engle
Ivano Neira
Aquaculture/Fisheries Center
University of Arkansas at Pine Bluff
Pine Bluff, Arkansas

Printed December 2005

USAID
FROM THE AMERICAN PEOPLE

Managing Editor: Jeff Burright
Student editorial assistance provided by:
David Glindmeyer & Chris Flemming
Design: Krystal Hennes

Aquaculture CRSP | Oregon State University | 418 Snell Hall | Corvallis, OR 97331-1643

In the spirit of science, the Program Management Office of the Aquaculture Collaborative Research Support Program (CRSP) realizes the importance of providing a forum for all research results and thought and does not endorse any one particular view.

The opinions expressed herein are those of the author and do not necessarily represent an official position or policy of the United States of Agency for International Development (USAID) or the Aquaculture CRSP. Mention of trade names or commercial products does not constitute endorsement or recommendation for use on the part of USAID or the Aquaculture CRSP. The authors are solely responsible for the accuracy, reliability, and originality of work presented here, and neither USAID nor the Aquaculture CRSP can assume responsibility for the consequences of its use.

This publication is made possible under the sponsorship of USAID under Grant No. LAG-G-00-96-90015-00 and the collaborating US and Host Country institutions.

Table of Contents

Tilapia Farm Business Management

Efficient management of a tilapia farm can make the difference between profits and losses, even in years with unfavorable prices and costs. Farm management involves more than just taking care of the biological processes involved; it includes paying close attention to economic and financial measures of the farm business also. This manual will provide a practical overview of economic and financial indicators and analyses to use to better understand the performance of the tilapia farm business. This should assist farm owners and managers to make more informed management decisions on tilapia farms.

The examples used in this training manual are all based on data obtained from different tilapia farms in Kenya during the period 2000-2005. The sample budgets and analyses are based on prices and cost conditions in the country at that time with some assumptions.

Enterprise Profitability

The purpose of a business is to make money, or to generate profits. This would seem to be a simple and straightforward concept. Nevertheless, there are several different ways to look at the profitability of a business activity. The particular type of analysis to be done will vary with the time frame selected, the scope or scale of the activity being selected, and the availability of data to do the analysis.

This manual will first present an analysis of the profitability of tilapia farming under the assumption that this is a new activity for the individual. The individual is not currently in the tilapia business. The first step for this individual would be to look at whether or not tilapia farming is profitable in a general sense in a typical or representative year. For this analysis, the individual would use an enterprise budget analysis to see whether tilapia farming was profitable or not. Profits would be determined by finding whether or not revenues generated from the sale of tilapia were greater than the sum of all costs involved in tilapia production. Average or typical values would be used for all costs and prices in the analysis.

The manual will then analyze in a general way whether or not it would be profitable to make a relatively small change in the management of the farm. This change might be to expand existing hectares by building more ponds, introduce polyculture with other species, change the interest rate for loans, or it might be to change the type of feed. The manual will explain how the proposed small change can be analyzed with a partial budget. In this case, all the new costs, added benefits, reduced costs, or reduced benefits that would result from the change would combine to see whether or not, overall, the benefits exceed the costs.

For a farm that is already in business, the best way to measure profit is to evaluate it on an annual basis using an income statement. The income statement is similar to an enterprise budget except that it uses actual farm revenues and expenses rather than average or typical prices and costs. If the total farm revenues from sales generated for the period are greater than the costs, then profits were generated for that period.

Many individuals plan over a horizon broader than one year and want to know how profitable their capital investment is over time. For this analysis, an indicator known as the "internal rate of return" is used. It shows the returns to the capital investment over the life of the investment. These returns measure the profitability of the investment capital.

Finally, the manual contains a section on risk analysis in tilapia farming. The incorporation and assessment of risk levels in enterprise budgets will also be demonstrated through the use of a risk analysis computer program (Crystal Ball®).

—Enterprise Budget Analysis—

The first step in the analysis of the economics of tilapia farming is to determine if it is possible to make money generally from this type of business activity. For this, the individual must perform an analysis called an "enterprise budget analysis." An enterprise budget provides a generalized snapshot of the costs and returns of a particular enterprise—in this case tilapia production—for a particular period of time. Figure 1a presents an example of a tilapia farm budget developed with data from Kenya.

It is important to think about the time period and the budgetary unit carefully. In aquaculture, a common budgetary unit is one pond of an average size for the type of business being analyzed. The example in Figure 1a is a whole-farm budget for a 1-ha tilapia farm in Kenya. Time periods used to develop enterprise budgets can be based on one production cycle, but are most often developed for a one-year period, as is the case in Figure 1a.

The basic headings of an enterprise budget can be seen in Figure 1a. The first column lists the various items to be included. The second column lists a description of each item. It is important that each item be thoroughly described. For example, gross returns (income generated from the sale of tilapia) on most tilapia farms in Africa will come from sales of live tilapia. Costs are divided into the categories variable (those that vary with production;

Figure 1a

Enterprise budget for a 1-ha tilapia farm in Kenya, fed with pelleted diet, stocked at 3.0 tilapia/m^2. Cost and price information is given in Kenyan shillings (KSh).

Item	Description	Unit	Quantity	Price/Unit	Total Cost
Gross Receipts					
Tilapia	Live	kg	10,464	100	1,046,400
Total gross receipts					1,046,400
Variable Costs					
Tilapia fingerlings	Hatchery-raised	Individual	36,000	3	108,000
Pelleted diet	15% crude protein	kg	34,992	12	419,904
Fertilizer	Urea	kg	528	20	10,560
	Diammonium phosphate	kg	256	22	5,632
Agriculture lime	Lime	kg	2,500	3.45	8,625
Field labor: stock, feed, fertilize, harvest		KSh	365	120	43,800
Labor, levee repairs, after draining		KSh	152	120	18,240
Security personnel		KSh	365	150	54,750
Interest on operating capital		KSh	669,511	12%	80,341
Total Variable Costs (TVC)		KSh			749,852
Net Returns above TVC		KSh			296,548
Fixed Costs					
Depreciation					
Equipment		KSh			9,000
Ponds		KSh			18,000
Interest on investment		KSh			28,500
Total Fixed Costs (TFC)		KSh			55,500
Total Costs (TC)		KSh			805,352
Net returns above TC		KSh			241,048
Net returns/ha		KSh/ha			241,048
Breakeven price per kg sold					
Above TVC		KSh/kg			72
Above TC		KSh/kg			77
Breakeven yield at KSh/kg					
Above TVC		kg/ha/year			7,499
Above TC		kg/ha/year			8,054

also called operating costs) and fixed (costs that will be incurred regardless of the level of production; also called ownership costs). Under variable costs, it is important to specify whether fingerlings are mono-sex or mixed-sex because prices and production performance will be different. Feed descriptions should specify the percentage of protein, and the fertilizer description should specify the type and formulation of fertilizer. The description of each item should provide sufficient information so as to be able to identify the prices and quantities needed. Fixed costs typically require additional supporting tables to identify depreciation costs and interest levels.

The next column indicates the unit used. Units must be specified carefully and are usually selected based on the most common unit purchased. It is critical that the units, prices, and quantities across rows are all consistent. In the Gross Returns row, in the budget in Figure 1a, the unit used is kilograms. This is the unit of sale of tilapia in Kenya. The fingerlings are sold individually, and this is the unit used in the budget. Feed, fertilizer, and lime are sold in kilograms. The unit used for labor is an hourly wage rate because workers are paid by the hour. Total variable costs and the fixed cost items are specified as a total amount of Kenyan shillings (KSh). Since fixed costs are frequently detailed in other tables and statements, a simple total is listed on the budget itself.

Quantities are expressed in the next column as the total quantity needed for one year of production for the production unit specified in the enterprise budget. Since the example budget is for a 1-ha tilapia farm, all the quantities needed for a 1-ha tilapia farm for one year are listed. In this case, the basic production assumptions are listed in Figure 1b. In this example, yields are 10,464 kg/ha of live tilapia. The quantity specified for each cost item is likewise for the budget unit of the farm and corresponds to the unit specified.

The next column in the budget details prices and unit costs (Figure 1a). Tilapia are sold for an average of KSh 100/kg. These prices appear in the column under price. It is important to use average prices in an enterprise budget. All other listed prices are average expected prices for the unit listed. The interest rate used for interest on operating capital in this budget is 12%. However, interest rates may change according to the type of lender. For the purposes of this manual, an interest rate of 12% was chosen.

The next column is the total cost or total revenue. This value is obtained by multiplying the quantity by the price per unit. For example, the price of KSh 100 kg of live tilapia is multiplied by the quantity of 10,464 kg to get total revenue of KSh 1,046,400. Under variable costs, the price of KSh 12 per kilogram of pelleted diet is multiplied by the 34,992 kg of feed required for 1-ha tilapia farm for one entire year of production.

