

**TILAPIA FARMING SUPPORT TOOL**  
**TFST 1.0**  
**USERS MANUAL**



**NOVEMBER 2003**

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## FOREWORD

Gertjan de Graaf (NEFISCO<sup>1</sup>, Amsterdam, the Netherlands) and Pieter Dekker (Xi<sup>2</sup>, Delft, the Netherlands) developed an Individual-Based Tilapia Farming Simulation Model.

The development of this model is the result of G.J. de Graaf's experiences with large-scale farming of Nile tilapia (*Oreochromis niloticus*) in Congo Brazzaville during a FAO/UNDP aquaculture project.

In Congo Brazzaville, use of proper feeding and stocking regimes led to productions of 6-8 t/ha/yr. and elimination of the famous tilapia stunting was not a problem. These results were published in a number of scientific articles (de Graaf *et al.* 1996, 1999). During the analysis of the Congo Brazzaville data and writing of the articles it was realised that there could be some basic biological driving forces behind the failure or success of tilapia farming, especially in rural Africa. Field experiments to test the validity of the ideas were too expensive to conduct.

However, the availability of the large data set acquired during five years of tilapia farming in Congo Brazzaville and the development of the computer industry with increased availability of cheap, powerful computers and software, provided the idea:

**“Why not build a simulation model that can identify the most important driving forces within the system?”**

The tilapia model was built in MATLAB and calibrated with the data set of Congo Brazzaville. The first simulations of the model provided good results and the idea of making a more user friendly version of the model to support tilapia farmers and students in developing countries was introduced.

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<sup>1</sup> <http://www.nefisco.org/software.htm>

<sup>2</sup> <http://www.xi-advies.nl>

Thanks to the financial support of GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit, German Technical Cooperation) we were able to develop this Tilapia Farming Support Tool (TFST), which you have downloaded free from the Internet.

Before you start using TFST, you should realize two things:

1. TFST is only a support tool, giving you a general idea of what you can do with your pond. However, it will never give you the complete picture and in some cases your reality may be completely different.
2. This is the first version of TFST developed using data obtained from the African continent. We did our best to include the major principles and driving forces in tilapia farming, but we acknowledge some shortcomings in the present version, For example, TFST does not encompass water temperature. Also, the relation between growth and the protein content of the feed can be improved.

For improvement of TFST, **we need your help**. You can be a passive consumer, (thanks, but TFST isn't working for me), or you can be an active consumer and share your suggestions with us, so that we can incorporate them and improve this free software. I hope you are an active consumer and that you will send your comments to us at [degraaf@nefisco.org](mailto:degraaf@nefisco.org)

## **The Program**

The program is based on population dynamics. In other words, it follows each individual fish in your virtual pond throughout the rearing period. In this respect, it differs from other aquaculture simulation software, which are based mostly on the flow of nutrients into the ponds. Because of this set up, there are two constraints you should realize:

- 1) Growth of fish depends on water temperature: higher temperatures lead to higher growth. This is not incorporated into the model. The program assumes that the water temperature in your pond **NEVER**

gets below 23 degrees Celsius. Do not use the program if the water in your ponds gets colder.

- 2) Growth of fish depends on feeding. If you do not feed your fish they will not grow. The program **DOES NOT** incorporate natural productivity or the water quality of your pond.

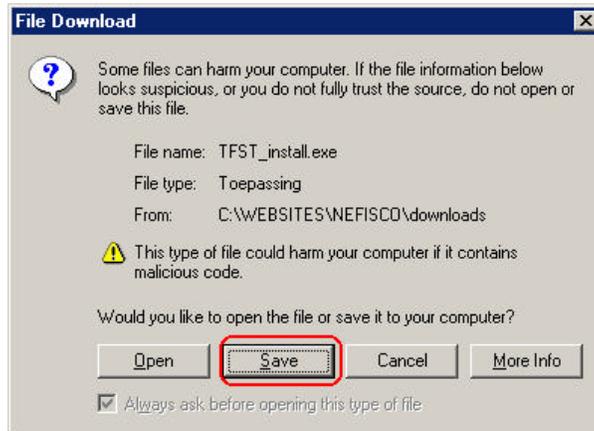
Gertjan de Graaf

Amsterdam, the Netherlands

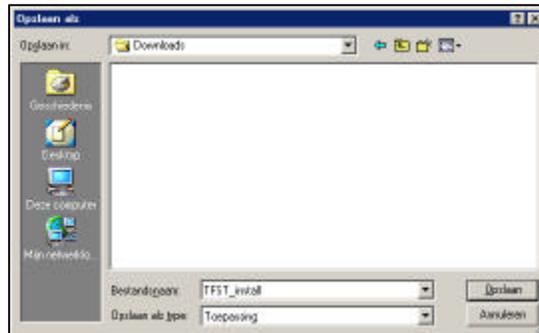
November 2003

## INSTALLING TFST

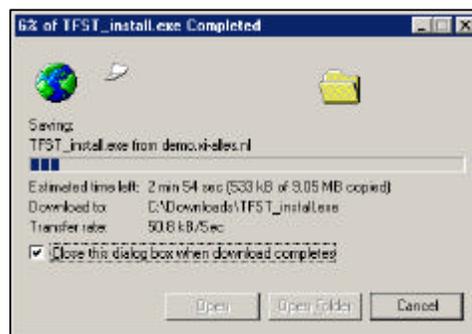
If you correctly downloaded TFST from our websites<sup>3</sup> you went through the following menus:



Select “Save” to save TFST installation on your hard disk.



Indicate the subdirectory on your hard disk where you want to save your file, in this example the subdirectory is C:\downloads.

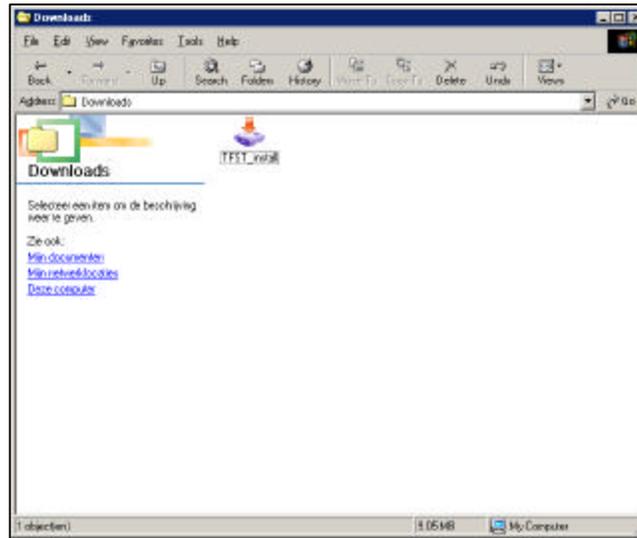


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<sup>3</sup> <http://www.nefisco.org/software.html>  
<http://www.xi-advies.nl/project-tilapias.shtml>

You will see the progress of downloading.

To install TFST, go to the subdirectory where you saved the installation file of TFST, in the example it is C:\downloads, and double click on the installation icon.



**Figure 1: Installing TFST**

The next pop up screens will guide you through the installation process:

1) Welcome to the install program: click **“Next”**



**Figure 2: Installation pop-up 1**

2) TFST is free software: click “Next”

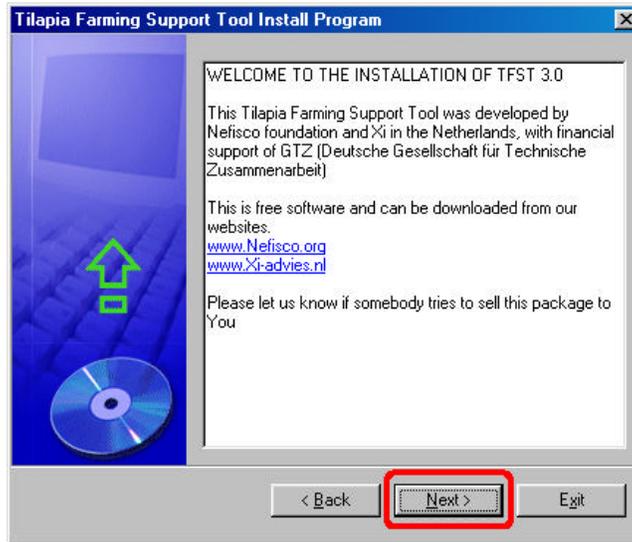


Figure 3: Installation pop-up 2

3) Read and agree with the Disclaimer/License agreement: click “Next”

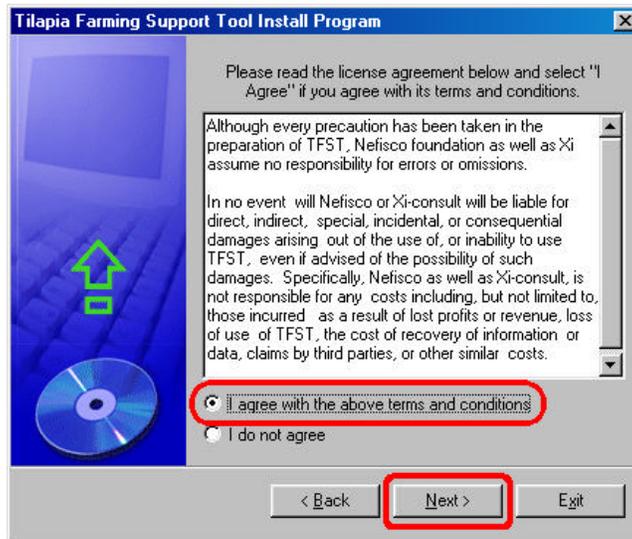
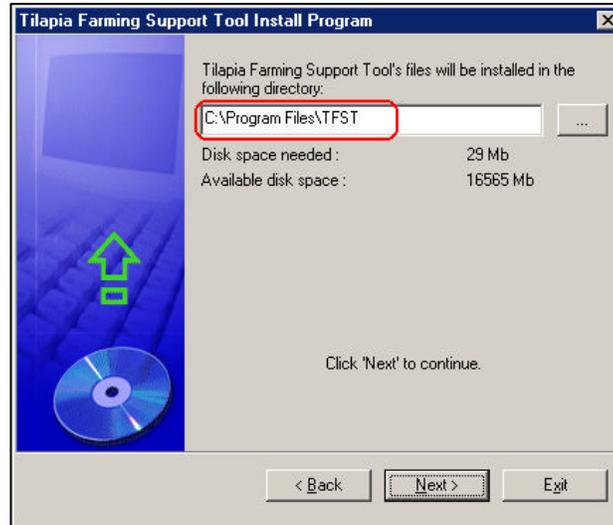


