Food and Agriculture Organization of the United Nations

Doing aquaculture as a business for small- and medium-scale farmers

Practical training manual

Module 2: The economic dimension of commercial aquaculture

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by

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Abstract

The "Doing aquaculture as a business for small- and medium-scale farmers. Practical training manual" is composed of two modules: Module 1 "The technical dimension of commercial aquaculture" and Module 2 "The economic dimension of commercial aquaculture".

The target users of both modules are trainers, educators, extension officers as well as small- and medium-scale fish farmers.

The purpose of this module is to enhance their knowledge and capacities in understanding and applying the basic economic and financial principles and concepts of commercial aquaculture in their daily activities.

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Abbreviations and acronyms

ASTF	Africa Solidarity Trust Fund
AU	African Union
BC	Beginning cash
BGI	Blue Growth Initiative
BPTC	Breakeven price above total cost
ca	Current asset
$CB_{after\ NOL}$	Cash (balance) after new operating loan
$CB_{before\ NOL}$	Cash (balance) available before any new operating loan
CB_{PBIL}	Cash balance available to pay back the investment loan
cif	Cash inflow
cl	Current liability
fc	Fixed cost
fce	Fixed cash expense
FMM	FAO Multipartner Programme Support Mechanism
GM	Gross margin
gr	Gross receipts
IL	Investment loan
lr	Loans repayment
$MCB_{required}$	Minimum ending cash balance required
ncai	Non-cash adjustments to income
NCFI	Net cash farm income
ncl	Non-current liability
noce	Non-operating expense
NFE	Non-farm expenses
NFI	Net farm income
NFIH	Net farm income per hectare/year
NFIN	Non-farm income
NFIO	Net farm income from operations
NOL	New operating loan
NR	Net returns
NW	Net worth
oce	Operating cash expense
PBP	Payback period
Q	Total quantity of fish harvested
r	Revenue
$RB_{IL,year1}$	Remaining balance on the investment loan
sca	Gains and losses on sale of capital asset
TA	Total assets
TC	Total costs
TCA	Total current assets
TCE	Total cash expenses
TCI	Total cash inflow
TCIF	Total cash inflow of the farm
TCL	Total current liabilities
TCO	Total cash outflow
TFC	Total fixed costs
TFCE	Total fixed cash expenses
TGR	Total gross receipts
TL	Total liabilities
TLR	Total loans repayment
TNCA	Total non-current assets
TNCAI	Total non-cash adjustments to income
TNCL	Total non-current liabilities
TNOCE	Total non-operating cash expenses
TOCE	Total operating cash expenses
TR	Total revenues
TSCA	Total gains and losses on sale of capital assets
TVC	Total variable costs
TVCE	Total variable cash expenses
UNECA	United Nations Economic Commission for Africa
UTIDA	User-Friendly Tool for Investment Decision Making in Aquaculture
vc	Variable cost
vce	Variable cash expense
WCED	World Commission on Environment and Development

Introduction

The "Doing aquaculture as a business for small- and medium-scale farmers. Practical training manual" is composed of two modules: **Module 1** "The technical dimension of commercial aquaculture" and **Module 2** "The economic dimension of commercial aquaculture".

The training on doing aquaculture as a business conducted by FAO brings together both its technical and economic dimensions, based on the principle that fish farmers need to know how to farm their fish species and how to manage their farms (Upton and Antonio, 1965).

The target users of both modules are trainers, educators, extension officers as well as small- and medium-scale fish farmers. The purpose of both modules is to enhance their knowledge and capacities in understanding and **applying the concepts necessary to commercial aquaculture** in their daily activities. Specifically, Module 2 addresses the **economic dimension** of commercial aquaculture.

Module 2 introduces the concept of sustainability and its principles for aquaculture development (Chapter 1), followed by the definition and characteristics of both commercial aquaculture and non-commercial aquaculture (Chapter 2). The concept of planning in commercial aquaculture is addressed in Chapter 3, which considers the basic principles of production economics (Section 3.1), the pricing of aquaculture products (Section 3.2), the basic record-keeping in commercial aquaculture (Section 3.3), the main financial documents (Section 3.4) – namely, the enterprise budget, income statement, balance sheet and cash flow – as well as the business plan (Section 3.5). The purpose of Chapter 4 is to show small- and medium-scale fish farmers how to assess the economic and financial viability of their fish farms. Specifically, it introduces the concepts and technicalities of cost structure, sensitivity, financial and cash flow analysis.

Both the financial statements (Chapter 3), and the analyses (Chapter 4) are based on the FAO "User-Friendly Tool for Investment Decision Making in Aquaculture" (UTIDA) and its assumptions are by no means exhaustive. UTIDA has been developed by the Aquaculture Branch of the FAO Fisheries and Aquaculture Department and the FAO Subregional Office for Eastern Africa to assist small- and medium-scale fish farmers in their decision whether or not to invest in aquaculture under specific assumptions. A beta version of the Tool is currently being prepared.

1 Sustainability principles

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).[1]

There are five aspects to sustainability in aquaculture: technical, economic, social, environmental and legal. However, sustainability is often only considered from an environmental perspective.

1.1 Technical sustainability

As with any other productive activity, in order to be sustainable aquaculture has to be technically adequate and feasible (**technical sustainability**). Specifically, it is necessary for fish farmers to identify the appropriate technologies, either imported or locally produced, and to utilize them properly within the production cycle.

Technical feasibility demands that (Hishamunda *et al.*, 2014):

- Fish farmers have the necessary knowledge and technical skills to grow a given aquaculture organism.

[1] The term "sustainable development" first appeared in the document Our Common Future, released in 1987 by the Brundtland Commission, formerly World Commission on Environment and Development (WCED).

- Production inputs and growing conditions of cultured species are adapted to local conditions. For aquaculture to be sustainable, local technology should be able to produce the necessary production inputs.

1.2 Economic sustainability

Aquaculture has to be economically viable (**economic sustainability**). Otherwise, fish farmers may decide to focus their efforts on other opportunities.

Economic viability requires aquaculture farms to be profitable and competitive over time. Without economic viability, aquaculture can only continue if subsidized (Hishamunda *et al.*, 2014).

Promoting an aquaculture business that is unable to finance itself may be counterproductive and block the dynamism of the sector.

1.3 Social sustainability

Aquaculture should be socially acceptable (**social sustainability**). **Social acceptability**, also known as social licence, refers to the degree to which aquaculture is accepted by local and neighbouring communities, the various interest groups and society as a whole. These attitudes to aquaculture are largely determined by its perceived benefits (Hishamunda *et al.*, 2014).

To be socially acceptable, aquaculture operations should benefit a broader proportion of society, including women and young people, rather than a small elite.

1.4 Environmental sustainability

Aquaculture has to be respectful of the environment (**environmental sustainability**).

Environmental integrity requires that negative impacts be mitigated, thereby enabling farmers to continue production at the same site over time (Hishamunda *et al.*, 2014). Inherent to the very definition of sustainable development, aquaculture activities should maximize benefits from the use of resources without compromising those of future generations (**intergenerational equity**) (WCED, 1987).

1.5 Legal sustainability

To enable the development and growth of the sector, aquaculture has to be governed by adequate, clear and stable laws and regulations (**legal sustainability**).