In this same column, once all the costs have been calculated, they are summed to obtain the Total Variable Costs. Subtracting Total Variable Costs from the Gross Returns gives a measure of the Returns Above Variable Costs. The positive Returns Above Variable Costs indicates that it is profitable to operate in the short term. All variable costs of production are covered. However, if Returns Above Variable Costs were negative, it would be best to minimize losses by shutting down all production activities.

In the next section of the enterprise budget, fixed costs are specified. Fixed costs include depreciation, interest on the investment, and any other costs that are not related to the actual production of the business. These costs are summed to obtain Total Fixed Costs. These are added to Total Variable Costs to obtain Total Costs. Subtracting Total Costs from Gross Returns generates Net Returns. This is the actual measure of profit for this business. In this case, net returns are positive at KSh 241,048. This level of net returns indicates that this type of enterprise, given the prices and costs used in this budget, is profitable, even in the longer term. If net returns were negative, then it would not be profitable.

—Breakeven Analysis—

Breakeven prices and yields offer additional insights into the overall feasibility of the operation. To calculate the breakeven price above variable cost, divide the total variable costs by the total quantity produced on the farm. In this budget, breakeven price above total variable cost was KSh 72/kg of tilapia produced. This indicates that tilapia production will be profitable as long as the price is above KSh 72/kg.

Breakeven price above total cost is calculated by dividing total costs by the quantity produced on 1 ha of the farm. In these budgets, this breakeven price comes out to KSh 77/kg. In other words, as long as the price of tilapia is above KSh 77/kg, this operation is profitable in the long term; all annual variable and fixed costs will be covered at this price.

Breakeven yield is calculated in a similar manner. To calculate breakeven yield above variable cost, divide total variable costs by the price and then divide by the 1 ha in the farm to obtain 7,499 kg/ha. As long as production per ha is above 7,499 kg, then it is profitable to raise tilapia in the short run. To calculate breakeven yield above total costs, divide total costs by the price and then divide by the 1 ha in the farm to obtain a breakeven yield of 8,054 kg/ha. If production levels are above 8,054 kg/ha, this operation will be profitable, even in the long run. At this level of production, there is enough production to cover both all variables and all fixed costs.

—Sensitivity Analysis—

Enterprise budgets should always be developed based on average expected prices, costs, quantities, and yields. If ten-year averages are available, these can be used, but it is important to use conservative estimates. In some cases, certain prices and costs may be highly variable. In these cases, especially when the particular price or quantity has a large effect on net returns, a type of analysis called a sensitivity analysis can be performed. In a sensitivity analysis, a range of possible values for the particular price or quantity in question is substituted for the mean value, and a table is developed.

Figures 2a, 2b, and 2c provide examples of sensitivity analyses done for the tilapia budgets by varying feed prices, survival rate, and farm size. As an example, as feed prices increased from KSh 8/kg to KSh 16/g, net returns/ha decreased from KSh 397,812 to KSh 84,284. Breakeven prices increased from KSh 62/kg to KSh 92/kg. In Figure 2b, as the survival rate increased from 75% to 95%, net returns/ha increased from KSh 149,533 to KSh 274,920 and breakeven prices above total costs decreased from KSh 83/kg to KSh 75/kg. In Figure 2c, as farm size increased from 0.5 to 8 ha, net returns/ha increased from KSh 228,445 to KSh 251,803, and breakeven prices above total costs decreased from KSh 156/kg to KSh 9/kg.

—Partial Budget Analysis—

A partial budget is developed when the farm manager is considering a relatively small change on the farm. This change may involve building additional ponds, changing type of feed, changing stocking rates with polyculture, etc.

To develop a partial budget analysis, it is necessary to define a base production scenario in sufficient detail to identify the changes that would result. The following categories are used in the partial budget: Additional Revenue, Additional Costs, Reduced Revenue, and Reduced Costs.

Additional Revenue is revenue to be received only if this alternative is adopted. It is not received under the base production scenario. Additional revenue can be received if a new enterprise is added or if there is a change that will cause yields, production levels, or selling price to increase.

Reduced Costs are those incurred under the base production scenario that would no longer exist under the treatment being analyzed. Cost reduction can be due to eliminating an enterprise, reducing input use, substituting more of one input for another, or being able to purchase inputs at a lower price. Reduced costs may be either fixed or variable. A reduction in fixed costs will occur if the proposed treatment will reduce or eliminate the current investment in machinery, equipment, breeding livestock, land, or buildings.

Figure 1b

Characteristics of a production cycle used in development of an annual enterprise budget for a 1-ha farm in Kenya (it is assumed that two ponds are simultaneously stocked with tilapia fingerlings every month to be able to have continuous production).

Production Characteristic	Unit	Value
Stocking density	tilapia/m^2	3.00
Initial number of tilapia	#	1,500
Initial weight of tilapia stocked	g	10.00
Initial biomass	g	15,000.00
Tilapia finerling cost	KSh/ind	3.00
Survival	%	90%
Cycle length	days	270.00
Year	yr	365.00
Tilapia price	KSh/kg	100.00
FCR	Ratio	3.46
Pelleted diet	KSh/kg	12.00
1 U.S. $	KSh	76.00
Growth rate tilapia	g/day	1.16
Final number of tilapia	#	1,350
Individual harvest weight of tilapia	g	323.20
Yield–live tilapia	kg/ha	10,464
Total amount of feed per batch	kg	1,458
Interest on operating capital	%	12%
Opportunity cost (savings account)	%	6%
Annual depreciation on equipment	yrs	10
Annual depreciation on ponds	yrs	20
Terms of loans for equipment and ponds	yrs	10
Proportion of capital borrowed	%	50%
Investment cost of		
Machinery and equipment	KSh	100,000
Ponds	KSh	600,000
Total amount of loan	KSh	350,000
Cash available from owner	KSh	150,000
Capital available from owner	KSh	804,000
Total investment	KSh	1,154,000
Proportion of investment capital provided by owner	%	70%
Percentage of TVC that must be borrowed at beginning of the year to operate, for income statement	%	50%

Other Assumptions	Unit	Value
Total farm area	ha	1
Area of individual ponds	ha	0.05
Cost to build ponds	KSh/pond	30,000
Land cost	KSh/ha	304,000
Ponds	#	20
Hourly wage	KSh/hr	120
Month	days	30
Batch cycle length	months	9
Average pond depth	m	0.80
Urea		
Cost	KSh/kg	20
Quantity	kg/ha	44
Diammonium phosphate		
Cost	KSh/kg	22
Quantity	kg/ha	21
Agricultural lime		
Cost	KSh/kg	3.45
Quantity	kg/ha	2,500

Additional Costs are costs that do not exist in the base production scenario. The treatment being analyzed may cause additional costs because of the use of new production inputs or the expanded use of production inputs. Substitution of more of one input for another would be another cause. Additional costs may be either variable or fixed, as there will be additional fixed costs whenever the proposed alternative requires additional capital investment.

Reduced Revenue is revenue received under the base production scenario that is not received in the treatment being analyzed. Revenue may be reduced if the change causes a reduction in yields or production levels, or if the selling price will decrease.

Once the data are compiled for each treatment in the partial budget format sketched out in Figure 3, the total value is computed within each category (i.e., all the additional costs are summed to obtain total additional costs). The value of the additional costs is added to the reduced revenue. This represents the negative or adverse effect on profits for this particular treatment. On the other side, the total value of the additional revenues is added to the reduced costs to compute the total value of the benefits of this particular treatment. The sum of the additional costs and reduced revenue is subtracted from the sum of the additional revenue and reduced costs to calculate the net change if this treatment were adopted. If the net change is negative, the base production scenario is more profitable. However, if the net change is positive, this treatment is more profitable than the base scenario. The treatment that has the highest positive net change is the most profitable alternative of those analyzed.

Figure 3 presents an analysis of a proposed change on a tilapia farm: whether or not to switch the type of feed from a pelleted diet to rice bran. The advantage of the rice bran is that it costs less than pellets. However, the disadvantage is that feed conversion ratios are higher and growth rates lower with rice bran.

In the partial budget format, there would be reduced tilapia revenue with a value of KSh 624,000. This reduced revenue results from lower yields of fish when fed rice bran as compared to pellets. No additional cost would apply to a switch from pellets to rice bran, nor would there be any additional revenue. Figure 3 also provides details of the reduced costs that would be incurred by switching to rice bran. The net change in profit would be negative (KSh 180,561). Since the net change is negative, the proposed change would not be profitable or a wise decision. If the net change had been positive, it would be profitable to make this change.

Figure 2a

Effect on net returns/ha and breakeven price above total cost of varying feed prices.