Figure 4: Installation pop-up 3

4) Select the subdirectory for the installation or agree with the standard setting: click **“Next”**



**Figure 5: Installation pop-up 4**

5) Create this new sub directory: click **“Yes”**



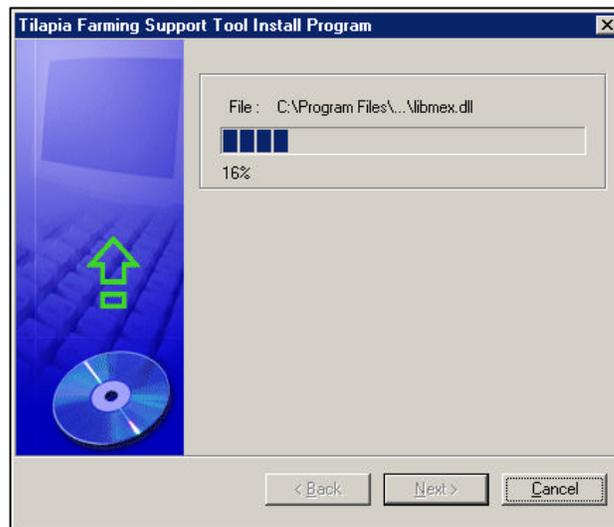
**Figure 6: Installation pop-up 5**

6) Start installation: click “**Start**”



**Figure 7: Installation pop-up 6**

7) The progress bar



**Figure 8: Installation pop-up 7**

## STARTING TFST

Once you have installed TFST properly, you can start TFST by clicking on the

 icon on your desktop, or by opening it through the menu: **start** → **programs** → **TFST** → **TFST**

The first time you start TFST you will be guided through two introduction pages, please read them carefully. Fill the check box on the bottom left of the page if you want to skip the introduction pages the next time you start TFST, then start TFST (Figure 9).



Figure 9: The second introduction page

If you want to read the introduction again later, go in the main menu to **“Help”** and double click on **“Introduction.”**

## THE STRUCTURE OF TFST

Before we present the details of the different menus of TFST, we will explain to you the main structure and how TFST works.

TFST consists of three main programs (Figure 10):

- **The database:** This contains all the information you provided on your pond, the type of tilapia, the second species in your pond, type of feed prices, investments, etc. This data is used in the simulation of the optimisation program.
- **The simulation program:** This is the main program, which simulates your pond after you have provided the needed details. Here you can simulate one setting for your pond and rearing system precisely and the results can be displayed with a number of graphics. If you want to see if there are alternative options, which give higher financial benefits, then you'll have to run the optimisation program.
- **The optimisation program:** Here you can look for better alternatives. The main settings you used in the simulation program are automatically exported to this program. You can select other rearing systems and different types of feed, look at the number of days you culture your fish, different stocking rates, etc, and see if this improves the financial performance. After running "Optimise" you can display the three best options: "Gold," "Silver" and "Bronze." Then, the settings of the selected option are automatically exported to the main screen of the simulation program, where you can do a new precise simulation with this setting.

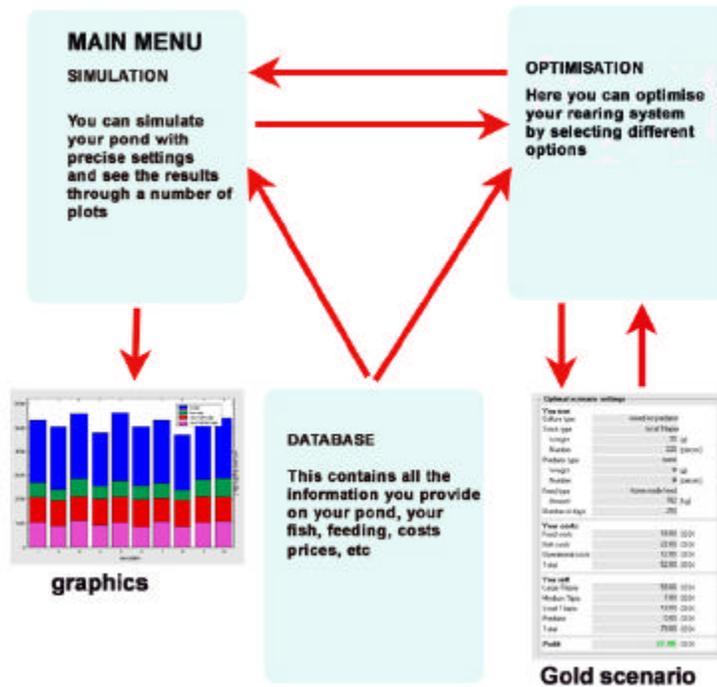
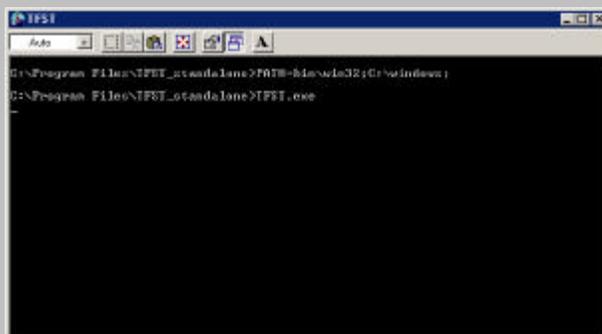


Figure 10: The structure of TFST

Once TFST is started, you will notice a MSDOS screen is operating in the background.  TFST

This is part of the stand-alone version of TFST made in Matlab and has no further function for you. **If TFST crashes**, you will see here an indication what went wrong in the software. If this is the case, please send us the lines displayed in this screen.

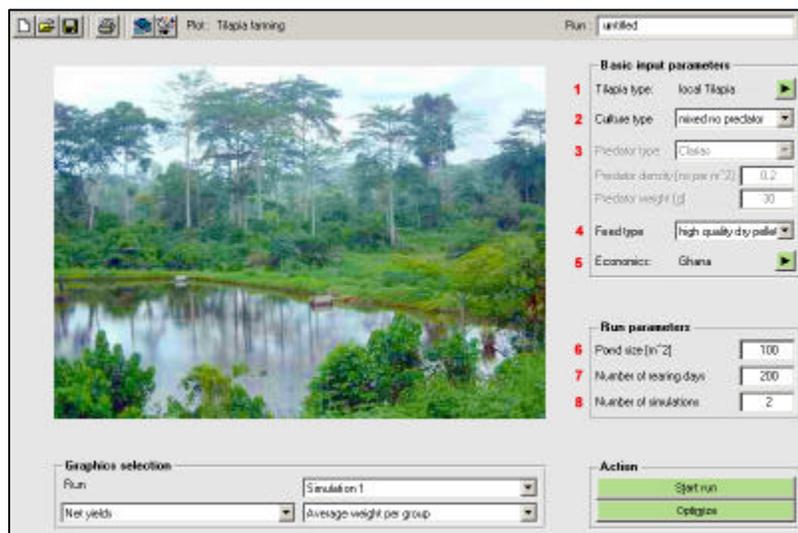


## THE MAIN MENU

Once you have started TFST, you arrive in the main simulation menu. In this main screen (Figure 11), you can set the basics of a simulation such as:

1. The type of tilapia you use
2. The culture system, i.e. mixed, mixed with a predator, all male
3. Information on the predator, if you use one
4. The type of feed you use
5. Financial information and prices
6. The size of your pond
7. The number of days you keep the fish in your pond
8. The number of simulations you want to carry out

Details on each function are provided in the following paragraphs.



**Figure 11: The Main menu**

## TILAPIA TYPE

TFST operates with two types of tilapia (Figure 12):

1. A local strain of tilapia, which is the common tilapia used for years in your area.

2. A Genetically Improved Farmed Tilapia (GIFT strain) developed by ICLARM and a number of fisheries research stations. The growth of this strain is much higher if compared with local strains. However, they are at present only produced in a limited number of countries.



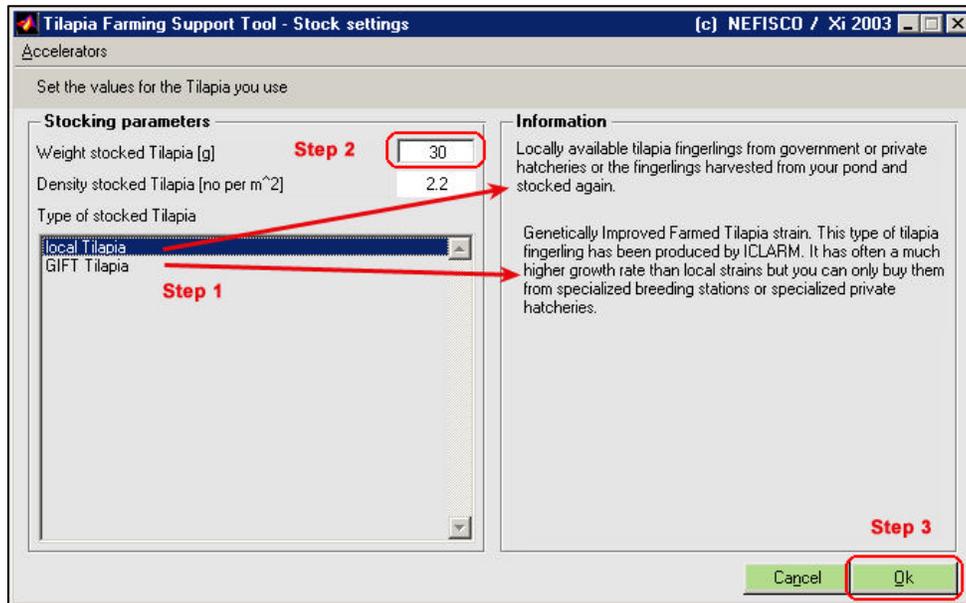
**Figure 12: Local and GIFT tilapia of the same age<sup>4</sup>**

In the tilapia menu, you indicate the type of tilapia you want to use and the weight of the tilapia fingerlings you stock. You enter this menu by clicking on the green arrow.