Laws and regulations in which the rights and obligations of each actor are clearly defined reassure entrepreneurs. Stability is necessary to give investors the time to adapt, and adopt laws and regulations. Frequent changes are not conducive to investment and create a climate of mistrust among investors (Percy and Hishamunda, 2001).

2 Commercial aquaculture: definitions

Commercial aquaculture refers to "fish farming operations whose goal is to maximize profits, where profits are defined as revenues minus costs (perhaps discounted)" (Ridler and Hishamunda, 2001; Percy and Hishamunda, 2001).

The key principles to distinguish between commercial and non-commercial aquaculture are: the presence of a business orientation in the former, in addition to the adoption of remunerated factors of production, such as labour. Non-commercial farms rely primarily on household members for labour, while commercial farms tend to hire labour (Ridler and Hishamunda, 2001).

Commercial aquaculture supplies aquatic products for consumption, including fish, molluscs, crustaceans and aquatic plants, generates profits, creates jobs, pays incomes, wages and salaries, and provides tax revenue (Cai *et al.*, 2009).

Commercial fish farmers actively participate in markets by purchasing their inputs and ensuring the sale of their outputs. Non-commercial fish farmers may also purchase inputs – mainly seeds and feed – and sell their outputs; however, these fish farmers primarily make use of family labour, and the potential sale of any surplus of aquaculture products is generally performed on-site. For non-commercial fish farmers aquaculture is not the core economic activity, but is practised to diversify production, improve resource utilization and reduce risks such as harvest failures or market falls (Ridler and Hishamunda, 2001).

In commercial aquaculture, farming systems can be intensive, semi-intensive or extensive; fish farms can be small-, medium- or large-scale.[2] Commercial aquaculture should therefore not be considered synonymous with large companies or corporations.

3 Planning in commercial aquaculture

The following sections will introduce the basic principles of production economics (Section 3.1), the pricing of aquaculture products (Section 3.2), together with the basic record-keeping (Section 3.3), the main financial statements for commercial aquaculture (Section 3.4 – namely, enterprise budget, income statement, balance sheet and cash flow) in addition to the business plan (Section 3.5).

3.1 Basic principles of production economics in aquaculture

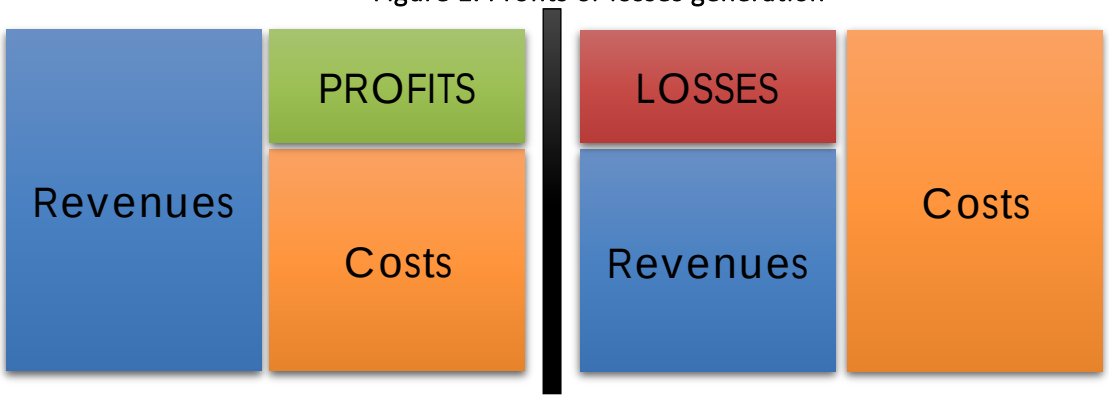
In commercial aquaculture, one of the farmers' primary goals is to maximize their profits.

Profit is a business performance indicator, calculated by subtracting total costs from total revenues, where the total revenues represent the gross income of the aquaculture farm, obtained by summing up all the receipts generated by the sales of aquaculture products. The total costs refer to the monetary value of all expenses associated with the aquaculture farm (e.g. fingerlings, feed, chemicals, ponds, machinery, etc.).

If the total revenues are higher than the total costs, the business is generating a profit. If, on the other hand, total costs are higher than total revenues, the business is generating a loss (Figure 1).

[2] See Module 1: The technical dimension of commercial aquaculture.

Figure 1. Profits or losses generation



Based on the preferences and behaviour of consumers, farmers must take care to identify:

- What to produce: the aquaculture products (e.g. fish, molluscs, crustaceans and/or aquatic plants), and their form (e.g. live, frozen, processed);
- How much to produce: the target quantity;
- How to produce: define the resources required and how to combine them for efficient production;
- For whom to produce: the target markets.

This cannot be accomplished without the proper elaboration of financial statements, as well as the marketing and business plans.

3.2 Pricing of aquaculture products

In competitive markets, prices are determined by the interaction between supply and demand (Shang, 1981; Jolly and Clonts, 1993). When determining the price of aquaculture products farmers have to cover the costs of production at the very least, aim to generate a profit and, at the same time, set a price which consumers are willing to pay.

Consumers' willingness to pay can be investigated through market analysis.[3] In addition, the calculation of break-even prices can provide useful information for the setting of prices.

Given the quantity of fish harvested, the break-even price above total cost (BPTC) is the price at which fish farmers should sell their fish without making any profit. It is calculated by dividing total costs (TC) by the total quantity of fish harvested (Q), as shown in Equation 1.

$$BPTC = \frac{TC}{Q} \quad (1)$$

Given consumers' willingness to pay, as long as the price of aquaculture products is higher than the BPTC, the business will be able to generate profits.

[3] See Section 3.5 "Business plan".

3.3 Basic record-keeping in commercial aquaculture

Record-keeping refers to the systematic collection, recording and storage, in a standardized format, of the biological, technical, economic and/or financial data, information, activities and transactions that take place during the lifespan of the fish farm.

As various studies demonstrate (Shang, 1981; Okechi, 2004; Engle and Neira, 2005) commercial aquaculture requires systematic and detailed record-keeping, in order to:

- provide a means of evaluating the performance and the biological or economic feasibility of the fish farm;
- identify the factors accountable for the economic and financial viability and profitability of the fish farm;
- provide fish farmers with reliable information on which to base decisions affecting their farm operations;
- improve the efficiency of farm operations.

Record-keeping represents the starting point for the preparation of accurate financial statements (Section 3.1) and, subsequently, to assess the economic and financial viability of fish farms. For example, assessments can be made with the cost structure, sensitivity, financial and cash flow analyses that will be introduced in Chapter 4.

Records can be kept on an annual, seasonal and daily basis (Shang, 1981). Table 1 shows an example for the record-keeping of variable inputs, which vary with the level of production (e.g. fingerlings, feed, fertilizers, fuel, electricity and water). For each item of variable input a description should be provided, as well the quantity and its unit, the unit cost and currency, and the total cost (calculated by multiplying quantity and unit cost).

Table 1. Example of record-keeping form for variable inputs

Date	Pond no.	Item	Description	Quantity	Unit cost	Total cost
10/01/2016	1	Seed	Nile tilapia fingerlings	360 kg	USD 0.16	USD 58
…						

Source: adapted from Shang (1981)

Table 2 shows an example of record-keeping for labour inputs. For each economic activity (e.g. pond preparation, stocking, feeding, harvesting, etc.), a record should be kept of the type of labour (e.g. full-time, part-time, occasional, etc.), the number of persons per day or per hour, the wage per person per day (or per hour) and the total labour cost (by multiplying number and wage).