Feed Price (KSh/kg)	Net Returns (KSh/kg)	Breakeven Price (KSh/kg)
8	397,812	62
10	319,430	69
12	241,048	77
14	162,666	84
16	84,284	92

Figure 2b

Effect on net returns/ha and breakeven price above total cost of varying survival rates.

Survival Rate (%)	Net Returns (KSh/kg)	Breakeven Price (KSh/kg)
75	149,533	83
80	181,005	81
85	209,575	79
90	241,048	77
95	274,920	75

Figure 2c

Effect on net returns/ha and breakeven price above total cost of varying farm size.

Farm Size (ha)	Net Returns/ha (KSh/ha)	Breakeven Price (KSh/kg)
0.5	228,445	156
1.0	241,048	77
3.0	249,256	25
5.0	250,898	15
8.0	251,803	9

Figure 3

Partial budget analysis used to evaluate the economic effect of changing from a pelleted diet feed to rice bran which is assumed to exhibit lower cost (3.5 KSh/kg), but a higher FCR.

Value of parameters that change

	Feed		
	Pelleted diet	**Rice bran**	**Change in cost**
Tilapia sales	1,046,400	422,400	624,000
Feed total cost	419,904	72,072	347,832
Fingerlings total cost	108,000	59,904	48,096
Interest on operating capital	80,341	32,830	47,511

Additional costs (KSh)	
None	
Reduced revenue	
Tilapia sales	624,000
A. Total additional costs and reduced revenue (KSh)	624,000
Additional revenue (KSh)	
None	
Reduced costs (KSh)	
Tilapia fingerlings	48,096
Feed	347,832
Interest on operating capital	47,511
B. Total additional revenue and reduced costs (KSh)	443,439
Net change in profit (B-A)	(180,561)

Monitoring Business Performance

—Monitoring Profits—

A financial statement, referred to as an income statement or a profit and loss statement, is used to monitor profits in a farm business from one year to the next. The income statement itemizes all farm income and all farm expenses. The fundamental indicators calculated in the income statement are net farm income from operations and net farm income.

Figure 4 illustrates an income statement for the 1-ha tilapia farm. Revenue is KSh 1,046,400. Expenses are divided into cash and non-cash (depreciation) expenses. Thus, variable costs are included under Cash Farm Expenses. Interest paid on long-term loans (KSh 39,607) is added to Total Variable Cash Expenses for Total Cash Expenses of KSh 749,289.Depreciation costs are included under Non-Cash Adjustments to Income. Net Farm Income From Operations is obtained by subtracting Non-Cash Adjustments to Income from Net Cash Farm Income to obtain KSh 270,111. Any gain or loss from the sale of capital assets such as machinery or land would be used to adjust Net Farm Income From Operations to calculate Net Farm Income.

—Monitoring Solvency and Liquidity—

Solvency and liquidity are important financial measures of the overall well-being of a business. Solvency refers to the value of the assets owned by the business as compared to the amount of liabilities. Assets, of course, refer to the value of anything owned by the business, whereas liabilities refer to any debt obligations that the business has outstanding. Liquidity refers to the ability of a business to meet cash flow obligations. Liquidity is critical to maintain smoothly running financial transactions of the business.

A financial instrument known as the balance sheet is used as the basis for measuring and monitoring solvency and liquidity in the farm business. The balance sheet lists all assets and liabilities for the business. Net worth, also known as owner equity, is calculated on the balance sheet by subtracting the total value of all liabilities from the total value of all assets of the business.

Figure 5 presents an example of a balance sheet for the 1-ha tilapia farm. The current assets include the cash available in the farm business and total KSh 190,000. Owned equipment and farm infrastructure are listed under noncurrent assets. Total assets are KSh 1,194,000. Current liabilities include the payments due over the next year for the tilapia farm. Noncurrent liabilities include the remainder of the equipment and pond construction loans. Total liabilities are KSh 483,694.

Total owner equity is KSh 710,306. Over time, the net worth should increase as the liabilities decrease and assets increase through equity gained with payments of principal.

Figure 4

Income statement for a 1-ha tilapia farm in Kenya, fed with pelleted diet, stocked at 3.0 tilapia/m^2

Revenue	
Tilapia Sales	1,046,400
Total Income	**1,046,400**
Cash Farm Expenses	
Variable Cash Expenses	
Fingerlings	108,000
Feed	419,904
Fertilizer	16,192
Lime	8,625
Field labor: stock, feed, fertilized, harvest	43,800
Labor, levee repairs, after draining	18,240
Security personnel	54,750
Interest on operating line of credit[a]	40,171
Total Variable Cash Expenses	**709,682**
Fixed Cash Expenses	
Interest paid on long-term loans[b]	39,607
Total Fixed Cash Expenses	**39,607**
Total Cash Expenses	**749,289**
Net Cash Farm Income (income above variable costs)	**297,111**
Non-Cash Adjustments to Income	
Fish inventory adjustment	-
Depreciation on equipment	(9,000)
Depreciation on ponds	(18,000)
Net Farm Income From Operations	**270,111**
Gain/Loss on sale of capital assets	
Machinery	-
Land	-
Other	-
Net Farm Income	**270,111**

Total Interest Expense	79,778
Opportunity Cost of Unpaid Labor	15,000
Opportunity Cost of Management	25,000
Total Farm Assets	1,194,000
Opportunity Cost of all Capital (6% of Total Farm Assets)	71,640
Net Worth (Owner's Equity)	710,306
Return on Assets	**309.889**
Rate of Return on Assets	**26%**
Return on Equity	**230,111**
Rate of Return on Equity	**32%**
Operating Profit Margin Ratio	**0.30**
Return to Labor and Management	**278,249**
Return to Labor	**253,249**
Return to Management	**263,249**

[a] 50% of total variable cost must be borrowed at beginning of the year to operate.

[b] Interest for equipment and ponds loan paid the second year. (See Tables 1 and 2, page 25)

Figure 5

Balance sheet for a 1-ha tilapia farm in kenya, fed with pellets, stocked at 3.0 tilapia/m^2. Values are given in Kenyan shillings. (End of second year of operation)

Asset/Liability	
Current Assets	
Cash/checking account	50,000
Inventories	
Crops (Tilapia fingerlings)	-
Accounts receivable	140,000
Total Current Assets	**190,000**
Noncurrent Assets	
Machinery and equipment	100,000
Land	304,000
Ponds	600,000
Total Noncurrent Assets	**1,004,000**
Total Assets	**1,194,000**
Current Liabilities	
Payments on debt due and payable over next year	175,976
Total Current Liabilities	**175,976**
Noncurrent Liabilities	
Equipment Loan	43,960
Pond Loan	263,758
Total Noncurrent Liabilities	**307,718**
Total Liabilities	**483,694**
Owner Equity	
Contributed capital	670,306
Retained earnings	40,000
Total Owner Equity	**710,306**
Total Liabilities and Owner Equity	**1,194,000**

Measuring Efficiency

—Production & Input Use Efficiency—

Production efficiency refers to biological measures that are maintained by most farms. The key variables to use here would include measures such as yield of live tilapia per hectare, survival, growth of tilapia, and others as listed in Figure 1b. Input use efficiency measures can also be used to evaluate farm efficiency. The feed conversion ratio is the most important measure of input use efficiency, but similar measures can be calculated for labor, utility use, and other inputs. The farm manager should review these types of measures at least once a year and compare them with previous years. This manual will concentrate on economic and financial measures and will not go into production or biological efficiency measures.

—Financial Efficiency—

Financial efficiency measures are designed to measure solvency and liquidity and to identify weaknesses in structure or mix of types of assets and liabilities. The primary sources of data to calculate financial measures are the balance sheet and the income statement.

—Solvency—

Solvency refers to the value of assets owned by the business compared to the amount of liabilities owed. Common measures of solvency include the following:

Debt/Asset Ratio. The debt/asset ratio is a measure of business solvency. The debt asset ratio is calculated by dividing total farm liabilities by total farm assets using current market values for each.

$$\text{Debt/asset ratio} = \frac{\text{total farm liabilities}}{\text{total farm assets}}$$

Smaller values are preferred to larger ones. Smaller values indicate a better chance of maintaining the solvency of the business should it be faced with a period of adverse economic conditions. Low debt/asset ratios may also indicate that a manager is reluctant to use debt capital to take advantage of profitable investment opportunities. In Figure 6, the debt/asset ratio for the example 1-ha tilapia farm is 0.41. This value is less than 1 and indicates a solvent business. This indicator should decrease as equity in the business grows.