Tilapia type:	local Tilapia	
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<sup>4</sup> <http://www.worldbank.org/html/cgiar/newsletter/Oct94/SupTil.html>



**Figure 13: The Tilapia menu**

First you select the tilapia type (Figure 13). On the right hand side of the screen a small description of your tilapia is displayed. Then you enter the stocking weight of your tilapia fingerlings. Note that you cannot change the stocking density of your tilapia. TFST uses a standard setting of 2.2 fingerlings per m<sup>2</sup> or 22,000 fingerlings per ha. When finished, click on the “OK” button. Your settings will be saved and you will return to the main menu.

## CULTURE TYPE

TFST can work with four culture types:

1. **Mixed without a predator:** You stock your pond with un-sexed tilapia fingerlings, in general 50% of the fingerlings will be male and 50% will be female
2. **Mixed with a predator:** In order to get rid of the excessive fingerling production, predators can be raised in combination with tilapia. In TFST, you can use the African catfish or the African snakehead.

3. **All male culture, sex reversed:** with this option, you stock your pond with all male fingerlings that are produced with hormone treatment in their early life. Sex reversed fingerling in general can only be obtained from specialized hatcheries and are 100% male even if you buy them at a weight of 15 grams.
4. **All male culture, hand sexed:** You stock your pond with all male fingerlings that are obtained by hand sexing. This can be done at a specialized hatchery or you can sex the fingerlings harvested from your own pond. Hand sexing can only be done correctly with fish larger than 35 grams, which means that in the “Tilapia type menu” you should give a stocking weight of 35 grams. With hand sexing, there is always a small sexing error (5%) which is incorporated in TFST.

Standard TFST opens with “**mixed culture, no predator.**” In the menu you can select your own option. If you select “**mixed with a predator,**” you will see that the menu just below “**predator type**” pops up and you have to fill in the information on the predator you use.

## PREDATOR TYPE

If you intend to use a predator in your pond, you first have to indicate which predator you want to use: the African catfish or the African snakehead.

The second step is to provide the density and the weight of the stocked predator.

For the African catfish you can stock up to 1 fingerling per m<sup>2</sup> (10,000 per ha) and the

maximum stocking density for African snakeheads is set at 0.1 fingerling per m<sup>2</sup> (1000 per ha). Above these values the results are not coherent with the reality in the field.

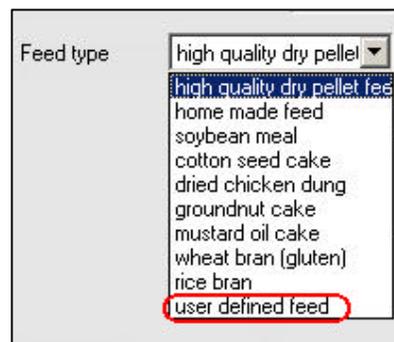
#### NOTE

Here, TFST has a geographical problem, as it was developed with data from the African continent. In some countries of Asia, Southeast Asia and South America, the African catfish is imported and raised in ponds and you can use this setting if fingerlings are available. For the African snakehead it is more complicated, as they are only found on the African continent. For Asia and Southeast Asia the snakehead settings could be representative for the use of the “Asian snakehead” (*Channa Striatus*). The efficiency of predation for the African snakehead or the Asian snakehead is more or less in the same order, but for growth, we do not know. So please realize that TFST is not calibrated for this option and results can be unreliable.

***We need your co-operation to solve this and include more predators in updated versions of FTST***

#### FEED TYPE

Selecting the type of feed you use is straightforward: just select one from the menu. You can define one type yourself, if the feed you use is not among the pre-defined ones. You can include your own type of feed in the “**economic menu**”.



Go to the economic menu by clicking on the green arrow



## THE ECONOMIC MENU

The economic menu consists of three sub menus (Figure 14):

1. **Investments and labor:** here you provide the details of the costs of constructing your pond and the prices of labor needed to operate your farm.
2. **Input and feed:** here you give information on the cost of fingerlings and the feed you use.
3. **Farm gate prices:** here you enter the selling price of the fish.

In the main menu, you can enter the name of your country and the name of your currency. Automatically, TFST gives all the results in your own currency. You open the sub menus by clicking on the name of the sub menu.

The screenshot shows the 'Tilapia Farming Support Tool - Stock settings' window. The title bar indicates the user is 'NEFISCO / 2003'. The 'Your currency name' field is set to 'ZAR' and the 'Your country name' field is set to 'South Africa'. Three sub-menu tabs are visible: 'Investment and labour', 'Input and feed', and 'Farm gate prices'. The 'Investment and labour' tab is active, showing three tables: 'Investment', 'Maintenance costs', and 'Labour costs'.

Investment				
	Investment [ZAR]/[ha]	Amortisation [yr]	Interest [%]	Cost [ZAR]/[ha][yr]
Fish farm	20000.00	20	15	3195.23
Equipment	1600.00	5	15	477.30

Maintenance costs				
Maintenance and replacements			[%]	Cost [ZAR]/[ha][yr]
Fish farm			3	600.00
Equipment			3	48.00

Labour costs			
	Price [ZAR]/[day]	Unit / [ha]	Cost [ZAR]/[ha][yr]
Skilled labour	32.00	0.1	1168.00
Unskilled labour	15.00	1	5475.00

Figure 14: The Economic menu

## Investment and Labor

In this submenu, you provide information on your investment, maintenance and labor costs of your farm.

***Please note that TFST calculates on a hectare basis, which means that you have to convert all your costs here, i.e. your pond is 100 m<sup>2</sup> or 0.01 ha, and the construction costs for this pond were 200 ZAR. Therefore, your construction costs for TFST are 20000 ZAR/ha. If your pond is 5000 m<sup>2</sup> or 0.5 ha and your investments were 1250000 CFA then your construction costs were 2500000 CFA/ha, etc.***

## Investments

For your investments you provide:

- Investments made to construct your pond
- Investments made in equipment needed to operate your farm
- Amortization period, the time period needed to pay off the investments or for equipment that has to be replaced completely at the end of the time period
- Interest rate, the annual interest rate you pay to the bank/NGO if you borrowed the money. Even if you constructed the farm with your own money, you have to indicate the interest rate.

TFST automatically converts all your values into costs per hectare, per year.

<b>Investment</b>	Investment [ZAR]/[ha]	Amortisation [yr]	Interest [%]	Cost [ZAR]/[ha][yr]
Fish farm	20000.00	20	15	3195.23
Equipment	1600.00	5	15	477.30

## Maintenance

Once you have constructed your farm, you have to carry out maintenance continuously to keep it in good order. As a standard, TFST calculates maintenance cost as 3% of the investment costs, but you can change this figure if you think it is higher.

Maintenance costs		
Maintenance and replacements	[%]	Cost [ZAR]/[ha][yr]
Fish farm	<input type="text" value="3"/>	<input type="text" value="600.00"/>
Equipment	<input type="text" value="3"/>	<input type="text" value="48.00"/>

## Labor

You need people to run your farm. This can be yourself, family members or hired staff, but in all cases, it costs you money. TFST makes a division in “**Skilled**” and “**Unskilled**” labor. Skilled labor, for example a general manager, is needed if you have a large farm.

In the menu you enter the salary to pay per day, and the number of persons you employ (**again, calculated per hectare**). TFST converts it automatically into annual costs per hectare.

Labour costs			
	Price [ZAR]/[day]	Person / [ha]	Cost [ZAR]/[ha][yr]
Skilled labour	<input type="text" value="32.00"/>	<input type="text" value="0.1"/>	<input type="text" value="1168.00"/>
Unskilled labour	<input type="text" value="15.00"/>	<input type="text" value="1"/>	<input type="text" value="5475.00"/>

## Input and Feed

Fingerlings and feed are often the major costs and you enter these costs in the submenu “**Input and feed**”

## Fingerling Prices

Fingerling prices are the price per fish and there are five categories as discussed before:

1. Tilapia, mixed male and female
2. Tilapia, all sex reversed
3. Tilapia, all male, hand sexed
4. Catfish
5. Snakehead

**Note:** please make sure the prices conform to the type and weight of your tilapia fingerlings, for example, if you use GIFT tilapia then also give the price of GIFT fingerlings. The prices are **NOT UPDATED AUTOMATICALLY** if you change the Tilapia type or stocking weights in the main menu.

Input costs for local Tilapia			
Price of Tilapia and predator fingerlings	Weight [gr]		Cost [ZAR]
Tilapia, mixed male and female	25	per piece	0.80
Tilapia, all male, sex reversed	25	per piece	2.00
Tilapia, all male, hand sexed	25	per piece	3.60
Catfish	30	per piece	2.00
Snakehead	30	per piece	2.00

## Feed Prices

Providing the feed costs is straightforward, just fill in the different cells with the price **per ton of feed**. TFST converts it automatically into the feed cost per

ton of fish harvested from your pond, and adapts the growth rate of your fish to the protein content of your feed<sup>5</sup>.

You can define your own feed. If it is not in the predefined list, enter the name of your feed and the percentage of protein it contains, the latter based on dry matter.

Feed costs		Price [ZAR]/[ton]	Cost [ZAR]/[ton fish]
high quality dry pellet feed		2000.00	3000.00
home made feed		800.00	2000.00
soybean meal		640.00	2560.00
cotton seed cake		480.00	2400.00
dried chicken dung		640.00	3200.00
groundnut cake		400.00	2000.00
mustard oil cake		640.00	3200.00
wheat bran (gluten)		400.00	2400.00
rice bran		320.00	3200.00
Feed from Bobo	Percentage protein: 28	420.00	1848.25

### Please Note

It is possible that some of the pre-defined feeds are not available in your country. TFST keeps the standard values if you do not provide a price for these feeds. In this case, you will get ridiculous results in Optimise if you include them in the search. . . . .

### Farm Gate Prices

The price for which you sell your fish (farm gate price) in most cases depends on the size of the fish. Therefore, in this menu (Figure 15) you first make the different categories of fish you sell, then give the price per kilogram for each category.