Table 2. Example of record-keeping form for labour

Date	Pond no.	Economic activity	Type of labour	Number	Wage	Total labour cost
10/01/2016	1	Pond preparation	Full-time	2 persons/day	USD 50	USD 100
…						

Source: adapted from Shang (1981)

An example of a record-keeping form for loans is provided in Table 3. The table consists of a descriptive and a quantitative section. The descriptive section should include information on:

- amount, types (e.g. short-, medium- or long-term loans) and sources of funds borrowed;
- investments for which the funds were borrowed in terms of rationale, type of investment and cost – e.g. purchasing or leasing land for aquaculture purposes, the construction of ponds, aquaculture support infrastructure, and the purchase of equipment and machinery etc.;

- interest rate at which the funds borrowed for capital assets will be reimbursed;
- number of years granted to the borrower by the financier to repay the loan;
- starting date when the funds were granted to the borrower by the financier;
- deadline by which the borrower has to repay the loan to the financier;
- the payment schedule, including the dates when these are due.

The quantitative section should keep track of the total payment amount, the interest and principal paid, and the balance.[4] In this example, the calculation of payments of the investment loan are based on constant payments and a constant interest rate. These calculations are based on assumptions made by UTIDA to estimate the amortization of the loans automatically and are by no means exhaustive.

Table 3. Example of record-keeping form for loans

Descriptive section	
Loans	USD 100 000
Investment	USD 150 000
Interest rates	10%
Loan repayment term	5 years
Start date of loan	10/01/2016
End date of loan	10/01/2021
Dates when payments due	10 January of each year

Quantitative section				
Date	Total Payment (USD)	Payment of interest (USD)	Payment of principal (USD)	Principal balance (USD)
10/01/2017	26 380	10 000	16 380	83 620
10/01/2018	26 380	8 362	18 018	65 603
10/01/2019	26 380	6 560	19 819	45 783
10/01/2020	26 380	4 578	21 801	23 982
10/01/2021	26 380	2 398	23 982	–
Total	*131 899*	*31 899*	*100 000*	

3.4 Financial statements

For each of the following financial statements (enterprise budget, income statement, balance sheet, cash flow statement), this section will provide a simple definition (what), the rationale behind their drafting (why) and the basic steps for producing them (how).

For the equations below, the following standard has been adopted: the lowercase letters refer to the single item – e.g. (r) for revenues – while uppercase detects the total amount – e.g. (TR) for total revenues.

It is worth mentioning that the financial statements are based on UTIDA and its assumptions, and are by no means exhaustive.

[4] For an explanation of the terminology used, see Section 4.4 “Cash flow analysis”.

Enterprise budget

What is an enterprise budget?

It is an estimate of a fish farm's costs, revenues and profitability for a particular period, given a chosen set of assumptions and values (Engle and Neira, 2005; Engle, 2010).

Why do you prepare an enterprise budget?

To establish whether the fish farm is likely to be profitable over the chosen period.

How do you draw up an enterprise budget?

First, the period (e.g. monthly, quarterly, annually or growing cycle) and the unit of analysis (e.g. pond, cage or tank) have to be selected.

A possible structure for an enterprise budget in shown in Table 4.[5]

The first column lists the items to be included; the second column provides a comprehensive description of these, while the third column describes the unit of each item. The total quantities are inserted in the fourth column, and the unit prices are in the fifth one. The units of analysis, quantities and prices have to be consistent across the rows.

The sales of a farmed fish species (gr_A), e.g. Tilapia, are calculated by multiplying the estimated production quantity in the considered period (q_A) by the price at which Tilapia is expected to be sold, as shown in Equation 2.

Total gross receipts (TGR) represent the gross income of the fish farm, obtained by summing up the projected gross receipts (gr) generated by the sales of all aquaculture products (Equation 3).

Costs here refer to the projected monetary value of all the inputs to be paid to culture the selected aquaculture products. Costs are classified into variable and fixed expenses.

Variable (or operating) costs vary with the level of production, e.g. fingerlings and feed, while fixed costs are incurred regardless of the level of production – such as the interest paid on investment loans.

Total variable costs (TVC) are given by the sum of all the expected cost items encompassed in the category (Equation 4). Total fixed costs (TFC) are calculated in the same way (Equation 5). Total costs (TC) sum up the projected TVC and TFC (Equation 6).

The gross margin (GM), the income above the TVC, is obtained by subtracting TGR from TVC (Equation 7). GM is a measure of profitability in the short term (Engle, 2010). The net returns (NR) figure is obtained by subtracting TC from TGR (Equation 8), a measure of long-term profitability (Engle and Neira, 2005; Engle, 2010).

[5] The proposed enterprise budget is adapted from UTIDA.

Table 4. Example of enterprise budget

Item	Description	Unit	Quantity	Unit price (LC)	Total Year 1 (LC)
Gross receipts (gr)					
Sales of marketable Tilapia	Average revenue of whole table-sized Tilapia	Kg	q_A	p_A	$gr_A = q_A \times p_A$ (2)
Sales of other fish species	Average revenue of other categories of fish	Kg	q_B	p_B	$gr_B = q_B \times p_B$
Total gross receipts (TGR)		LC			$TGR = gr_A + gr_B$ (3)
Variable costs (vc)					
Fingerlings	Average expenditure of fish used for stocking	no	q_1	p_1	$vc_1 = q_1 \times p_1$
Feed	Average expenditure of artificial feed	kg	q_2	p_2	$vc_2 = q_2 \times p_2$
Fertilizer					
Urea	Ave rage expenditure of Nitrogen-based inorganic fertilizer	kg	q_3	p_3	$vc_3 = q_3 \times p_3$
Diammonium phosphate	Average expenditure of Phosphorus-based inorganic fertilizer	kg	q_4	p_4	$vc_4 = q_4 \times p_4$
Lime	Average expenditure of material used to correct water acidity	kg	q_5	p_5	$vc_5 = q_5 \times p_5$
Organic fertilizer	Average expenditure of compost, organic waste, etc.	kg	q_6	p_6	$vc_6 = q_6 \times p_6$
Veterinary and pharmaceutical products					
Formalin	Average expenditure of this disinfectant/ sanitizer	kg	q_8	p_8	$vc_8 = q_8 \times p_8$
Potassium permanganate	Average expenditure of this disinfectant	kg	q_9	p_9	$vc_9 = q_9 \times p_9$
Employees					
Field workers	Average level of remuneration paid to people employed in field activities on a full-time basis	no	q_{11}	p_{11}	$vc_{11} = q_{11} \times p_{11}$
Guards	Average level of remuneration paid to security staff	no	q_{12}	p_{12}	$vc_{12} = q_{12} \times p_{12}$
Managers	Average level of remuneration paid to directors	no	q_{14}	p_{14}	$vc_{14} = q_{14} \times p_{14}$
Secretaries	Average level of remuneration paid to people involved in secretarial activities of the farm	no	q_{18}	p_{18}	$vc_{18} = q_{18} \times p_{18}$
Accountants	Average level of remuneration paid to people involved in accounting activities of the farm	no	q_{19}	p_{19}	$vc_{19} = q_{19} \times p_{19}$
Drivers	Average level of remuneration paid to drivers of vehicles and other farm machineries	no	q_{20}	p_{20}	$vc_{20} = q_{20} \times p_{20}$
Annual cost of service providers	Average level of remuneration paid to temporary specialized staff	no	q_{23}	p_{23}	$vc_{23} = q_{23} \times p_{23}$
Other variable costs					
Maintenance and repairs	Average level of expenditures made on various maintenance and repairs on the farm during the year	LC			vc_{26}
Fuel and lubricants	Average level of expenditures made on all kinds of fuel and lubricants needed on the farm during the year	Litre	q_{27}	p_{27}	$vc_{27} = q_{27} \times p_{27}$
Electricity	Average level of expenditures on electricity consumed on the farm during the year	Kwh	q_{28}	p_{28}	$vc_{28} = q_{28} \times p_{28}$
Water	Average level of expenditures on water resources consumed on the farm during the year	Litre	q_{29}	p_{29}	$vc_{29} = q_{29} \times p_{29}$