Equity/Asset Ratio. The equity/asset ratio indicates what part of total assets is financed by the owner's equity capital.

$$\text{Equity/asset ratio} = \frac{\text{total equity}}{\text{total assets}}$$

Higher values of the equity/asset ratio are preferred, but the value of this ratio cannot exceed 1. If the equity/asset ratio = 1, liabilities then must be 0. An insolvent business would have a negative equity/asset ratio because equity would be negative. The equity/asset ratio for the 1-ha farm in Figure 6 is 0.59. There is high equity in this business. This example is for a new business with little debt load. Over time, as the loans are paid off, equity will increase in relation to the level of assets.

Debt/Equity Ratio. The debt/equity ratio is also called the leverage ratio. The debt/equity ratio compares the proportion of financing provided by lenders with that provided by the business owner.

$$\text{Debt/equity ratio} = \frac{\text{total liabilities}}{\text{total equity}}$$

When the debt/equity ratio = 1, lenders and owner are providing an equal amount of financing. Smaller values of the debt/equity ratio are preferred. The debt/equity ratio will approach zero as liabilities approach zero. Very large values result from very low equity, which means an increasing chance of insolvency. The debt/equity ratio for the 1-ha tilapia farm in Figure 6 is 0.68. In this example farm, there is very high equity because the majority of the capital is owned, indicating high solvency. Thus, this low value indicates a relatively low level of financial risk in the early years of the business.

Change in Net Worth. A change in net worth indicates business growth, additional capital investment, and a greater borrowing capacity.

$$\text{Net worth} = \text{total assets} - \text{total liabilities}$$

The owner would want to see net worth increase over time.

Figure 6

Financial efficiency indicators for a 1-ha tilapia farm in kenya, fed with pellets, stocked at 3.0 tilapia/m^2.

Debt/asset ratio	=	total farm liabilities / total farm assets	=	483,694 / 1,194,000	=	0.41
Equity/asset ratio	=	total equity / total assets	=	710,306 / 1,194,000	=	0.59
Debt/equity ratio	=	total liabilities / total equity	=	483,694 / 710,306	=	0.68
Net worth	=	total assets – total liabilities	=	1,194,000 – 483,694	=	710,306
Current ratio	=	current farm assets / current farm liabilities	=	190,000 / 175,976	=	1.08
Working capital	=	current assets – current liabilities	=	190,000 – 175,976	=	14,024
Return to labor and management	=	net farm income from operations + interest expenses adjusted net farm income (ANFI) – opportunity cost of capital	=	270,111 + 79,778 349,889 – 71,640	=	278,249
Returns to labor	=	return to labor and management – opportunity cost of management	=	278,249 – 25,000	=	253,249
Returns to management	=	return to labor and management – opportunity cost of labor	=	278,249 – 15,000	=	263,249
Return on assets	=	net farm income from operations + interest expenses – opportunity cost of labor – opportunity cost of management	=	270,111 + 79,778 – 15,000 – 25,000	=	309,889
Rate of return on farm assets	=	return on assets / average asset value x 100	=	309,889 / 1,194,000 x 100	=	26%
Return on equity	=	net farm income from operations – opportunity cost of labor – opportunity cost of management	=	270,111 – 15,000 – 25,000	=	230,111
Rate of return on farm equity	=	return to equity / average equity value x 100	=	230,111 / 710,306 x 100	=	32%
Operating profit margin ratio	=	return to assets / gross revenue of farm	=	230,111 / 1,046,400	=	0.22

—Liquidity—

Liquidity is the ability of a business to meet cash flow obligations Liquidity is important to keep financial transactions of the business running smoothly. Common measures of liquidity include the following:

Current Ratio. The current ratio is a quick indicator of a firm's liquidity. Current assets will be sold or turned into salable products in the near future and will generate cash to pay debt obligations that come due.

$$\text{Current ratio} = \frac{\text{current farm assets}}{\text{current farm liabilities}}$$

The higher the value of the current ratio, the more liquid. The current ratio is 1.08 for the 1-ha farm in Figure 6. In future years, this value should increase because payments on debt will lower liability levels.

Working Capital. Working capital is the difference between current assets and current liabilities. It represents excess shillings available from current assets after current liabilities have been paid. Working capital for the example farm in Figure 6 is KSh 14,024. This value will increase as growth of the tilapia crop increases asset values.

—Profitability—

A business that is both solvent and liquid will not necessarily be profitable. Profitability is calculated generally by subtracting total costs from total revenue. It is measured from the income statement. However, net farm income can be further partitioned into returns or profits attributable to each of the four primary factors of production: land, labor, capital, and management. Returns to capital can be further partitioned into returns to equity capital (capital owned by the farmer).

Net Farm Income. Net farm income measures the return to operator's equity, capital, unpaid labor, and management. It is measured from the income statement. Net farm income is measured as follows:

Total revenue,
Less total expenses,
Equals net farm income from operations,
Plus or minus the gain/loss on the sale of capital assets,
Equals net farm income.

The gross farm revenue "pie" can be divided among the parties who supply resources to the farm business.

Return to Labor and Management. The return to labor and management is what remains from net farm income after charging out returns for the use of all capital. Some businesses have more assets or borrow more money than others.

Return to labor and management is calculated as follows:

Net farm income from operations,
Plus interest expenses,
Equals adjusted net farm income,
Less opportunity cost of capital.

The returns to labor and management can be further partitioned into returns to either labor or returns to management. These measures indicate whether net farm income was sufficient to provide a return at least equal to the opportunity costs of labor and management. Return to labor is calculated as:

Return to labor and management,
Less opportunity cost of management,
Equals return to labor.

Returns to labor for the 1-ha tilapia farm in Figure 6 are KSh 253,249. This is a positive return to the labor resources used.

Return to Management. Return to management is that portion of adjusted net farm income remaining after opportunity costs of both labor and capital have been subtracted. It represents a residual return to the owner for the management input. Negative returns to management are not unusual, but positive net returns should be the goal. Returns to management are calculated as:

Return to labor and management,
Less opportunity cost of labor,
Equals return to management.

Returns to management for the 1-ha tilapia farm are KSh 263,249 (Figure 6). These are positive returns to the management resource used.

Rate of Return on Farm Assets (ROA). The rate of return on farm assets can be compared to rates of return on other long-term investments. It is calculated as follows:

Rate of return on assets (%) =
$$\frac{\text{return to assets}}{\text{average asset value}} \times 100$$

The ROA is independent of the type and amount of financing. It can be compared to other similar farms, returns from other investments, opportunity costs of the farm's capital, and past ROAs for the farm to measure profitability.

Return to assets is calculated as follows:

Adjusted net farm income,
Less opportunity cost of unpaid labor,
Less opportunity cost of management,
Equals return to assets.

In Figure 6, the rate of return on farm assets is 26%. This rate of return is reasonable for many types of agricultural operations.

Rate of Return on Farm Equity (ROE). The rate of return on farm equity is more indicative of the farm's financial progress. It measures the percent return to owner's net worth or equity. If the farm has no debt, the return on equity is equal to the return on assets. It is calculated as:

Rate of return on equity (%) =
$$\frac{\text{return on equity}}{\text{average equity}} \times 100$$

The return on equity is calculated as follows:

Net farm income from operations,
Less opportunity cost of unpaid labor,
Less opportunity cost of management,
Equals return on equity.

The rate of return on equity in Figure 6 is 32%. This low rate reflects the high amount of equity for the business.

Operating Profit Margin Ratio. The operating profit margin ratio measures the proportion of gross revenues left after paying expenses. It is calculated as:

$$\text{OPMR} = \frac{\text{return to farm assets}}{\text{gross revenue of farm}}$$

The higher the value, the more profit the business is generating per dollar of revenue. Farms with large investments in fixed assets such as land and few operating expenses will show a higher OPMR. Farms with more rented assets will have a higher ROA but a lower OPMR.

The only problem is if both ROA and OPMR are below average; then problems of profitability are evident. The operating profit margin ratio is 0.22. This indicates that, for every Kenyan shilling of revenue, 22 cents remained as profit after paying the operating expense needed to generate that shilling.

—Cash Flow—

There are financial considerations that can be as important to the economic feasibility of a business as profitability. Positive cash flow can often make the difference between success and failure of an aquaculture business, especially in the early years of start up.

A cash flow budget is one of the most useful financial instruments. It provides critical insights into whether the business will have adequate cash available when needed to meet its financial obligations. It can be used to evaluate borrowing needs and to determine cash needed to repay any new loans.

Cash flow budgets can be structured differently depending upon the purpose for which the analysis is being developed. For detailed financial planning, monthly cash flow budgets are useful. Quarterly budgets can be used to develop estimates of cash flow needs over a several-year period. Annual cash flow budgets are used in investment analyses to determine cash flow over the life of the investment.