<sup>5</sup> The conversion factors used are provided in Annex 1

Provide the price per fingerling as entered in the input menu, if you sell **fingerlings**<sup>6</sup> harvested from your pond or stock the fingerlings again in one of your other ponds.

If you do not sell fingerlings, but sell these small fish on the market for consumption then the price will be much lower, but you still have to enter the price per fish. For example, you sell the fish between 20 and 50 g for two ZAR per kg. One kilogram contains  $1000/35 = 28$  fish. Therefore, the selling price is  $2/28 = 0.07$  ZAR per piece.

Farmgate price Tilapia			
	From [g]	To [g]	Revenue [ZAR]
Very small	0	20	per kg 0.80
Fingerlings	20	50	per piece 0.80
Small sized fish	50	120	per kg 4.00
Medium sized fish	120	170	per kg 8.00
Large sized fish	170	end up	per kg 16.00

Farmgate price predator			
	From [g]	To [g]	Revenue [ZAR]
Cattish	100	end up	per kg 16.00
Snakehead	100	end up	per kg 16.00

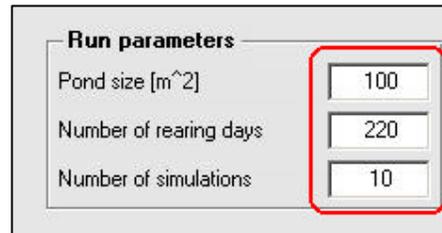
**Figure 15: Farm gate prices**

Click on **“Ok”** once you have provided all the economic details of your farm, the data will be saved and you will return to the main menu.

<sup>6</sup> For example to your neighbour fish farmer

## POND AND SIMULATION SETTINGS

You are almost ready to start your simulation. In the “Run parameters” provide:



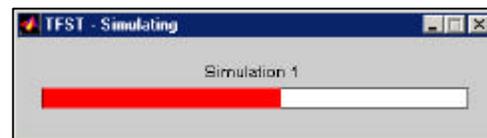
The image shows a dialog box titled "Run parameters" with three input fields: "Pond size [m^2]" with the value 100, "Number of rearing days" with the value 220, and "Number of simulations" with the value 10. A red rectangle highlights these three input fields.

- The size of your pond or farm in m<sup>2</sup>
- The number of days you raise your fish
- The number of simulations you want to carry out. One simulation is a complete rearing cycle. With 10 simulations, you repeat the simulation ten times with the same settings, and TFST shows you the ranges of the results. A set of several simulations is called a run in TFST

Click “**Start**” to start your simulation and a bar will



appear indicating the progress of your simulation. With small ponds, it takes 1-2 minutes to complete a simulation run. But the larger your farm the more time it takes

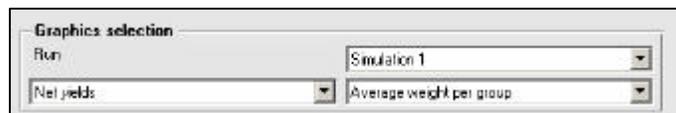


to complete a run, which is the reality of TFST as it is based on Individual Based modelling and follows each individual fish in your pond.

Once the run is completed, the progress bar disappears and you see that the

“**graphics menu**”

becomes brighter and you can visualize the



The image shows a dialog box titled "Graphics selection" with two dropdown menus. The first dropdown menu is labeled "Run" and has "Simulation 1" selected. The second dropdown menu is labeled "Net yields" and has "Average weight per group" selected.

results of the simulation with this menu.

## VISUALIZING THE RESULTS OF YOUR SIMULATION

In the main menu, you can visualize the results either of a complete run or of each individual simulation. For each you can see a graphics on:

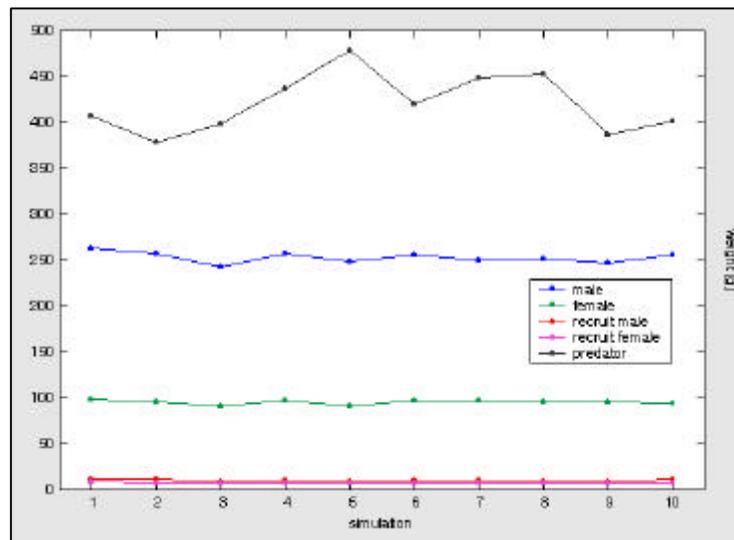
- Average weight of your fish at harvest
- The net yield at harvest and the development of the yields during the rearing in case you selected an individual simulation
- The percentage of the different categories of fish in your pond at harvest or the development over time, in case you selected an individual simulation
- Your costs, revenues and profit and their development over time in case you selected an individual simulation

### Results of a Complete Run

To view the results of a simulation, select the type of graph you want to display in the left menu and it will automatically pop up.



Examples of the four graphs are presented below:



**Figure 16: Example of average weight at harvest obtained from 10 simulations of one pond**

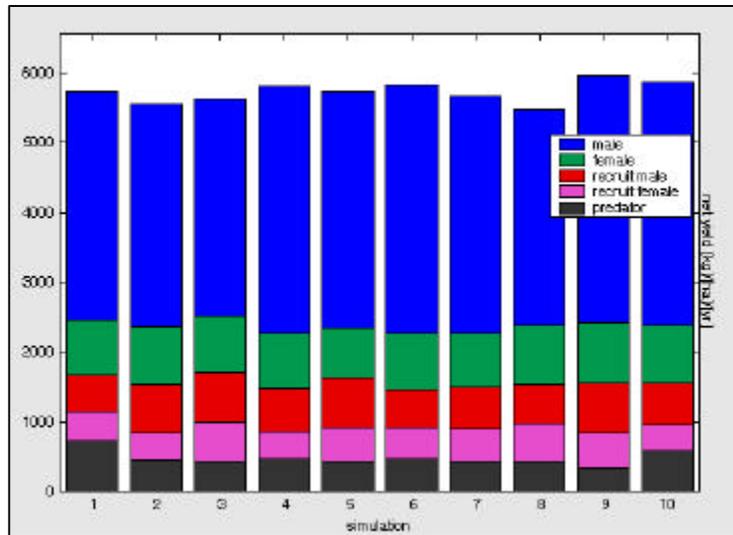


Figure 17: Example of net yields (kg/ha/year) obtained from 10 simulations of one pond

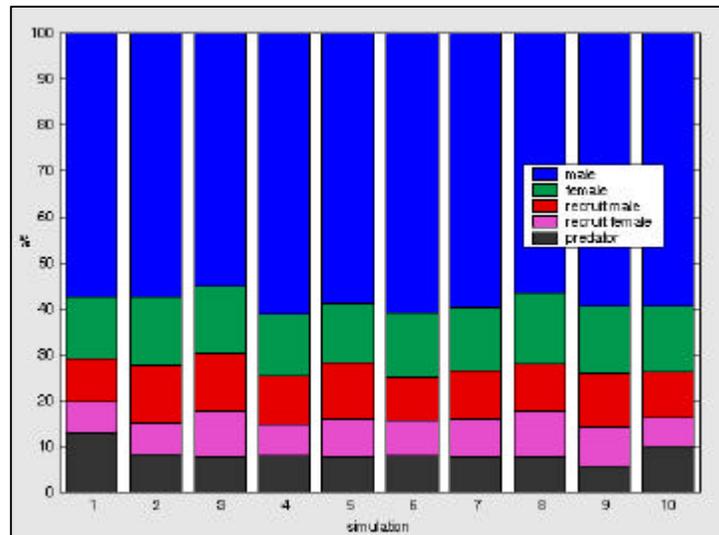
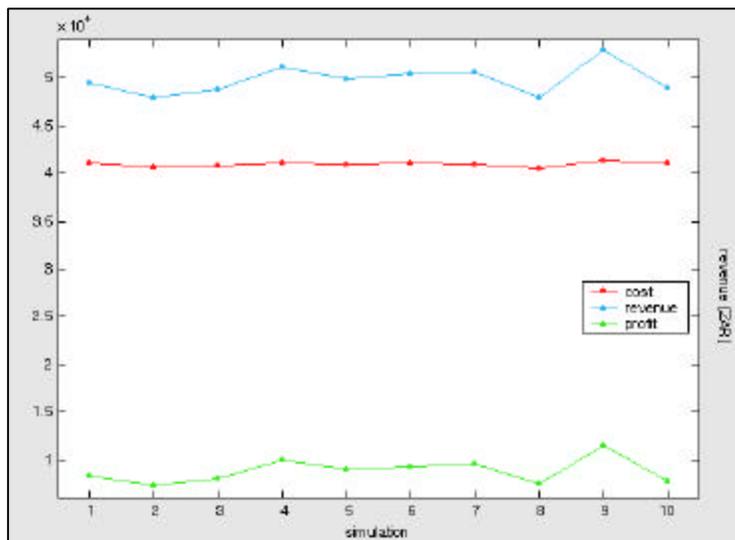


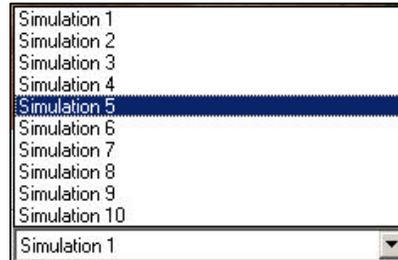
Figure 18: Example of relative biomass obtained from 10 simulations of one pond