Item	Description	Unit	Quantity	Unit price (LC)	Total Year 1 (LC)
Interest on operating loan	Average level of interests paid to lenders (banks, etc.) of operating funds	%	q_{30}	p_{30}	$vc_{30} = q_{30} \times p_{30}$
Total variable costs (TVC)		LC			$TVC = vc_1 + \cdots + vc_{30}$ *(4)*
Fixed costs (fc)					
Interest on investment loan	Average level of interests paid to lenders (banks, etc.) of investment funds	%	q_{31}	p_{31}	$fc_{31} = q_{31} \times p_{31}$
Farm insurance	Average level of annual amount of money paid to ensure the farm during the year	ha	q_{32}	p_{32}	$fc_{32} = q_{32} \times p_{32}$
Property taxes	Average level of annual amount of money paid as property taxes during the year	LC			fc_{33}
Other fixed costs	Average level of other fixed costs not identified above	LC			fc_{34}
Depreciation					
Support Infrastructure	Average level of the estimated annual reductions in the value of support infrastructure	LC			fc_{35}
Equipment and machinery	Average level of the estimated annual reductions in the value of equipment and machinery	LC			fc_{36}
Ponds	Average level of the estimated annual reductions in the value of ponds	LC			fc_{37}
Total fixed costs (TFC)		LC			$TFC = fc_{31} + \cdots + fc_{37}$ *(5)*
Total costs (TC)		LC			$TC = TVC + TFC$ *(6)*
Gross margin (GM)		LC			$GM = TGR - TVC$ *(7)*
Net returns (NR)		LC			$NR = TGR - TC$ *(8)*

ha = hectare; kg = kilogram; kwh = kilowatt-hour; LC = Local Currency; no = Number.

Income statement

What is an income statement?

It is a financial statement that summarizes the financial transactions of the fish farm occurring over a selected period, usually a year (Manning and Hishamunda, 2001). It contains the revenues, costs and the net income (or net returns).

Why do you prepare an income statement?

To assess if the fish farm is profitable over the chosen period.

How do you draw up an income statement?

A possible structure for an income statement in shown in Table 5.[6]

The sales of a farmed fish species (r_A), e.g. Tilapia, are calculated by multiplying quantity produced in the considered period (q_A) by the price at which harvested Tilapia was sold (p_A), as shown in Equation 9.

Total revenues (TR) represent the gross income of the fish farm obtained by summing up the revenues (r) generated by the sales of all aquaculture products (Equation 10).

Expenses refer to the cost of assets consumed or services used to culture the selected aquaculture products in the process of generating revenues (Kimmel *et al.*, 2000). Expenses can be classified into different categories. Cash expenses are related to a payment in cash, while non-cash expenses are not related to cash payment (e.g. depreciation). Cash expenses can be divided into variable and fixed expenses. Variable (or operating) expenses vary with the level of production (e.g. fingerlings and feed), while fixed expenses are incurred regardless of the level of production, such as the interest paid on investment loans.

The total variable cash expenses (TVCE) figure is achieved by the sum of all the items of expenditure encompassed in the category (Equation 11). Total fixed cash expenses (TFCE) are calculated in the same way (Equation 12). Total cash expenses (TCE) sum up TVCE and TFCE (Equation 13).

Net cash farm income (NCFI), the net income above cash expenses, is obtained by subtracting TCE from TR (Equation 14).

By subtracting the total non-cash adjustments to income (TNCAI) from the NCFI, the net farm income from operations (NFIO) is calculated. NFIO, the net income above cash and non-cash expenses, is generated by the fish farm's core activity and excludes income from other sources (Equation 15).

Net farm income (NFI) is given by the difference between NFIO and the total gains and losses on sale of capital assets (TSCA), as shown in Equation 16. NFI represents the primary measure of farm profitability (Engle, 2010).

[6] The proposed income statement is based on UTIDA.

Table 5. Example of income statement

Item	Year 1 (LC)
Revenues (r)	
Sales of marketable Tilapia	$r_A = q_A \times p_A$ *(9)*
Sales of other fish species	r_B
Total revenues (TR)	$TR = r_A + r_B$ *(10)*
Cash farm expenses	
Variable cash expenses (vce)	
Fingerlings	vce_1
Feed	vce_2
Fertilizer	
Urea	vce_3
Diammonium phosphate	vce_4
Lime	vce_5
Organic fertilizer	vce_6
Other fertilizers	vce_7
Veterinary and pharmaceutical products	
Formalin	vce_8
Potassium permanganate	vce_9
Other veterinary products	vce_{10}
Permanent Employees	
Field workers	vce_{11}
Daytime guards	vce_{12}
Night-time guards	vce_{13}
Farm managers	vce_{14}
Production managers	vce_{15}
Sales managers	vce_{16}
Other managers	vce_{17}
Secretaries	vce_{18}
Accountants	vce_{19}
Drivers	vce_{20}
Unpaid permanent employees (hypothetical cost)	vce_{21}
Occasional employees	
Occasional field workers	vce_{22}
Service providers	vce_{23}
Other occasional employees	vce_{24}
Unpaid occasional employees (hypothetical cost)	vce_{25}
Other variable cash expenses	
Maintenance and repairs	vce_{26}
Fuel and lubricants	vce_{27}

Item	Year 1 (LC)	
Electricity	vce_{28}	
Water	vce_{29}	
Interest on operating loan	vce_{30}	
Total variable cash expenses (TVCE)	$TVCE = vce_1 + \cdots + vce_{30}$	*(11)*
Fixed cash expenses (fce)		
Interest on investment loan	fce_{31}	
Farm insurance	fce_{32}	
Property taxes	fce_{33}	
Other fixed costs	fce_{34}	
Total fixed cash expenses (TFCE)	$TFCE = fce_{31} + \cdots + fce_{34}$	*(12)*
Total cash expenses (TCE)	$TCE = TVCE + TFCE$	*(13)*
Net cash farm income (NCFI) – income above cash expenses	$NCFI = TR - TCE$	*(14)*
Non-cash adjustments to income (ncai)		
Fish inventory adjustment	$ncai_I$	
Depreciation		
Support infrastructure	$ncai_{II}$	
Equipment and machinery	$ncai_{III}$	
Ponds	$ncai_{IV}$	
Total non-cash adjustments to income (TNCAI)	$TNCAI = ncai_I + \cdots + ncai_{IV}$	
Net farm income from operations (NFIO) income above cash and non-cash expenses	$NFIO = NCFI - TNCAI$	*(15)*
Gains and losses on sale of capital assets (sca)		
Land	sca_V	
Equipment and machinery	sca_{VI}	
Other	sca_{VII}	
Total gains and losses on sale of capital assets (TSCA)	$TSCA = sca_V + \cdots + sca_{VII}$	
Net farm income (NFI) per year	$NFI = NFIO \pm TSCA$	*(16)*

LC = Local Currency

Balance sheet

What is a balance sheet?