There are certain key principles to keep in mind when constructing a cash flow budget. Minor as it may seem, it is important to keep in mind that only cash inflows and outflows are considered. No non-cash revenue or non-cash expenses are considered. Thus, a cash flow budget cannot be used to measure profit. The enterprise budget or the income statement is used to measure profit, not the cash flow budget. For example, depreciation is not included in the cash flow budget, but payments of principal and interest on all loans are.

Inventory values are not included, but the proceeds from sales of any capital assets are included.

A primary concern in the cash flow budget is the timing of receipt of revenue and expenses. Each type of revenue or expense is charged during the specific period when it is incurred. Thus, if a major capital asset is purchased during a given period, it is charged at that time in its entirety.

The cash flow budget begins with a beginning cash balance, or the amount of cash on hand at the beginning of the period. This is followed by each source of farm cash revenue generated by sales of the crop or of other capital assets. The cash revenue items are summed to generate total cash inflow for the time period.

Operating expenses are itemized first. This is followed by expenses associated with the purchase of capital assets such as equipment or breeding stock. When the cash flow budget is to be used to apply for financing of a loan, family living expenses are also included. The next section on expenses includes principal and interest payments for each separate loan. All expenses are summed to calculate total cash outflow.

The difference between total cash inflow and total cash outflow is the cash available. If the cash available is negative, this means that there is insufficient cash generated during the period to meet all cash obligations, and additional borrowing is needed for that time period. After adding in the new borrowing, the cash balance is obtained. Cash balance becomes the beginning cash available at the start of the next time period.

At the bottom of the cash flow budget, it is useful to keep an accounting of the debt outstanding for each loan. In this manner, principal payments in a time period can be subtracted out of the balance owed.

Figure 7 presents a quarterly cash flow budget for the 1-ha tilapia farm example for the second year of production. This is a quarterly budget describing the cash inflows and outflows during a typical business year. One production cycle is conducted per year. The same amounts of operating expenses are incurred in each quarter, respectively. However, receipts from tilapia sales are recorded in each quarter. Living expenses amount to KSh 50,000 per quarter. Annual payments of pond and equipment loans are scheduled for the fourth quarter.

Because there is a constant monthly production, all the operating expenses and tilapia sale receipts are the same for all the quarters. The ending cash balance must always be positive and, in this particular example, higher than KSh 50,000 (this quantity is not a fixed rule). New operating loans must be made if there is a cash deficit. These loans must be repaid as soon as possible, with interest charges being calculated over the lifetime of the loan.

In the cash flow budget, some beginning cash is assumed and, because it is the second year of production, KSh 261,600 of revenue are assumed to be available from sale of tilapia in each quarter (Figure 7). The cash inflow generated by the production every quarter of the second year is more than sufficient to make partial payments on loans. The ending cash balance must always be positive and, in this particular example, equal or higher than KSh 50,000 (this quantity is not a fixed rule). Three payments of KSh 50,000 and KSh 49,213 in the last quarter of the second year cover the whole operating expenses of the carryover debt. Figure 7 assumes carryover debt of KSh 199,213 from the preceding year. With an interest rate of 12%, interest charges were calculated as follows:

First-quarter:
KSh 199,213 x 12% x 3/12 of a year =KSh 5,976

Second-quarter:
KSh 149,213 x 12% x 3/12 of a year =KSh 4,476

Third-quarter:
KSh 99,213 x 12% x 3/12 of a year =KSh 2,976

Fourth-quarter:
KSh 49,213 x 12% x 3/12 of a year =KSh 1,476

Total KSh 14,906

Figure 7

Quarterly cash flow budget for a 1-ha tilapia farm in Kenya, fed with pellets, stocked at 3.0 tilapia/m^2. Second year of production. Values are given in Kenyan shillings.

Item	Quarter I	Quarter II	Quarter III	Quarter IV	Total
Beginning Cash	**50,000**	**38,246**	**27,992**	**19,238**	**50,000**
Receipts from tilapia sold	261,600	261,600	261,600	261,600	1,046,400
Cash Inflow	**311,600**	**299,846**	**289,592**	**280,838**	**1,096,400**
Operating Cash Expenses					
Fingerlings	27,000	27,000	27,000	27,000	108,000
Feed	104,976	104,976	104,976	104,976	419,904
Urea	2,640	2,640	2,640	2,640	10,560
Diamonium phosphate	1,408	1,408	1,408	1,408	5,632
Lime	2,156	2,156	2,156	2,156	8,625
Field labor: stock, feed, fertilized, harvest	10,950	10,950	10,950	10,950	43,800
Labor, levee repairs, after draining	4,560	4,560	4,560	4,560	18,240
Security personnel	13,688	13,688	13,688	13,688	54,750
Total Operating Expenses	**167,378**	**167,378**	**167,378**	**167,378**	**669,511**
Living Expenses	**50,000**	**50,000**	**50,000**	**50,000**	**200,000**
Other Expenses	**-**	**-**	**-**	**-**	**-**
Scheduled Debt Payments					
Pond Principle	-	-	-	19,147	19,147
Interest (12% APR)	-	-	-	33,949	33,949
Equipment Principle	-	-	-	3,191	3,191
Interest (12% APR)	-	-	-	5,658	5,658
Operating Principle	50,000	50,000	50,000	49,213	199,213
Interest (12% APR)	5,976	4,476	2,976	1,476	14,906
Total Cash Outflow	**273,354**	**271,854**	**270,354**	**330,011**	**1,145,573**
Cash Available	**38,246**	**27,992**	**19,238**	**(49,173)**	**(49,173)**
New Borrowing	**-**	**-**	**-**	**99,173**	**99,173**
Cash Balance	**38,246**	**27,992**	**19,238**	**50,000**	**50,000**
Debt Outstanding					
Ponds	282,905	282,905	282,905	263,758	263,758
Equipment	47,151	47,151	47,151	43,960	43,960
Operating	149,213	99,213	49,213	99,173	99,173

Cash Flow Coverage Ratio	**-0.79**
Debt-Servicing Ratio	**0.25**
Cash Flow Risk and Sensitivity Ratio	
excess available cash/total cash available	-0.04
excess available cash/cash operating expenses	-0.07
excess available cash/total liabilities	-0.12

Notice that the life of an individual loan depends on the amount of time elapsed until loan repayment. For instance, interest charges for the first partial payment of the carryover debt are calculated over a period of three months because the payment is made at the end of the first quarter. Notice also that a debt outstanding remains at the end of each quarter because some cash must be kept for unforeseen expenses and also because receipts are not sufficient to make complete payment of this debt.

Cash available at the end of the first quarter becomes the beginning cash of the next quarter. If cash available is positive, no new borrowing is needed. However, if cash available is negative, as in the fourth quarter, then new borrowing is needed to both meet the cash shortfall of the next quarter and provide some cash to begin the next quarter. Payments made on a loan during the quarter are subtracted out of the debt outstanding lines.

Figure 8 (page 26) presents a yearly cash flow budget for the 1-ha tilapia farm example for the horizon of the project (10 years). This is a yearly budget describing the cash inflows and outflows during the horizon of this project. One production cycle is conducted per year. Scheduled debt payments and debt outstanding are obtained from Tables 1 and 2 that show pond and equipment estimation loans for equal yearly payments.

Table 1

Amortization of pond loan. All figures in Kenyan shillings, 12% annual interest rate.

Amount of the loan (KSh)	300,000
Interest rate	12%
Years of the loan	10

Year	Total Payment	Payment of Interest	Payment of Principal	Principal Balance
1	53,095	36,000	17,095	282,905
2	53,095	33,949	19,147	263,758
3	53,095	31,651	21,444	242,314
4	53,095	29,078	24,018	218,296
5	53,095	26,196	26,900	191,396
6	53,095	22,968	30,128	161,269
7	53,095	19,352	33,743	127,526
8	53,095	15,303	37,792	89,734
9	53,095	10,768	42,327	47,406
10	53,095	5,689	47,406	-

Table 2

Amortization of equipment loan. All figures in Kenyan shillings, 12% annual interest rate.

Amount of the loan (KSh)	50,000
Interest rate	12%
Years of the loan	10

Year	Total Payment	Payment of Interest	Payment of Principal	Principal Balance
1	8,849	6,000	2,849	47,151
2	8,849	5,658	3,191	43,960
3	8,849	5,275	3,574	40,386
4	8,849	4,846	4,003	36,383
5	8,849	4,366	4,483	31,899
6	8,849	3,828	5,021	26,878
7	8,849	3,225	5,624	21,254
8	8,849	2,551	6,299	14,956
9	8,849	1,795	7,055	7,901
10	8,849	948	7,901	-

Figure 8

Annual cash flow budget for a 1-ha tilapia farm in Kenya, fed with pellets, stocked at 3.0 tilapia/m^2. Values are given in Kenyan shillings.