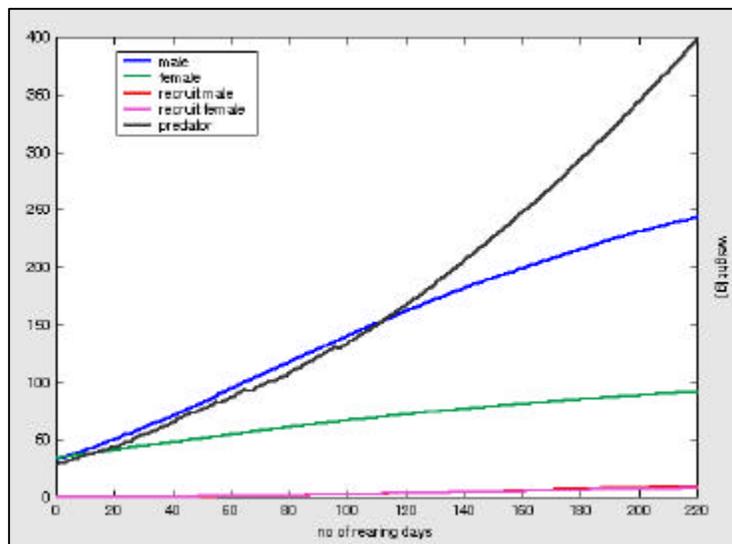
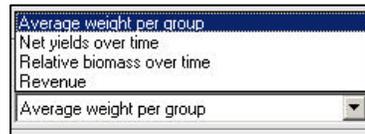
**Figure 19: Example of cost, revenue and profit obtained from 10 simulations of one pond (on a ha basis)**

## Results of an Individual Simulation

If you want to see the results of each individual simulation, you must first select the simulation number in the right menu and the type of graph from the right menu below.



Examples of the four types of graphs are presented below:



**Figure 20: Example of the development of the average weight in one simulation**

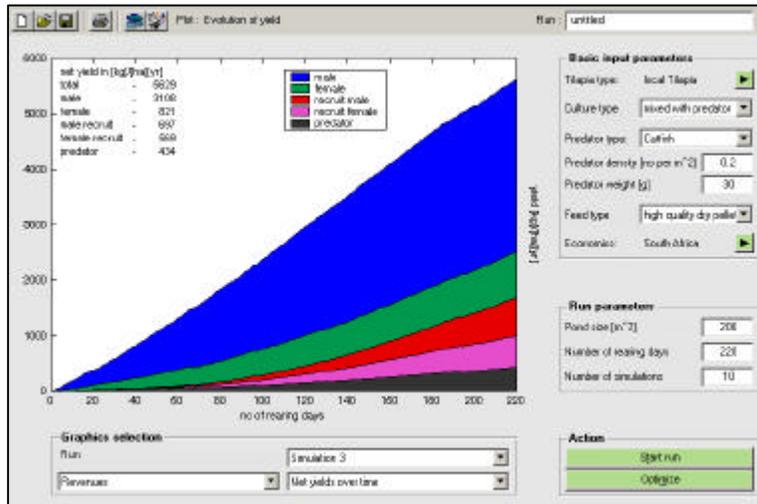


Figure 21: Example of the development of the net yields in one simulation

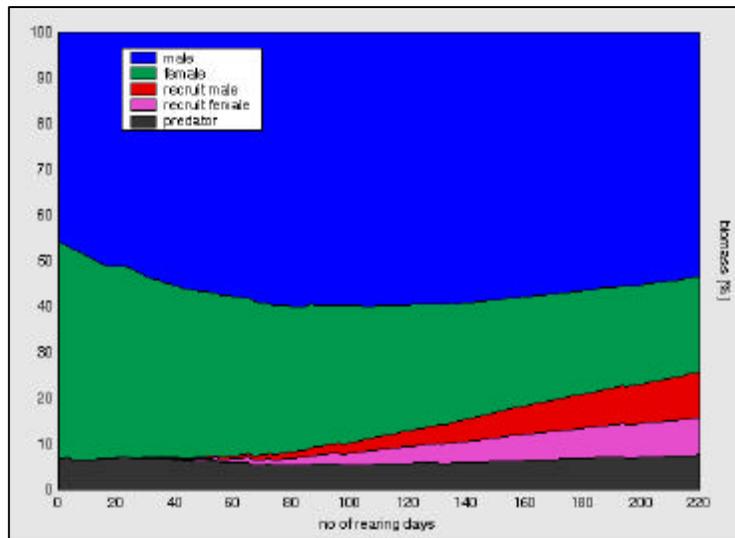
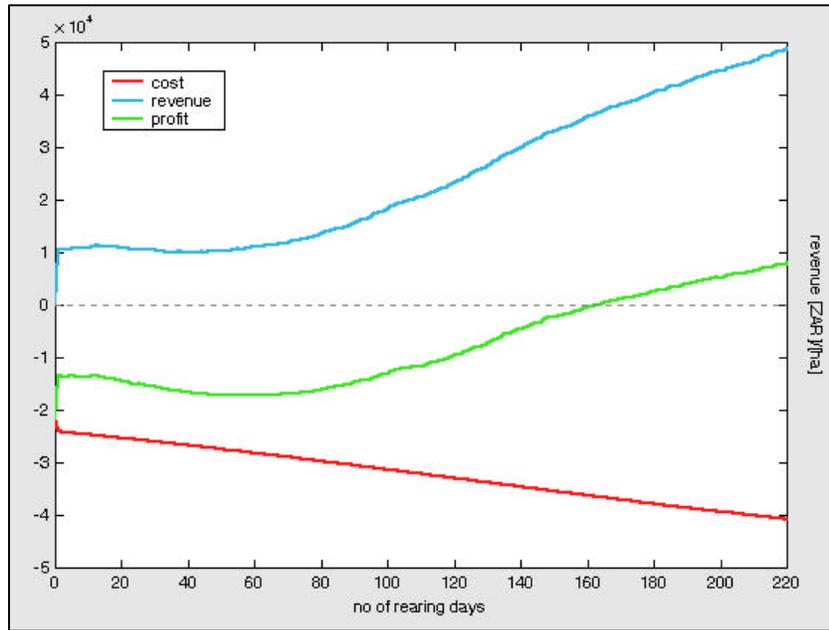


Figure 22: Example of the development of the relative biomass in one simulation



**Figure 23: Example of the development costs, revenues and profits of one simulation**

## OPTIMISING THE RESULTS OF YOUR POND

Once you have simulated with your own preferences or your real settings, you can use “TFST-Optimize” to see if there are alternatives providing a better financial performance. You start this module either by clicking on the Icon in the menu bar or by clicking on the Optimize button below right in the main menu (Figure 24)

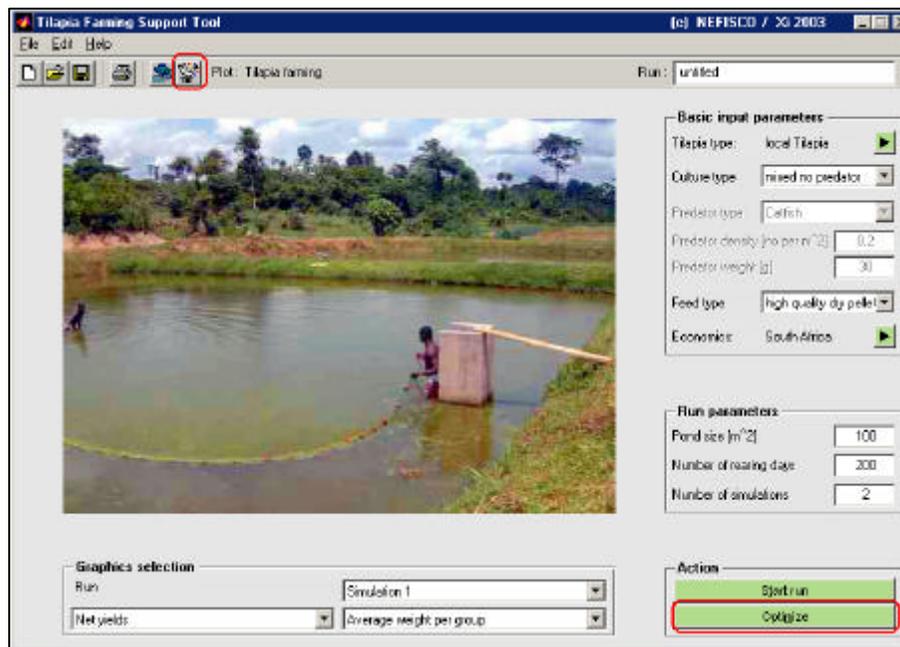
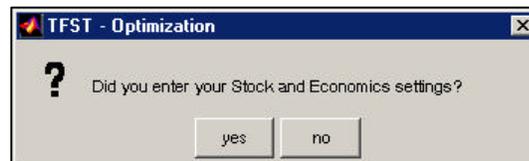


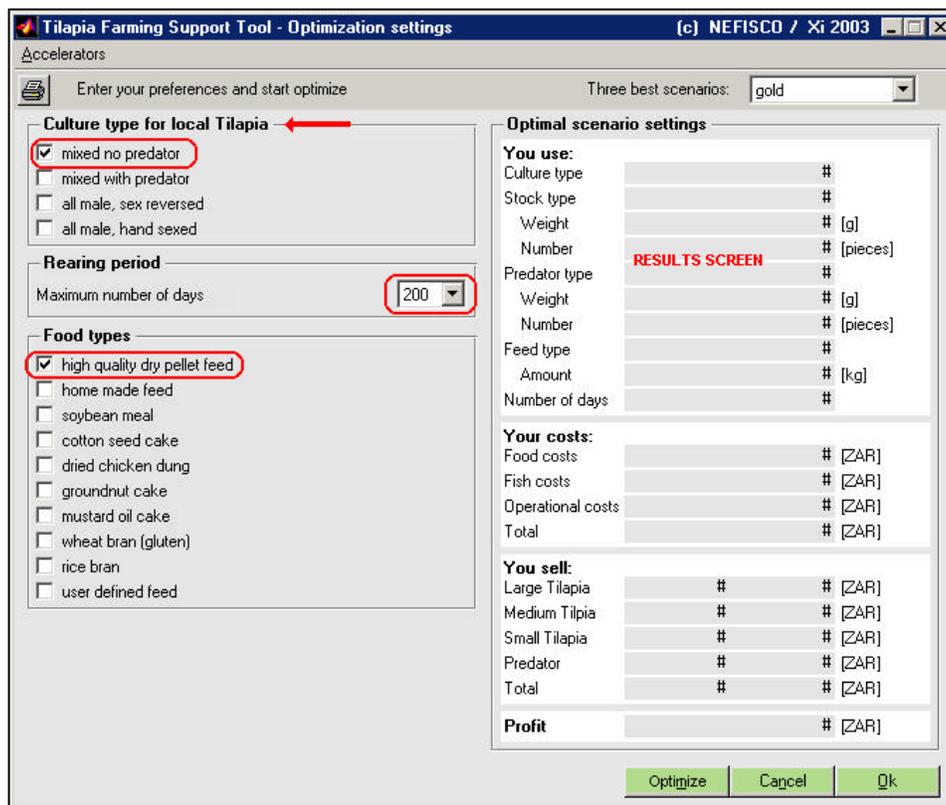
Figure 24: Start Optimise

After you start, the Optimise warning message “Did you enter your Stock and Economic settings?” will pop up. This is of utmost



importance, if you did not provide your own data the optimisation would be carried out with our default settings. Click “**Yes**” If you are sure that you have provided the proper data. If you are not sure check, and start Optimise again.