It is a financial statement containing the value of all assets and liabilities of the fish farm over a given time period (Manning and Hishamunda, 2001).

Why do you prepare a balance sheet?

To measure the financial position and strength of the fish farm through its net worth and its solvency and liquidity ratios (Manning and Hishamunda, 2001).[7]

How do you draw up a balance sheet?

A possible balance sheet structure is shown in Table 6.[8]

Assets, which refer to the value of anything owned by the fish farm, are classified into current and non-current. Current assets (ca) include cash and other assets (e.g. fish inventory, prepaid expenses and accounts receivable) that are expected to be converted in cash within the reference period of the balance sheet, generally within the year. Non-current assets (nca) comprise assets that are not expected to be converted into cash within the year, such as land, ponds, infrastructure, equipment etc. (Engle, 2010).

Total assets (TA) are obtained by summing up total current assets (TCA) and total non-current assets (TNCA), as shown in Equation 17.

Liabilities refer to any debt or obligation arising during the course of the business operations, which the fish farm has outstanding. Liabilities are grouped into current and non-current (Engle and Neira, 2005).

Current liabilities (cl) refer to the amounts due to creditors within the accounting year (i.e. operating loans), while non-current liabilities (ncl) are the fish farm's long-term financial obligations that are not due within the year (i.e. investment loans).

Total liabilities (TL) are obtained by summing up total current liabilities (TCL) and total non-current liabilities (TNCL), as shown in Equation 18.

The net worth (or owner's equity) is calculated by subtracting the total value of all liabilities from the total value of all assets of the fish farms (Equation 19).

[7] The solvency and liquidity ratios will be introduced in Section 4.3, related to "Financial analysis".

[8] The proposed balance sheet is adapted from UTIDA.

Table 6. Example of balance sheet

Item	Year 1 (LC)	
ASSETS		
Current assets (ca)		
Cash balance	ca_A	
Fish inventory	ca_B	
Prepaid expenses[9]	ca_C	
Accounts receivable[10]	ca_D	
Total current assets (TCA)	$TCA = ca_A + \cdots + ca_D$	
Non-current assets (nca)		
Land	nca_E	
Support infrastructure	nca_F	
Equipment and machinery	nca_G	
Ponds	nca_H	
Total non-current assets (TNCA)	$TNCA = nca_E + \cdots + nca_H$	
Total assets (TA)	$TA = TCA + TNCA$	*(17)*
LIABILITIES		
Current liabilities (cl)		
Operating loan	cl_1	
Accounts payable[11]	cl_2	
Total current liabilities (TCL)	$TCL = cl_1 + cl_2$	
Non-current liabilities (ncl)		
Investment loan	ncl_3	
Capital lease	ncl_4	
Total non-current liabilities (TNCL)	$TNCL = ncl_3 + ncl_4$	
Total liabilities (TL)	$TL = TCL + TNCL$	*(18)*
Net worth (NW)	$NW = TA - TL$	*(19)*

LC = local currency

[9] Prepaid expenses: "expenses paid in cash and recorded as assets before they are used or consumed" (Kimmel *et al.*, 2000); for example, fingerlings expenses paid at the beginning of a growing cycle started in the reference year that will end in the next one.

[10] Accounts receivable: "income that has been earned but for which no cash payment has been received" (Engle, 2010); for example, fish sold on credit, used equipment sold on credit, etc.

[11] Accounts payable: "an expense that has been incurred but not yet paid" (Engle, 2010); for example, feed purchased on credit.

Cash flow statement

What is a cash flow statement?

A financial statement containing the fish farm's total cash inflows and outflows over a given time period.

Why do you prepare a cash flow statement?

To identify the borrowing needs of fish farms, when they are likely to arise, the loan repayment capacity and when it might be possible for a loan to be repaid (Manning and Hishamunda, 2001).

How do you draw up a cash flow statement?

A possible structure for a cash flow statement is shown in Table 7.[12]

Revenues and expenses are reported in the cash flow statement, in the period they were incurred. Non-cash revenues and expenses, like accounts receivable or depreciation, are not considered (Engle and Neira, 2005).

The beginning cash (BC) – the amount of cash available at the beginning of the year – is itemized first, followed by each source of farm cash revenue generated by sales of farmed fish species or other capital assets (cif). The total cash inflow (TCI) is obtained by summing up BC and total cash inflow of the farm (TCIF), as shown in Equation 20.

Operating (or variable) cash expenses (oce) are followed by non-operating (or fixed) cash expenses (noce), non-farm expenses (NFE) and loans repayment (lr), which includes principal and interest payments for each loan. All cash expenses are summed up to calculate total cash outflow (TCO), as shown in Equation 21.

The difference between TCI and TCO is the cash balance available before any new operating loan $(CB_{before\ NOL})$, as shown in Equation 22.

If $CB_{before\ NOL}$ is negative, a new operation loan (NOL) is needed for that period. After adding NOL, the cash balance after the new operating loan $(CB_{after\ NOL})$ is obtained (Equation 23). $CB_{after\ NOL}$ in the reference period (e.g. year 1) will be reported as BCB in the next period (year 2).

How to calculate the amount of the New Operation Loan (NOL) is shown in Section 4.4 addressing cash flow analysis.

[12] The proposed cash flow is adapted from UTIDA.

Table 7. Example of cash flow

Item	Year 1 (LC)
Beginning cash (BC)	BC
Cash inflow (cif)	
Cash revenues from sales of tilapia	cif_A
Cash revenues from sales of other fish	cif_B
Cash revenues from sales of capital assets	cif_C
Total cash inflow of the farm (TCIF)	$TCIF = cif_A + \cdots + cif_C$
Non-farm income (NFIN)	$NFIN$
Total cash inflow (TCI)	$TCI = BC + TCIF + NFIN$ (20)
CASH OUTFLOW	
Operating cash expenses (oce)	
Fingerlings	oce_1
Feed	oce_2
Fertilizers (including lime)	oce_3
Veterinary and pharmaceutical products	oce_4
Permanent employees	oce_5
Occasional employees	oce_6
Maintenance and repairs	oce_7
Fuel and lubricants	oce_8
Electricity	oce_9
Water	oce_{10}
Prepaid expenses	oce_{m11}
Other operating cash expenses	oce_{12}
Total operating cash expenses (TOCE)	$TOCE = oce_1 + \cdots + oce_{12}$
Non-operating cash expenses (noce)	
Farm insurance	$noce_{13}$
Property taxes	$noce_{14}$
Other fixed cash expenses	$noce_{15}$
Total non-operating cash expenses (TNOCE)	$TNOCE = noce_{13} + \cdots + noce_{15}$
Non-farm expenses (NFE)	NFE
Loans repayment (lr)	
Investment loan – principal	lr_{15}
Investment loan – interest	lr_{16}
Operating loan – principal	lr_{17}
Operating loan – interest	lr_{18}
Total loans repayment (TLR)	$TLR = lr_{15} + \cdots + lr_{18}$

Item	Year 1 (LC)
Total cash outflow (TCO)	$TCO = TOCE + TNOCE + NFE + TLR$ *(21)*
Cash balance available before any new operating loan $(CB_{before\ NOL})$	$CB_{before\ NOL} = TCI - TCO$ *(22)*
New operating loan (NOL)	NOL
Cash balance after new operating loan $(CB_{after\ NOL})$	$CB_{after\ NOL} = CB_{before\ NOL} + NOL$ *(23)*

LC = local currency

3.5 Business plan

What is a business plan?