Item	Year 0[a]	Year 1	Year 2	Year 3	Year 4	Year 5
Beginning Cash		**150,000**	**50,000**	**50,000**	**47,492**	**162,436**
Receipts from tilapia sold		348,800	1,046,400	1,046,400	1,046,400	1,046,400
Cash Inflow		**498,800**	**1,096,400**	**1,096,400**	**1,093,892**	**1,208,836**
Operating Cash Expenses						
Fingerlings		108,000	108,000	108,000	108,000	108,000
Feed		279,936	419,904	419,904	419,904	419,904
Urea		6,125	10,560	10,560	10,560	10,560
Diamonium phosphate		3,267	5,632	5,632	5,632	5,632
Lime		5,003	8,625	8,625	8,625	8,625
Field labor: stock, feed, fertilized, harvest		25,404	43,800	43,800	43,800	43,800
Labor, levee repairs, after draining		10,579	18,240	18,240	18,240	18,240
Security personnel		31,755	54,750	54,750	54,750	54,750
Total Operating Expenses		**470,068**	**669,511**	**669,511**	**669,511**	**669,511**
Living Expenses		**116,000**	**200,000**	**200,000**	**200,000**	**200,000**
Other Expenses		**-**	**-**	**-**	**-**	**-**
Scheduled Debt Payments						
Pond Principle		17,095	19,147	21,444	24,018	26,900
Interest (12% APR)		36,000	33,949	31,651	29,078	26,196
Equipment Principle		2,849	3,191	3,574	4,003	4,483
Interest (12% APR)		6,000	5,658	5,275	4,846	4,366
Operating Principle		-	199,213	99,173	-	-
Interest (12% APR)		-	14,906	2,975	-	-
Total Cash Outflow		**648,013**	**1,145,573**	**1,033,604**	**931,455**	**931,455**
Cash Available		**(149,213)**	**(49,173)**	**62,796**	**177,741**	**292,685**
New Borrowing		**199,213**	**99,173**	**-**	**-**	**-**
Cash Balance		**50,000**	**50,000**	**62,796**	**177,741**	**292,685**
Debt Outstanding						
Ponds		282,905	263,758	242,314	218,296	191,396
Equipment		47,151	43,960	40,386	36,383	31,889
Operating		199,213	99,173	-	-	-
Net Cash Flow[b]	(1,154,000)	(121,268)	376,889	376,889	376,889	376,889
NPV	1,084,883					
IRR	20%					

[a] A year 0 is included to account for total investment costs (construction of ponds and buildings and aquisition of equipment).

[b] Values in the row "Net Cash Flow" are calculated as the difference between annual receipts and the sum of operating and other expenses. Living expenses and debt payments are not included in this calculation. Net Cash Flow values are used in the calculation of NPV and IRR.

Year 6	Year 7	Year 8	Year 9	Year 10
277,381	**392,325**	**507,270**	**622,214**	**737,159**
1,046,400	1,046,400	1,046,400	1,046,400	1,046,400
1,323,781	**1,438,725**	**1,553,670**	**1,668,614**	**1,783,559**
108,000	108,000	108,000	108,000	108,000
279,936	279,936	419,904	419,904	419,904
6,125	6,125	10,560	10,560	10,560
3,267	3,267	5,632	5,632	5,632
5,003	5,003	8,625	8,625	8,625
25,404	25,404	43,800	43,800	43,800
10,579	10,579	18,240	18,240	18,240
31,755	31,755	54,750	54,750	54,750
470,068	**470,068**	**669,511**	**669,511**	**669,511**
116,000	**116,000**	**200,000**	**200,000**	**200,000**
-	**-**	**-**	**-**	**-**
30,128	33,743	37,792	42,327	47,406
22,968	19,352	15,303	10,768	5,689
5,021	5,624	6,299	7,055	7,901
3,828	3,225	2,551	1,795	948
-	-	-	-	-
-	-	-	-	-
931,455	**931,455**	**931,455**	**931,455**	**931,455**
407,630	**522,575**	**637,519**	**752,464**	**867,408**
-	**-**	**-**	**-**	**-**
407,630	**522,575**	**637,519**	**752,464**	**867,408**
161,269	127,526	89,734	47,406	-
26,878	21,254	14,956	7,901	-
-	-	-	-	-
376,889	376,889	376,889	376,889	376,889

Compiling a Business Plan

A carefully prepared and well thought-out business plan is an essential step in either initiating or monitoring the financial performance of a business. There are two major components of a business plan: the marketing plan and the financial analysis.

The marketing plan is often the most overlooked component of a business plan. Many growers focus on the technical aspects of fish production and do not spend time considering market opportunities. Yet the most successful aquaculture businesses often are those that are market-oriented, have diverse markets, and are committed to their customers.

A potential producer should begin by talking to all local retail operations or stands in the open-air market that handle the aquatic crop to be raised. Even if the grower intends to sell strictly to a processing plant, it is important to understand the product qualities and characteristics expected by the retail operators and end consumers. For those who intend to sell directly to a processing plant, some key considerations are:

1) Historical prices paid;

2) Dockage rates (kilograms or percentage deducted from the total delivery rate) for trash-fish, out-of-size product, etc;

3) Transportation charges;

4) Payment frequency to growers;

5) Delivery volume requirements;

6) Quality standards, procedures, and requirements including flavor scores, sizing, and meat quality;

7) Delivery quotas and scheduling patterns for delivering product; and

8) Availability of delivery contracts.

The business plan should include a thorough discussion of the proposed production system, stocking rates, fingerling sources, and anticipated feed rates. For example, the feed rate should be appropriate for the stocking rate. Possible production problems such as disease occurrence should be mentioned. There are many excellent books on the preparation of a business loan proposal on farm management and on the financial analysis of agricultural businesses.

The business plan should include the following financial statements:

1) Annual estimated costs and returns. Also known as an enterprise budget, this statement is described above.

2) Estimate of required financing. The business proposal must clearly summarize financing requirements for the fish farm. Required financing should be divided into the following loan categories: operating, equipment, and real estate. The amount of capital for an operating loan is based on the amount of variable cost required. Equipment loans cover the purchase of any new or additional equipment necessary, while a real estate loan covers the cost of constructing ponds, buildings, or other relatively permanent structures. Repayment schedules should be specified to demonstrate how revenues will cover debt payments.

3) Pro forma balance sheet. This statement is described on page 14. Minimum standards used by lenders to evaluate the current ratio (also referred to as working capital on current position asset/ liabilities) range from 1.3 to 1.5 with the higher level being preferred.

4) Pro forma income statement. This statement is described on page 14 in detail.

5) Pro forma cash flow budget. This statement is described in detail on page 22. Cash flow budgets need to be prepared for each year of the life of equipment that is financed. Family living expenses should be included in the cash flow budget to ensure that the need for income for family support does not conflict with business cash needs.

6) Personal financial statement. This is only required for business plans that will be used to request a loan.

7) Brief resumé of borrower. This is only required for business plans that will be used to request a loan. Operating capacity and management skills will be critical to the success of the tilapia business. If the owner does not have these skills, the business proposal must include funds to hire a manager.

In evaluating a business plan and loan application, lenders will take into consideration several factors. Owner equity, the current ratio (from the balance sheet), the loan to appraisal value, and the value of farm production are key indicators for many lenders. The overall character and honesty of the individual is also considered. Earnings will be examined in great detail along with repayment capacity. These will be viewed in terms of sustaining production over a three-year price cycle. Collateral and capital of the individual operator will also affect the level of the lender's decision.

Investment Analysis

Capital on a farm or other business can be used in two general types of investments:

1) Operating inputs; and
2) Capital assets such as land, machinery, buildings, and orchards.

Analytical methods used to evaluate the two different types of capital use need to be different because timing of expenses and returns is different. Production inputs have expenses and returns typically within one year or less whereas investments in capital assets mean large initial purchases and then additional operating expenses and returns spread over a number of future time periods. Investment refers to the addition of intermediate and long-term assets to business. These types of assets have long-lasting consequences.

Three principle indicators of investment returns will be presented:

1) Payback Period
2) Net Present Value
3) Internal Rate of Return

—Payback Period—

The payback period is the number of years it would take for an investment to return its original cost through the annual net cash revenues it generates. If net cash revenues are constant each year, the payback period can be calculated as follows:

$$P = \frac{I}{E}$$

where:
P = payback period in years
I = amount of investment
E = expected annual net revenue

Where annual net cash revenues are not equal, they should be summed year by year to find the year where the total is equal to the amount of the investment. The payback period can be used to rank investments according to the payback period (a shorter period is better). The payback period has the advantage of being easy to use, and it quickly identifies investments with the most immediate cash returns. Disadvantages of the payback period are that it ignores any cash flows occurring after the end of the payback period and it ignores the timing of cash flows during the payback period. The payback period is more a measure of the investment's contribution to liquidity than to profitability. It is not the best method for evaluating the profitability of an investment. According to the annual cash flow budget presented in Figure 8, the payback period for the 1-ha tilapia farm would be 3.53 years. This is calculated from the average net cash flows over the 10-year useful life of the project. Nevertheless, the cash flow budget shows that it would be well into the fifth year before this level of investment would be paid off.