When you arrive in the “Optimise Menu,” you can enter your preferences in the left part of the menu, and in the right part, the results will be displayed after you have run Optimise (Figure 25).



**Figure 25: The Optimise menu**

TFST-Optimise looks at:

- The type of fingerling you use: mixed, all male, sex reversed, all male hand sexed
- The rearing period
- The type of feed used
- The use of a predator: catfish or snakehead

- The stocking density of the used predator

Please note the phrase **“Culture type for local Tilapia”** on top of the input menu. It means that in the main menu the local strain was selected as your “Tilapia type”. If in the main menu GIFT tilapia is selected you will see here **“Culture type for GIFT Tilapia”**.

**This means that Optimise ONLY calculates with the selected tilapia type setting. It cannot compare between a local and GIFT strain tilapia. If you want to compare the two you have to run Optimise two times, once for the local strain and again for the GIFT strain.**

The Optimise menu opens with the standard scenario “mixed, no predator”, “300 rearing days” **and** “high quality feed” but you can replace with your own preferences.

#### OPTIMISING WITH A PREDATOR

If you click the check box **“Mixed with predator,”** a new menu appears below in the menu **“The predator settings.”** Again, you see that it is the setting either for catfish or for snakehead, depending on your selection in the main menu.

In this menu, you can indicate how you want to search for alternatives, if you intend to use a predator in your pond:



**Predator settings for Catfish**

from    step    to     fixed  
 Density range    0.2    0.1    0.5    0.2



**Predator settings for Snakehead**

from    step    to     fixed  
 Density range    0.02    0.01    0.05    0.02

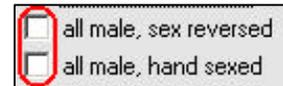
**Density range:** you can search with a fixed stocking density of your predator, or you can select a range of stocking densities: 0.1-1.0 per m<sup>2</sup> (1000-10.000 per ha) for catfish or 0.01-0.1 per m<sup>2</sup> (100-1000 per ha) for snakehead.

## Weight in the Main Menu

TFST automatically defaults to the weight of the predator you entered in the main menu.

## OPTIMISING WITH ALL MALE FINGERLINGS

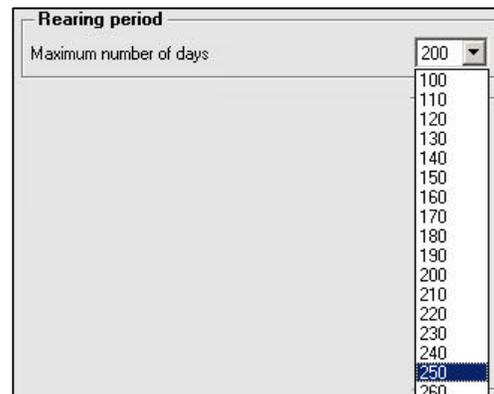
You can optimise for the use of all male fingerlings, sex reversed or hand sexed, if you have indicated in the main economic menu that you can buy them. If so, just click the check box and continue with the types of feed you want to use.



<input checked="" type="checkbox"/>	all male, sex reversed
<input type="checkbox"/>	all male, hand sexed

## OPTIMISING FOR THE NUMBER OF DAYS

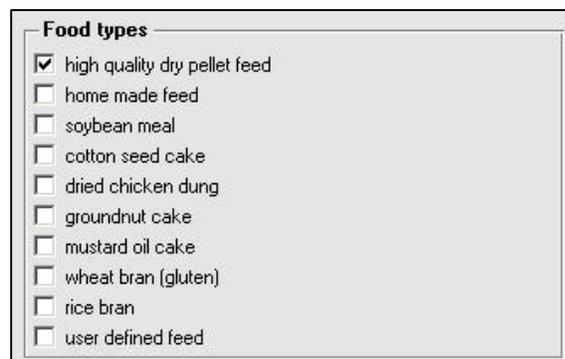
During the optimisation you can see if increasing or decreasing the number of rearing days will have an impact on the financial performance. Just select in the “Rearing period” the maximum number of days you want to raise your fish and Optimise will use the range from 90 – this maximum number of days.



Rearing period	
Maximum number of days	200
	100
	110
	120
	130
	140
	150
	160
	170
	180
	190
	200
	210
	220
	230
	240
	250
	260

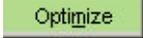
## OPTIMISING FOR DIFFERENT TYPES OF FEED

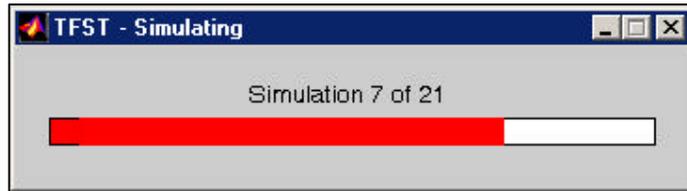
Here, the same as with the fingerlings, you can only optimise for a certain feed type if you have indicated in the main menu that you have access to it and provided a price for it. Click the check boxes to select the feed types you want to incorporate during the optimisation.



Food types	
<input checked="" type="checkbox"/>	high quality dry pellet feed
<input type="checkbox"/>	home made feed
<input type="checkbox"/>	soybean meal
<input type="checkbox"/>	cotton seed cake
<input type="checkbox"/>	dried chicken dung
<input type="checkbox"/>	groundnut cake
<input type="checkbox"/>	mustard oil cake
<input type="checkbox"/>	wheat bran (gluten)
<input type="checkbox"/>	rice bran
<input type="checkbox"/>	user defined feed

## START OPTIMISE

Start Optimise by clicking the “**Optimise button**” on the right side  below in the screen. After clicking, the “**Optimise bar**” will pop up, indicating the number of simulations that will be made, and the progress of the simulation process.



## RESULTS OF OPTIMISE

Once Optimise is ready with the calculations, the best results: “the gold scenario” will be automatically displayed (Figure 26).

In the example displayed, an optimisation was made for: mixed no predator, all male sex reversed and all male hand sexed, 360 days of rearing and a wide range of feed available.

The results indicate that using all male sex reversed fingerlings, rearing them for 263 days and feeding them with our own defined feed will give the highest profit of 690 ZAR for one rearing cycle of the pond/farm.

Select the “Silver” or “Bronze” to display the second best or third option.



By clicking on the “OK” button below right on the screen the displayed option will be automatically saved in the main menu settings (Figure 26, Figure 27) and you can run this scenario to get information that is more precise.

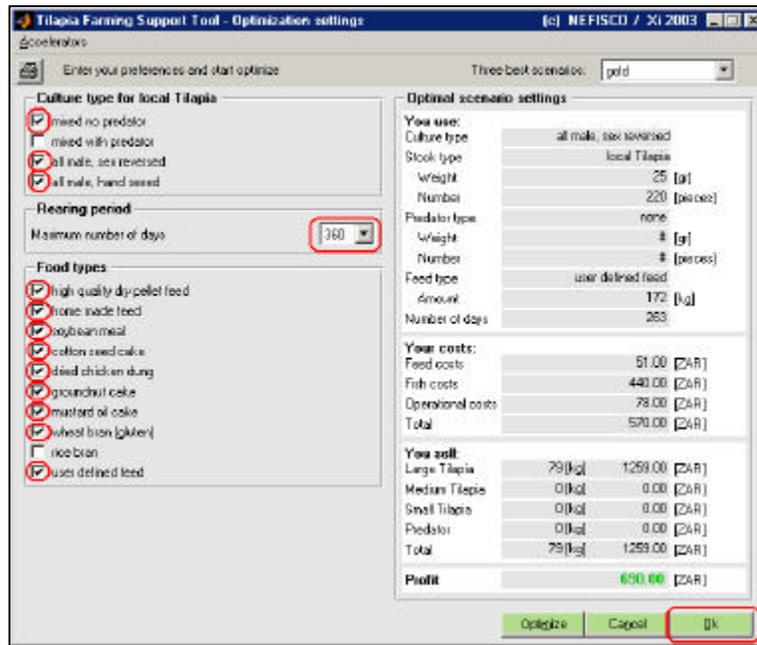


Figure 26: Results of running the Optimise module

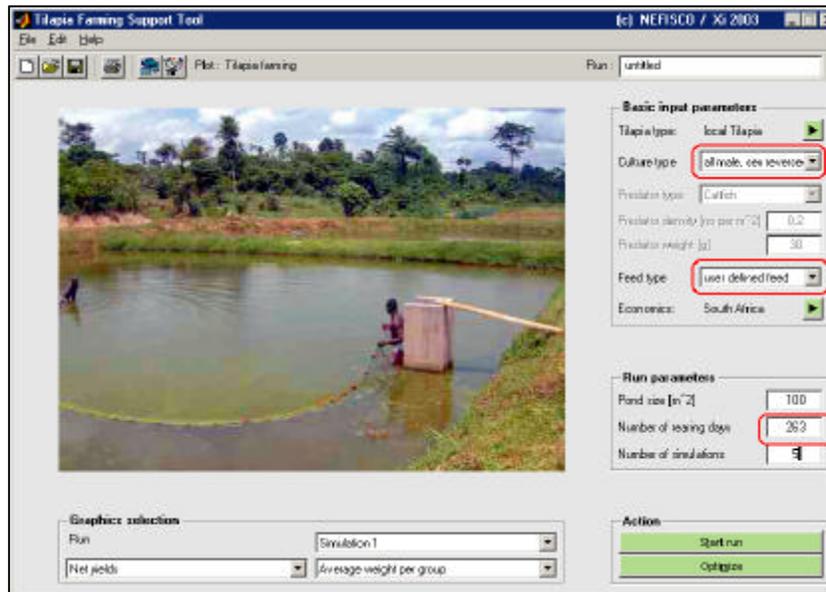


Figure 27: Using the results of Optimise again in the main menu.