It is a detailed written document addressing all the major aspects of the business (Manning and Hishamunda, 2001).

Why do you prepare a business plan?

To provide a guide for entrepreneurs, with a set of goals against which to monitor the business' financial performance. Even if different from a business loan proposal, it constitutes a major portion of the loan application required to convince a financial institution of the viability of the proposed business (Manning and Hishamunda, 2001; Engle and Neira, 2005).

How do you draw up a business plan?

A possible business plan structure in presented in Figure 2.[13]

The first section of the business plan describes the aquaculture business, including its legal structure, management capacity, borrower's financial history, production system and site.

The second section of the business plan includes the **marketing plan**, which outlines the market opportunities for the aquaculture activities and the marketing strategies to attract clients.

Marketing is the management process responsible for identifying and satisfying the needs of consumers in an efficient and profitable manner (Jolly and Clonts, 1993).

The marketing plan is composed of two sections: the market analysis and the marketing strategy. The marketing plan should identify, among other things: the markets; the distance between markets and fish farms; the markets' accessibility; the transportation costs; the frequency and scheduling of deliveries; the volume and size requirements of the market; the historical prices paid (Manning and Hishamunda, 2001).

The third section presents the estimated financing required and the pro-forma financial statements, (income statement, balance sheet and cash flow).[14] This section should include a summary of the financial needs in terms of type and amount of capital funds, e.g. short, medium- or long-term loans, and a description on the envisaged investments including the rationale, type and costs. The pro-forma financial statements compute the expected results of the proposed aquaculture business.

[13] The proposed business plan is based on Manning and Hishamunda (2001).

[14] How to draw up an income statement, a balance sheet and a cash flow was described in above Section 3.1.

Figure 2. Example of a business plan

Part 1: Preliminary pages
Title page
Table of contents
Executive summary
Part 2: Main body
Chapter 1: Anatomy of the proposed aquaculture business
Section 1.1: Description of the proposed venture
Section 1.2: Description of the site
Section 1.3: Description of the production system
Section 1.4: Discussion of the legal structure of the business
Section 1.5: Discussion of the management capacity
Section 1.6: Borrower's financial history
Chapter 2: Marketing plan
Chapter 3: Financial documents
Section 3.1: Estimated financing required
Section 3.2: Pro-forma financial statements
Section 3.2.1: Pro forma income statement
Section 3.2.2: Pro forma balance sheet
Section 3.2.3: Pro forma cash flow

Source: Manning and Hishamunda (2001).

4 Assessing the economic and financial viability

The following sections will introduce some useful tools to assess the economic and financial viability of fish farms, namely the cost structure, sensitivity, financial and cash flow analyses.

It is worth mentioning that the analyses are based on UTIDA and its assumptions, and are by no means exhaustive.

4.1 Cost structure analysis

What is a cost structure analysis?

It defines the weight (the relative proportion) of a single cost items on variable, fixed and total costs.

Why do you perform a cost structure analysis?

By showing the distribution of financial resources among factors of production, the cost structure analysis is useful to fish farmers seeking to improve the profitability of their farm (Manning and Hishamunda, 2001).

How do you carry out a cost structure analysis?

First step

Sum all variable cost (vc) items to calculate total variable costs (TVC), as shown in Equation 24.

$$TVC = vc_a + vc_b + \cdots + vc_n \quad (24)$$

Sum all fixed costs (fc) items to calculate total fixed costs (TFC), as shown in Equation 25.

$$TFC = fc_a + fc_b + \cdots + fc_n \quad (25)$$

Sum TVC and TFC to calculate total costs (TC), as shown in Equation 26.

$$TC = TVC + TFC \quad (26)$$

Second step

Calculate the relative proportion of each single cost on TVC, TFC and TC, as shown Table 8:[15]

Table 8. Example of cost structure analysis

Items	Percentage of variable costs	Percentage of fixed costs	Percentage of total costs
VARIABLE COSTS			
Fingerlings	$= vc_1/\text{TVC}$	na	$= vc_1/\text{TC}$
Feed	$= vc_2/\text{TVC}$	na	$= vc_2/\text{TC}$
Fertilizers	$= vc_3/\text{TVC}$	na	$= vc_3/\text{TC}$
Veterinary and Pharmaceutical Products	$= vc_4/\text{TVC}$	na	$= vc_4/\text{TC}$
Permanent Employees	$= vc_5/\text{TVC}$	na	$= vc_5/\text{TC}$
Occasional Employees	$= vc_6/\text{TVC}$	na	$= vc_6/\text{TC}$
Other Variable Costs	$= vc_7/\text{TVC}$	na	$= vc_7/\text{TC}$
TOTAL VARIABLE COSTS (TVC)	$= TVC/\text{TVC}$	na	$= TVC/\text{TC}$
FIXED COSTS			
Depreciation	na	$= fc_8/\text{TFC}$	$= fc_8/\text{TC}$
Other Fixed Costs	na	$= fc_9/\text{TFC}$	$= fc_9/\text{TC}$
TOTAL FIXED COSTS (TFC)	na	$= TFC/\text{TFC}$	$= TFC/\text{TC}$
TOTAL COSTS (TC)	na	na	$= TC/\text{TC}$