—Net Present Value—

Net present value (NPV) is also known as the discounted cash flow method. Net present value is equal to the sum of the present values for each year's net cash flow less the initial cost of the investment. Present value (PV) is equal to the current value of a sum of money to be received or paid in the future. It is found using a process called discounting (future value discounted back to the present to find the present value). It is equal to the sum of present values for each year's net cash flow less the initial cost of the investment. It can also be viewed as that sum of money which would have to be invested now at the given interest rate to equal the future value on the same date (interest rate is called the discount rate). Compounding and discounting are opposite or inverse procedures. A present value is compounded to find its future value and a future value is discounted to find its present value. Mathematically, NPV is calculated as follows:

$$NPV = \frac{P_1}{(1+I)^1} + \frac{P_2}{(1+I)^2} + K\,\frac{P_n}{(1+I)^n} - C$$

where:
NPv= Net Present Value
P_n = net cash flow in year n
I = discount rate
C = initial cost of investment

Investments with a positive net present value would be accepted; those with a negative NPV are rejected, and a zero value makes the investor indifferent. With a positive NPV, the rate of return of the investment is higher than the discount rate used, and it is greater than the opportunity cost of capital used as the discount rate. The limitations of the NPV analysis are that it depends on the discount rate and that it does not determine the actual rate of return. The NPV for the 1-ha tilapia farm is KSh 1,084,883, using a discount rate of 6% (Figure 8).

—Internal Rate of Return—

The internal rate of return (IRR) is the actual rate of return on the investment with proper accounting for the time value of money. It is also called the marginal efficiency of capital or yield on investment. The equation used is that for the NPV, but the equation is solved for I, the interest rate when NPV = 0. This equation is actually difficult to solve. It requires trial and error, but it can be solved through Microsoft Excel® and other programs. Its interpretation is that any investment with an IRR greater than the opportunity cost of capital is profitable. Some investors select an arbitrary cutoff point. Unlike the NPV, it can be used to rank investments which have different initial costs and lives. The limitation of the IRR is that it implicitly assumes that annual net returns or cash flows can be reinvested to earn a return equal to the IRR. If IRR is fairly high, this may not be possible and the IRR may overestimate the actual rate of return. The IRR calculated for the 1-ha tilapia farm in Figure 8 was 20%. Since this is higher than the 6% interest rate on savings accounts prevalent in Kenya (which would equate to the opportunity cost of capital), the conclusion would be that the investment in this farm operation would be a profitable investment.

Risk Analysis Through the Use of Risk Software

The concept of risk in agriculture enterprises refers to the level of uncertainty under which the different farm operations are carried out. In aquaculture farms, risk can be introduced by many factors. For instance, a failure in the aeration systems may lead to lethal dissolved oxygen (DO) concentrations during the evening hours, resulting in a massive fish kill. Incidents of this type bring about a reduction in the expected production levels. Risk is then introduced as the farm manager sees gross receipts drop to a level that may not be sufficient to cover operating expenses. Repeated episodes of low DO concentrations could cause enormous financial losses, eventually leading to the closure of the operation.

Uncertainty on the technical aspects of aquaculture production is not the exclusive source of risk. Fluctuations in input and output prices can make the difference between profit and losses. Of course, a higher degree of variability in prices will translate into a higher degree of risk in the operation. Unfortunately, risk cannot be measured from the enterprise budgets because these budgets are based on average values and reflect the expected level of net income generated by the farm. Sensitivity analyses represent an approach to measure risk. These analyses evaluate at what degree enterprise profitability is affected by changes in specific budget items. However, this type of analysis demands considerable time and effort, particularly if one wants to evaluate the effect of two or more changes.

Fortunately there are a number of commercially available software products that allow the user to incorporate a variability component into spreadsheet-based enterprise budgets and to measure the resulting risk level. One such program is Crystal Ball®, which functions as an add-in program to regular spreadsheets. The use of Crystal Ball as a risk analysis tool will be illustrated with an example based on the enterprise budget of Figure 1a (this example is included in the worksheet "Risk" within the Excel file "Examples").

Crystal Ball is a program that works within the MS Excel® platform. Upon installation of the program, a function bar will appear on the screen underneath the format bar. The main feature of Crystal Ball is that it allows the user to interact with Excel in a non-traditional way. Typically, the user accommodates single values in the spreadsheet cells, which are related via formulas that are defined in separate cells. Crystal Ball expands the capabilities of Excel by allowing the user to define probability distributions in the spreadsheet cells instead of just single values. For instance, Figure 1a indicates that tilapia price for whole fish is KSh 100/kg. However, it is known that tilapia prices may fluctuate widely within relatively short periods of time, and this variability is hard to capture in a single enterprise budget analysis. Assuming that historical information on tilapia prices is available, a probability distribution can be built to describe the variability of prices based on statistical parameters. In this example, we will assume that there is sufficient background information to confidently define a normal distribution of price/kg of tilapia, with a mean of KSh 100 and a standard deviation of KSh 7.

To enter this information in the spreadsheet, the cell containing the average or expected tilapia price (cell I11) must be selected. Next, the user must click on the icon "Define Assumption" located on the extreme left of the Crystal Ball bar. A window will pop up offering a selection of probability distributions. The normal distribution will be selected and then "OK" must be clicked. A new window will appear displaying a graphic depiction of the selected distribution and the corresponding statistical parameters. The normal distribution is defined in terms of a median and a standard deviation. In this example, Crystal Ball has assumed a mean of 100 and a standard deviation of 10 as default values. The latter will be replaced by 7. When these parameters are defined, the graph of the distri-bution scales automatically, comprising a range of prices between 79 KSh and 121 KSh. What this means is that tilapia prices can fluctuate between these boundary values, but there is a higher probability that they will be located around 100 KSh. A name can be assigned to the distribution probability in the box located in the upper section of the window ("Assumption Name"). The name "Price of Tilapia" will be entered. The final step is to click on "Enter" and then "OK." The window will disappear and the background of the cell I11 will automatically change to green. This is an indication that the probability distribution was successfully defined in this cell.

The same procedure will be used to define a normal distribution for the price of feed (cell I14). In this instance, a mean of 12 and a standard deviation of 1.40 will be used. The graph will indicate the prices KSh 7.80 and KSh 16.20 as boundary values. Finally, a triangular distribution will be developed for the FCR (cell I13). Usually, triangular distributions are selected when there is insufficient background information to define a normal distribution; nevertheless, the user might have a clear idea of the value most likely to occur and the values that would mark the boundaries of the distribution (maximum and minimum). For the FCR, it will be assumed that the likeliest conversion factor is 3.46, but could vary between 2 and 5. As it was explained before, the cell I13 must be selected, and then the icon "Define Assumption" must be clicked on. Next, the triangular distribution is selected and the minimum, maximum, and likeliest values are entered.

Up to this point, probability distributions have been defined for three budget items (price of tilapia, feed price, and FCR). The goal of the exercise is to measure the effect on net returns/ha of the variability in the mentioned items. To achieve this, the user must select the cell S49, which contains the formula that calculates net returns/ha, and then click on the icon "Define Forecast" (the third icon from left on the Crystal Ball bar). A new window will pop up requesting information on the cell. The name of the cell must be specified in the first box (Net returns/ha) and the units in the second box (KSh). After clicking on "OK," the window will disappear and the background of the cell S49 will change to blue, which indicates that Crystal Ball has been instructed to evaluate the effects of the variability in tilapia price, feed price, and FCR on the net returns/ha.

At this point, everything is ready to run a simulation with Crystal Ball. This program repeatedly recalculates the enterprise budget until an iteration limit is reached (the default specification is 500 trials). Then, the enterprise budget will be recalculated a total of 500 times, but each iteration will use different values for the price of tilapia, feed price, and FCR. Crystal Ball selects the values for each iteration based on the defined probability distributions through a sampling procedure known as Monte Carlo Sampling Method. As the enterprise budget is recalculated 500 times, instead of obtaining a single estimate of net returns/ha (as it is typically done in a spreadsheet), a whole range of possible outcomes occurring with different levels of probability will be shown.