## SAVING FILES

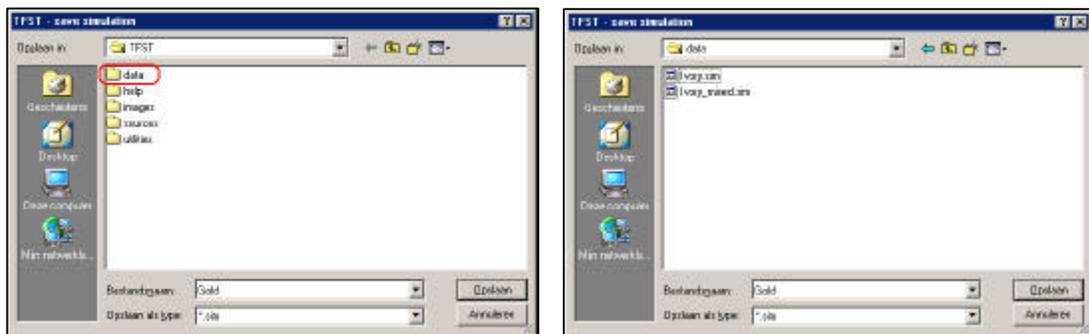
### SAVING THE RESULTS OF YOUR RUNS

You can save your settings once you have found your optimal settings

Go to **File** → **Save** (in the top left corner of the main screen) or click on the

“save button” 

The save menu will pop up and we recommend you save your data in the “data” subdirectory:



**Figure 28: saving your data files**

To open your files again go to **File** → **Open** or click on the “Open file

button”  and select the file you want to run again.

TFST only saves your settings and not the generated data, as this usually results in huge files.

## SAVING THE GRAPHICS OF YOUR RESULTS

Once you have completed a simulation and displayed the results as a graph, you can save this graph as a picture file by **File → Print** plot or by clicking on

the “**Printer button**” 

The save a picture menu will automatically pop up and you can save the file as a Bitmap file (bmp).

## AN EXAMPLE

To familiarize you with TFST in this chapter we present you an example.

### Note

**TFST includes variation, so your results of this exercise can differ slightly from the one presented here in the manual**

### MR KOFFI GOMBO FROM IVORY COAST

My name is Koffi Gombo, I am living in Ivory Coast, and constructing 10 ponds of 500 m<sup>2</sup> each in my home village.



**Figure 29: Mr Koffi's ponds, under construction**

Before I start running my farm I want to find the best way to do it and I will use TFST to give me an idea. To carry out this example, open the file "**Ivory Coast.sim.**"

In TFST, I use the following parameters:

### Main menu-Tilapia type

I will use a local tilapia as we do not have a strain GIFT in Ivory Coast and I will stock my pond with fingerlings of 35 grams.

### Economics menu-Investments

1. The currency in my country is the CFA
2. The name of my country is Ivory Coast
3. To construct one pond of 500 m<sup>2</sup> I pay 250.000 CFA. The construction of the 10 ponds cost me 2 500 000 CFA or **5 000 000 CFA/ha**
4. To run the farm I bought scales, buckets, a seine net, wheelbarrows, etc, this cost me 25 000 CFA or **50 000 CFA/ha**.
5. For the construction of the ponds I borrowed money from the local commercial bank and I have to pay an annual interest rate of 20%
6. Replacement and maintenance is 3% per year
7. My two nephews will operate the farm and I will pay them 1100 CFA per day. My farm is 0.5 ha operated by two nephews, so I need four persons/ha
8. I do not need skilled labor for my farm

I entered these values in the Investments menu (Figure 30):

Investment				
	Investment (CFA/ha)	Amortization (yr)	Interest (%)	Cost (CFA/ha/yr)
Fisheries	500,000	5	20	100,000
Equipment	25,000	5	20	107,500

Maintenance and repairs	
	Cost (CFA/ha/yr)
Fisheries	15,000
Equipment	15,000

Labor costs		
	Person (ha/yr)	Cost (CFA/ha/yr)
Skilled labour	0	0.00
Unskilled labor	4	4,400.00

Figure 30: Investments of Mr. Koffi

## Economic menu-inputs and feed

In my district I can buy mixed fingerlings, all male hand sexed fingerlings, catfish and snakehead fingerlings. All male sex reversed fingerlings are available from a specialized hatchery, located 200 km from my village.

Fingerlings	Weight (g)	Price CFA per piece
Mixed male and females	35	35
All male hand sexed	35	75
All male sex reversed	35	150
Catfish	15	100
Snakehead	15	100

All feed types are available and in Bobo-town a Tilapia feed, made of cottonseed cake, copra cake and wheat bran is available. It has a protein content of 30% and costs 140 000 CFA/ton. The other prices for feed are:

Feed type	CFA/ton
High quality Tilapia pellet	250 000
Home made Tilapia feed	150 000
Soy bean meal	160 000
Cotton seed cake	180 000
Dried chicken dung <sup>7</sup>	20 000
Ground nut cake	160 000
Mustard oil cake	160 000
Wheat bran	100 000
Rice bran	60 000

---

<sup>7</sup> Difficult to get

The values I entered in the Input and feed menu are presented in Figure 31.

The screenshot shows the 'Economic settings' window of the 'Tilapia Farming Support Tool'. The window title is 'Tilapia Farming Support Tool - Economic settings' and it includes '(c) NEFRSCO / XI 2003'. The 'Your currency name' is set to 'CFA' and 'Your country name' is 'Ivory coast'. The 'Input and feed' tab is selected.

**Input costs for local Tilapia**

Price of Tilapia and predator fingerlings	Weight [g]		Cost [CFA]
Tilapia, mixed male and female	35	per piece	35.00
Tilapia, all male, sex reversed	35	per piece	150.00
Tilapia, all male, hand bred	35	per piece	75.00
Catfish	15	per piece	100.00
Snakehead	15	per piece	100.00

**Feed costs**

	Price [CFA]/[ton]	Cost [CFA]/[ton fish]
high quality dry pellet feed	25000.00	54150.00
home made feed	15000.00	56450.00
soybean meal	15000.00	34872.00
cotton seed cake	15000.00	30633.60
dried chicken dung	20000.00	11336.60
groundnut cake	15000.00	36730.60
mustard oil cake	15000.00	50256.00
wheat bran (gluten)	10000.00	53526.00
rice bran	50000.00	56854.40
Bobo feed	14000.00	52724.00

Percentage protein: 30.00

Buttons: Cancel, OK

Figure 31: Inputs and feed costs of Mr. Koffi

## Economic Menu – Farm Gate Prices

The situation in my country is particular as we like to eat large fish and it is difficult to sell small fish, unless they are really cheap.

For my fish, I can fetch the following prices:

Very small tilapia 0-20 g	10 CFA/kg
Fingerlings 20-50 g	500 CFA/kg or 18 CFA per piece
Small tilapia 50-120 g	700 CFA/kg
Medium sized tilapia 120-200 g	1000 CFA/kg
Large tilapia 200 g and bigger	1200 CFA/kg
Catfish	1000 CFA/kg
Snakehead	1000 CFA/kg

I entered these values in the Farm gate prices menu (Figure 32):

Farmgate price Tilapia	
	Revenue [CFA]
Very small (0-20 g)	per kg 10.00
Fingerlings (20-50 g)	per piece 18.00
Small sized fish (50-120 g)	per kg 700.00
Medium sized fish (120-200 g)	per kg 1000.00
Large sized fish (200 g and bigger)	per kg 1200.00

Farmgate price predator	
	Revenue [CFA]
Catfish (100 g and up)	per kg 1000.00
Snakehead (100 g and up)	per kg 1000.00

Figure 32: Farm gate prices of Mr. Koffi

## Optimising

First, I want to know what will be the best feed to use. So, I optimise for “mixed culture,” 360 days and all the feed types, except “dried chicken dung” as this is very difficult to get.

Optimising takes some time as the farm has an area of 5000 m<sup>2</sup>. But after a while the results are displayed (Figure 33) and it indicates that I will produce 2695 kg of fish in one rearing cycle of 256 days. The best feed to use is soybean meal, because it is relatively cheap and has a high protein content. However, it also indicates that I will go bankrupt, because I produce too many small tilapia, which are fetching a low price at the market.

**Tilapia Farming Support Tool - Optimization settings** [c] NEFISCO / Xi 2003

Accelerators

Enter your preferences and start optimize Three best scenarios: gold

**Culture type for local Tilapia**

- mixed no predator
- mixed with predator
- all male, sex reversed
- all male, hand sexed

**Rearing period**

Maximum number of days: 360

**Food types**

- high quality dry pellet feed
- home made feed
- soybean meal
- cotton seed cake
- dried chicken dung
- groundnut cake
- mustard oil cake
- wheat bran (gluten)
- rice bran
- Bobo feed

**Optimal scenario settings**

**You use:**

Culture type	mixed no predator
Stock type	local Tilapia
Weight	35 [gr]
Number	11000 [pieces]
Predator type	none
Weight	# [gr]
Number	# [pieces]
Feed type	soybean meal
Amount	5873 [kg]
Number of days	256

**Your costs:**

Feed costs	939698.00 [CFA]
Fish costs	385000.00 [CFA]
Operational costs	997617.00 [CFA]
Total	2322315.00 [CFA]

**You sell:**

Large Tilapia	633 [kg]	759213.00 [CFA]
Medium Tilapia	482 [kg]	482071.00 [CFA]
Small Tilapia	1580 [kg]	631467.00 [CFA]
Predator	0 [kg]	0.00 [CFA]
Total	2695 [kg]	1872751.00 [CFA]

**Profit** -449564.00 [CFA]

Optimize Cancel Ok

Figure 33: Results of the first optimising of Mr Koffi

An alternative would be to use catfish as a predator. I optimise again with: mixed with a predator-catfish, 360 days, soybean meal as feed, and select a stocking range of 0.1-1 for the catfish density. Optimising takes even longer than the first time as it has to calculate 10 scenarios: one for each stocking density of catfish. Rearing tilapia with the African catfish will increase my yield to 3164 kg of which 447 kg is the catfish. I use 0.3 catfish fingerlings per m<sup>2</sup>, but I am still going bankrupt due to the large quantity of small tilapia I am producing.