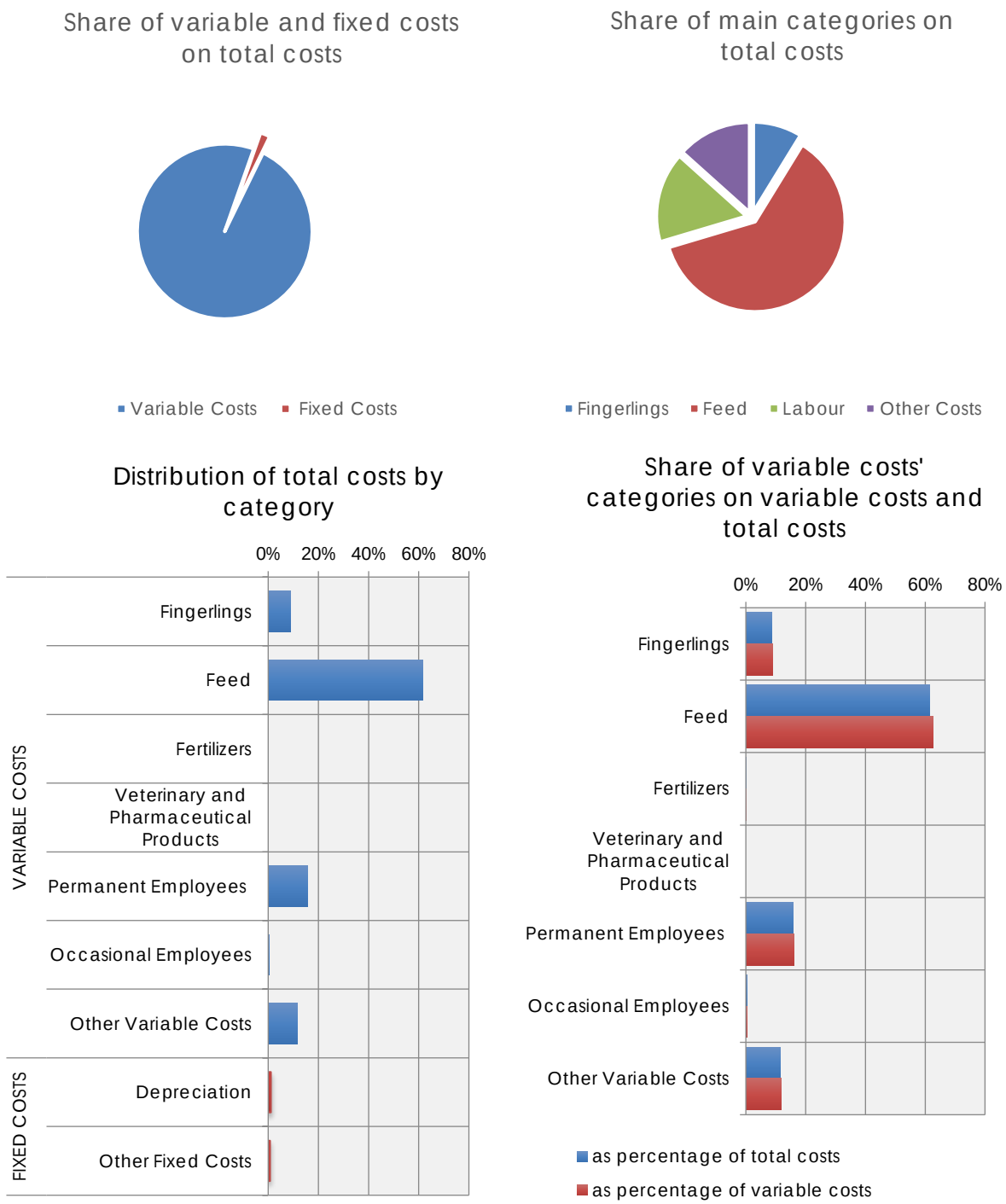
na = not applicable. Please note that Table 8 shows a tentative and not exhaustive list of costs.

[15] The proposed cost structure analysis is based on UTIDA.

Third step

Create charts to better visualize the results produced in the second step. Figure 3 below shows some examples.

Figure 3. Examples of charts for the cost structure analysis



4.2 Sensitivity analysis

What is a sensitivity analysis?

It shows how varying the costs or quantities of factors of production affect fish farm profitability.

Why do you perform a sensitivity analysis?

It is useful in order to assess the risks associated with a business (Manning and Hishamunda, 2001).

How do you carry out a sensitivity analysis?

Sensitivity analyses should be performed on key parameters (Engle, 2010).

First step

Select the factors of production (e.g. feed prices, survival rates and price of fish harvested) and profitability indicators (e.g. net farm income [NFI]),[16] as well as the break-even price above total cost (BPTC).[17]

Second step

Identify a range of possible values for the selected item, as shown in Table 9.

Table 9. Sensitivity analysis: second step

Scenario	Feed price (currency/kg)
Scenario 1	100
Scenario 2	125
Scenario 3	150
Scenario 4	175
Scenario 5	200

The number of envisaged scenarios could be more or less than five.

Third step

Detect how the selected parameter, e.g. the price of feed (p_b), affects the profitability indicator, e.g. NFI.

For example, the cost of feed is a variable cost (vc_b) obtained by multiplying $\boldsymbol{p_2}$ by the quantity of feed purchased (q_b), as shown in Equation 27.

$$vc_2 = \boldsymbol{p_2} * q_2 \qquad (27)$$

Since NFI is calculated by subtracting the total costs (TC) from the total revenues (TR), it is affected by $\boldsymbol{p_2}$ as demonstrated in Equation 28.

$$\begin{gathered} NFI = TR - TC = \\ = TR - (TVC + TFC) = \\ = TR - [(vc_1 + vc_2 + \cdots + vc_n) + TFC] = \\ = TR - [(vc_1 + \boldsymbol{p_2} * q_2 + \cdots + vc_n) + TFC] \end{gathered} \qquad (28)$$

[16] NFI measurement is addressed in the above Income statement section.

[17] See Section 3.2 “Pricing of aquaculture products”.

Fourth step

Calculate the effect of the different values of the selected item on farm profitability indicators, while holding the values of all other parameters constant, as shown in Table 10.

Table 10. Sensitivity analysis: third step

Scenario	Feed price (currency/kg)	NFI (currency)
Scenario 1	100	$= TR - [(vc_1 + \mathbf{100} \times q_2 + \cdots + vc_n) + TFC]$
Scenario 2	125	$= TR - [(vc_1 + \mathbf{125} \times q_2 + \cdots + vc_n) + TFC]$
Scenario 3	150	$= TR - [(vc_1 + \mathbf{150} \times q_2 + \cdots + vc_n) + TFC]$
Scenario 4	175	$= TR - [(vc_1 + \mathbf{175} \times q_2 + \cdots + vc_n) + TFC]$
Scenario 5	200	$= TR - [(vc_1 + \mathbf{200} \times q_2 + \cdots + vc_n) + TFC]$

4.3 Financial analysis

What is a financial analysis?

The assessment of the solvency, liquidity, profitability and financial efficiency of the fish farm.

Why do you perform a financial analysis?

It is useful to evaluate the sustainability of the fish farm.

How do you perform a financial analysis?

Calculate solvency, liquidity, profitability and financial efficiency ratios from data generated from the income statement and balance sheet (see Chapter 3).

Solvency indicators refer to the value of assets as compared to the amount of liabilities on the fish farm (Engle and Neira, 2005). Liquidity indicators refer to the ability of the fish farm to meet its cash flow obligations (Engle and Neira, 2005). Profitability indicators are generally calculated by subtracting total costs from total revenues (Engle and Neira, 2005). Financial efficiency indicators refer to how effectively a fish farm is able to generate income (Becker *et al.*, 2014).

Table 23 shows the formula for each indicator, as well as the unit of measurement and the financial statements containing the items required to calculate it.