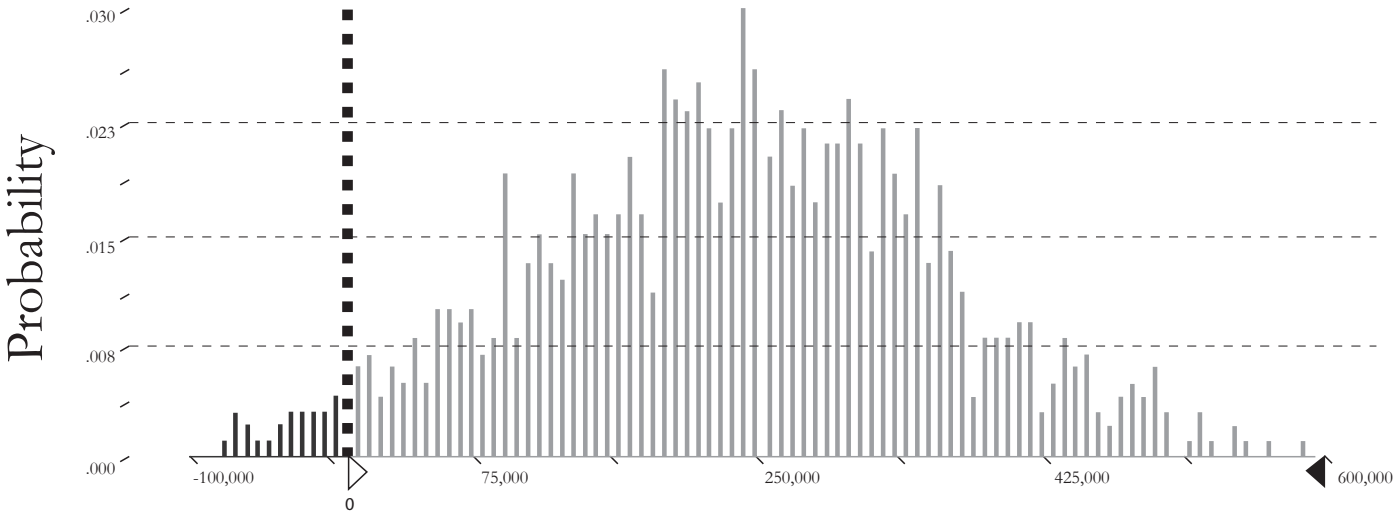
To get started with the simulation, the user must click the icon "Start Simulation"—the eleventh icon from the left on the Crystal Ball bar. Crystal Ball will conduct the 500 iterations, which may take a few seconds. At the end, a graph will appear on screen displaying the resulting probability distribution for net returns/ha. Figure 9 shows that net returns/ha can range from KSh – 100,000 to KSh 600,000 (the range is between KSh -74,333 and KSh 586,000 to be more exact). These results can be interpreted as follows: net returns/ha could be as low as KSh -74,333 if, as an unfortunate event, low tilapia prices coincide with high feed prices and high FCR. Similarly, net returns/ha could be as high as KSh 586,000 if tilapia prices are high and feed cost is low.

Sometimes it may be useful to determine what the probability is that net returns exceed or do not reach a certain arbitrary level. For instance, the user may be interested in assessing the likelihood of obtaining net returns above 300,000 KSh/ha. To do this, the user must define the limits of the relevant portion of the distribution. These limits can be specified in the boxes located at the left and right sides of the graph. Enter 300,000 in the left box. Crystal Ball automatically calculates the certainty level associated with the range KSh 300,000–586,000, which is 32%. In other words, there is a 32% likelihood of obtaining net returns above KSh 300,000.

In summary, Crystal Ball is a very useful tool to measure the amount of uncertainty, or risk, of a specific operation in a fast and efficient fashion. In the example, the risk implicit in the operation of the 1-ha tilapia farm was described in terms of variability in tilapia and feed prices. However, this basic model can be expanded to incorporate the effects of variability in other budget items, such as pond yields. The incorporation of additional factors of uncertainty in the model will result in a more accurate measurement of the risk levels associated with the activity.

Figure 9

Probability distribution of net returns for a tilapia farm feeding with pellets in Kenya. Likelihood of achieving profit was 97%, which corresponds to the portion of the distribution located to the right of the dashed line.



Crystal Ball® is a risk analysis, simulation, and optimization program designed by Decisioneering, Inc. Mention in this manual does not necessarily imply that the Aquaculture CRSP endorses its use.

Summary and Conclusions

A farmer who chooses to raise and sell fish with the intent of making a profit must manage the farm as a business if he/she is to be successful. Making decisions based on trying to produce the greatest weight of fish or even the lowest feed conversion ratio without examining the effects on the economics, capital position, or cash flow of the business is not likely to be a successful strategy.

The most fundamental types of financial records and analyses that all fish farmers should maintain include the following: enterprise budget, balance sheet, income statement, and cash flow budget. Each of these tools provides a different perspective on the farm business. The enterprise budget gives an estimate of the overall profitability of the enterprise. The balance sheet indicates the capital position and solvency of the business and whether net worth, or the wealth of the farm owner, is increasing over time. The income statement shows annual profits or losses of the business, while the cash flow budget shows whether or not the farm will be able to make its payments when the payments are due.

Many farmers have other farming or household activities in addition to raising fish. They may have cattle or grow fruit, vegetable, or grain crops. Other household activities, such as drying or salting and reselling the fish, may generate revenue as well. Any allocation of farm resources, such as land, manure, leaves, fruits, and time spent on other activities in addition to their fish ponds must be accounted for and assigned a cost value.

Most farmers do not like to spend the time to keep their farm records current, much less to prepare financial statements and analyze them as described in this manual. However, there is no other way to manage a business properly if the farmer wishes to make money. Decisions must be made that are in the best financial interest of the farm, but without carrying out the analyses presented in this manual the farmer will not know the economic consequences of management decisions.

These statements can be prepared once a year. It is best to establish a certain time each year to complete the analyses and then to spend some time thinking through the implications for each particular business. Once the farmer establishes this type of routine and practices it two or three times, the format becomes more clear and it begins to be less of a burden. By doing so, the farmer can compare each year's statements to the previous year and see whether financial progress has been made. It is hoped that this manual encourages fish farmers to schedule time to develop and utilize these analyses to make the best business decisions possible for their fish farming businesses.

Appendix: Record Keeping

It is not possible to analyze either the biological or economic feasibility of a tilapia farm without farm records. Record keeping may not be the farmer's preferred activity, but it is the cornerstone of a successful business.

This appendix provides examples of three of the most important types of datasheets to maintain. While additional records can be useful, these three sheets will enable the farmer to develop the most essential financial statement to analyze his/her farm business.

The Pond Construction and Monitoring Record records data on the construction of the pond, its area, and the cost of construction. The construction cost should include cost of any pipes, water supply, and drainage structures. If constructed by hand, the number of people and the number days it took to construct the pond should be required. The species stocked, and the number, total weight (in kg), and the average weight (in kg) should be recorded. Any special consideration or explanations should be noted under "Remarks."

The Feeding and Monitoring Record should be used to record the date of each feeding and/or fertilization activity. The type and weight of fertilizer should be recorded and the cost recorded under "Amount Spent." Likewise, the type and weight (in kg) of feed should be recorded with the cost recorded under "Amount Spent." The number of fish that died should be recorded each day that mortalities are observed. Dead fish should be removed each day to avoid double counting mortalities. Any unusual behavior during feeding should be noted under "Remarks."

The Marketing and Monitoring Record should be used to record information about each sale of fish. The date, pond number, species, time since stocking, average weight of fish sold, the number of fish sold, total weight, and total revenue received must be recorded. The specific name of the market where they are sold should also be recorded. Any additional fish restocked should be recorded by the number, total weight, average size, and total amount spent for each restocking event.

Record Keeping Forms

POND CONSTRUCTION AND MONITORING RECORD

NAME ……………………………… **STOCKING DATE**………………………

DATE	POND #	AREA	COST	DAYS	PEOPLE	SPECIES	STOCKING			REMARKS
							Number	Total weight (kg)	Average size (g)	
TOTAL										

FEEDING AND MONITORING RECORD

NAME …… **POND NAME** …… **STOCKING DATE** ……
POND SIZE …… **NO. OF FISH STOCKED** ……
SPECIES ……

DATE	FERTILIZER		FEEDS		NO. OF MORTALITY DIED IN PONDS	AMOUNT SPENT	REMARKS
	TYPE	WEIGHT KG	TYPE	WEIGHT KG			
TOTAL							

MARKETING AND MONITORING RECORD

NAME .....

DATE	POND #	SPECIES	TIME SINCE STOCKING	TOTAL HARVEST			MARKET PLACE	RESTOCKING			TOTAL SPENT	REMARKS
				Number	Total weight (kg)	Average size (g)		Number	Total weight (kg)	Average size (g)		
TOTAL												