Table 11. Financial analysis indicators

Indicator	Formula	Unit	Source
Solvency			
Net Worth	= Total Assets – Total Liabilities	Currency	BS
(Net) Capital Ratio	= Total Assets / Total Liabilities	Index	BS
Debt/Asset Ratio	= Total Liabilities / Total Assets	Index	BS
Equity/Asset Ratio	= Net Worth / Total Assets	Index	BS
Debt/Equity Ratio (Leverage Ratio)	= Total Liabilities / Net Worth	Index	BS
Debt Structure Ratio	= Current Liabilities / Total Liabilities	%	BS
Liquidity			
Current Ratio	= Current assets / Current liabilities	Index	BS
Acid Test Ratio	= Liquid assets / Current liabilities	Index	BS
Working Capital	= Current assets – Current liabilities	Currency	BS
Working Capital to Gross Revenues	= Working capital / Total revenues	%	BS, IC
Profitability			
Net Farm Income	= Total revenues – Total costs	Currency	IC
Return to labour and Management	= Adjusted net farm income (ANFI) – Opportunity cost of capital Where, Adjusted net farm income (ANFI) = Net farm income from operations + Interest expenses	Currency	BS, IC
Returns to Management	= Return to labour and management – Opportunity cost of labour	Currency	BS, IC
Return on Assets	ANFI – Opportunity cost of labour – Opportunity cost of management	Currency	BS, IC
Rate of Return on Farm Assets (ROA)	= (Return to assets / Asset value)*100	%	BS, IC
Return on Equity	= Net farm income from operations – Opportunity cost of labour – Opportunity cost of management	Currency	BS, IC
Rate of Return on Farm Equity (ROE)	= (Return to equity / Equity value)*100	%	BS, IC
Operating Profit Margin Ratio (OPMR)	= Return to assets / Total revenues	Index	BS, IC
Financial efficiency			
Operating Expense Ratio	= (Operating expenses – Depreciation) / Total revenues	Index	IC
Depreciation Expense Ratio	= Depreciation / Total revenues	Index	IC
Interest Expense Ratio	= Total farm interest expenses / Total revenues	Index	IC
Asset Turnover Ratio	= Total revenues / Average total farm assets	Index	IC
Net Farm Income Ratio	= Net Farm Income / Total revenues	%	IC

BS = Balance Sheet. IC =Income Statement. Table 23 shows a tentative and inexhaustive list of indicators.

Source: adapted from Engle and Neira (2005), Engle (2010) and Becker *et al.* (2014)

4.4 Cash flow analysis

What is a cash flow analysis?

The analysis of the fish farm's cash inflows and outflows.

Why do you perform a cash flow analysis?

It can be used to evaluate borrowing needs and to determine the cash needed to repay any new loan, the loan repayment capacity and when it might be possible for a loan to be repaid, i.e. the payback period (Manning and Hishamunda, 2001).

How do you carry out a cash flow analysis?

Calculate the new operating loan

Calculate the **New operating loan (NOL)** from data generated using the cash flow sheet (Chapter 3).

It is worth mentioning that the calculations here presented do not represent a commonly applied, standard process. These calculations are based on assumptions made by UTIDA in order to estimate NOL automatically and are by no means exhaustive.

The following calculations are presented as an example. In this case, if the **cash balance available before any new operating loan** ($CB_{before\ NOL}$) is higher than the **minimum ending cash balance required** ($MCB_{required}$), there is no need to take out a new operation loan, as shown by Equation 29.

$$If\,(CB_{before\ NOL}) > (MCB_{required}) \Rightarrow NOL = 0 \qquad (29)$$

It is assumed that the $MCB_{required}$ is equal to **Total operating cash expenses** ($TOCE$), which means that there should be enough cash to cover operating cash expenses at least, such as fingerlings, feed etc. (Equation 30).

$$MCB_{required} = TOCE \qquad (30)$$

If $CB_{before\ NOL}$ is lower (not greater) than the $MCB_{required}$, the fish farmer should ask for a new operating loan. However, in order to calculate the NOL, there are two scenarios to be considered:

- If $CB_{before\ NOL}$ is negative (lower than zero), the amount of the new operating loan should be able to cover the negative cash balance and operating cash expenses (Equation 31).

$$\begin{cases} CB_{before\ NOL} < MCB_{required} \\ CB_{before\ NOL} < 0 \end{cases} \Rightarrow NOL = CB_{before\ NOL} + MCB_{required} \qquad (31)$$

- If $CB_{before\ NOL}$ is positive (higher than zero), it can partially cover the operating cash expenses. Therefore, the amount of the new operating loan should be able to cover the remaining operating cash expenses (Equation 32).

$$\begin{cases} CB_{before\ NOL} < MCB_{required} \\ CB_{before\ NOL} > 0 \end{cases} \Rightarrow NOL = MCB_{required} - CB_{before\ NOL} \qquad (32)$$

Calculate the payback period of the investment loan

Calculate the payback period (PBP) by utilizing the data generated in the cash flow statement (Section 3.4). The PBP shows the number of years required to recover the investment loan (IL) through the expected annual cash balance available to pay back the investment loan.

It is worth mentioning that the calculations here presented do not represent a commonly applied, standard process. These calculations are based on the assumptions made in UTIDA to estimate PBP automatically and are by no means exhaustive.

The following calculations are presented as an example. In this case, the expected annual **cash balance available to pay back the investment loan** (CB_{PBIL}) can be calculated as follow:

$$\begin{cases} If(NOL) = 0 \Rightarrow CB_{PBIL} = CB_{before\ NOL} - MCB_{required} \\ If(NOL) > 0 \Rightarrow CB_{PBIL} = 0 \end{cases} \quad (33)$$

What is the rationale behind Equation 33?

If there is a need to take out a new operation loan (i.e. NOL higher than zero), there is no cash available to cover the expenses related to IL. On the other hand, a NOL equal to zero could imply the existence of net cash to pay back IL, after it had covered the operating cash expenses.

If during the period under consideration, the expected annual cash balance is constant ($CB_{PBIL_{costant}}$), PBP can be calculated as follows (Engle and Neira, 2005):

$$PBP = \frac{IL}{CB_{PBIL_{costant}}} \quad (34)$$

If the expected annual cash balance is not constant ($CB_{PBIL_{no\ costant}}$), they should be summed year by year to find the year where the total is equal to the investment amount (Engle and Neira, 2005).

In a given period, if the cash balance available to pay back the investment loan ($CB_{PBIL_{no\ costant},year_1}$) is higher than remaining balance on the investment loan ($RB_{IL,year_1}$), i.e. the principal balance of the investment loan (PB), then the fish farmer would be able to pay back the loan in that period (Equation 35).

$$(CB_{PBIL_{no\ costant},year_1}) > RB_{IL,year_1} \Rightarrow PBP = year_1 \quad (35)$$

Where, RB_{IL} or principal balance (PB) is achieved by subtracting the payment of principal (PP), i.e. the difference between the total payment (TP) and the payment of interest (PI) from the total amount of the investment loan (IL), as shown in Equation 36. In the amortization of the investment loan, the calculations for payments of investment loan (TP) could be based on constant payments and a constant interest rate, for example.

$$RB_{IL} = PB = IL - PP = \\ = IL - (TP - PI) \quad (36)$$

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The “Doing aquaculture as a business for small- and medium-scale farmers. Practical training manual” is composed by two modules: Module 1 “The technical dimension of commercial aquaculture” and Module 2 “The economic dimension of commercial aquaculture”. The target users of both modules are trainers, educators, extension officers as well as small- and medium-scale fish farmers. The purpose of this module is to enhance their knowledge and capacities in understanding and applying the basic economic and financial principles and concepts of commercial aquaculture in their daily activities.

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