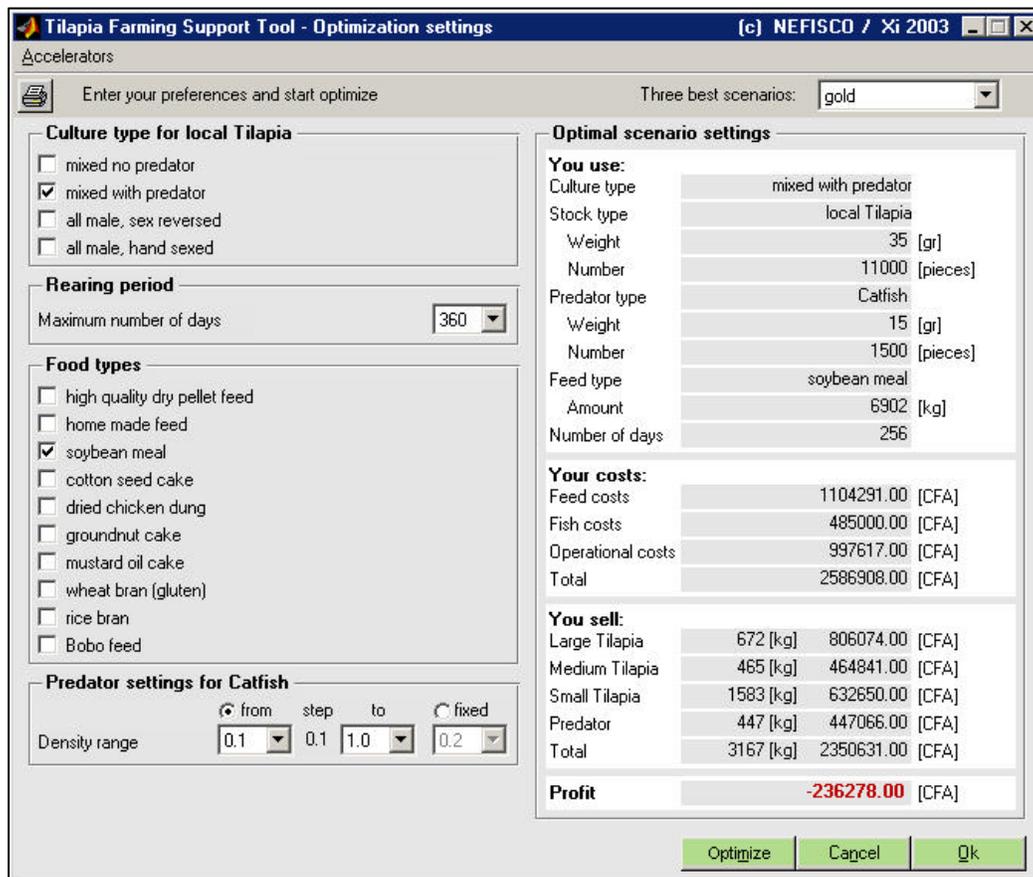
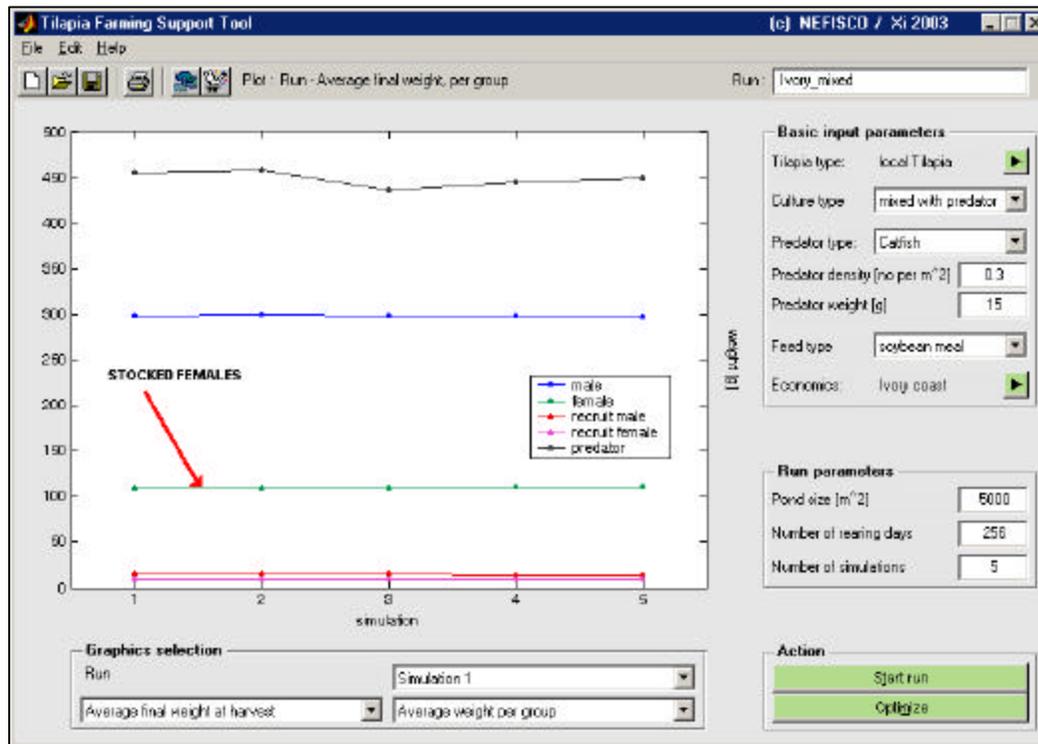


Figure 34: Results of optimising with African Catfish for Mr. Koffi

I save this option and run it again in the main menu to identify the problem.

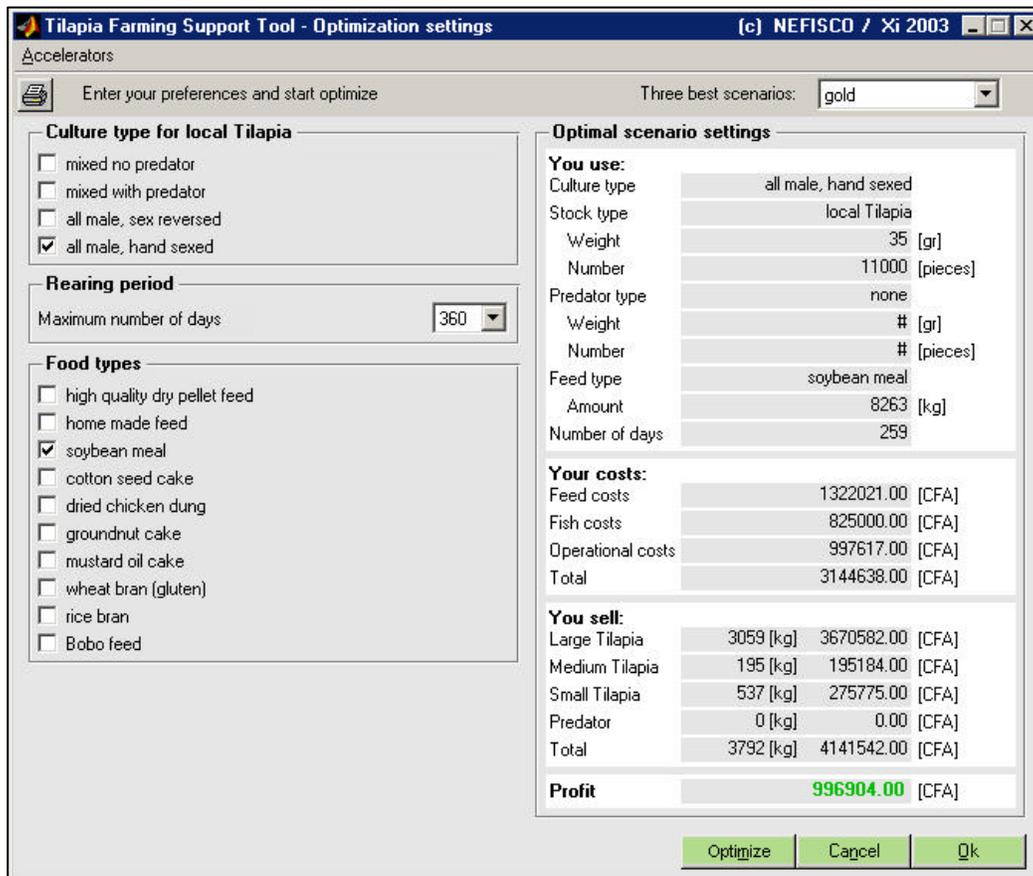
After running this scenario in the main menu it is clear (Figure 35) that the stocked females only reach a weight of about 100-120 gram at harvest, so most likely it is better not to stock females and only use all male fingerlings on my farm.



**Figure 35: Results of the run with catfish.**

The alternative is to use all male fingerlings, so I start optimise again and select: All male hand sexed, 360 days, with soybean meal as feed. The results (Figure 36) are much better now as I am producing 3792 kg of fish and make a profit<sup>8</sup> of 996 904 CFA per rearing cycle of 259 days.

<sup>8</sup> Without tax



**Figure 36: Results of optimising with all male hand sexed fingerlings**

The last option is to look at the use of sex reversed all male fingerlings (Figure 37). I would still make a profit of 638 296 CFA per rearing cycle but here the major bottleneck is the price of the sex-reversed fingerlings.

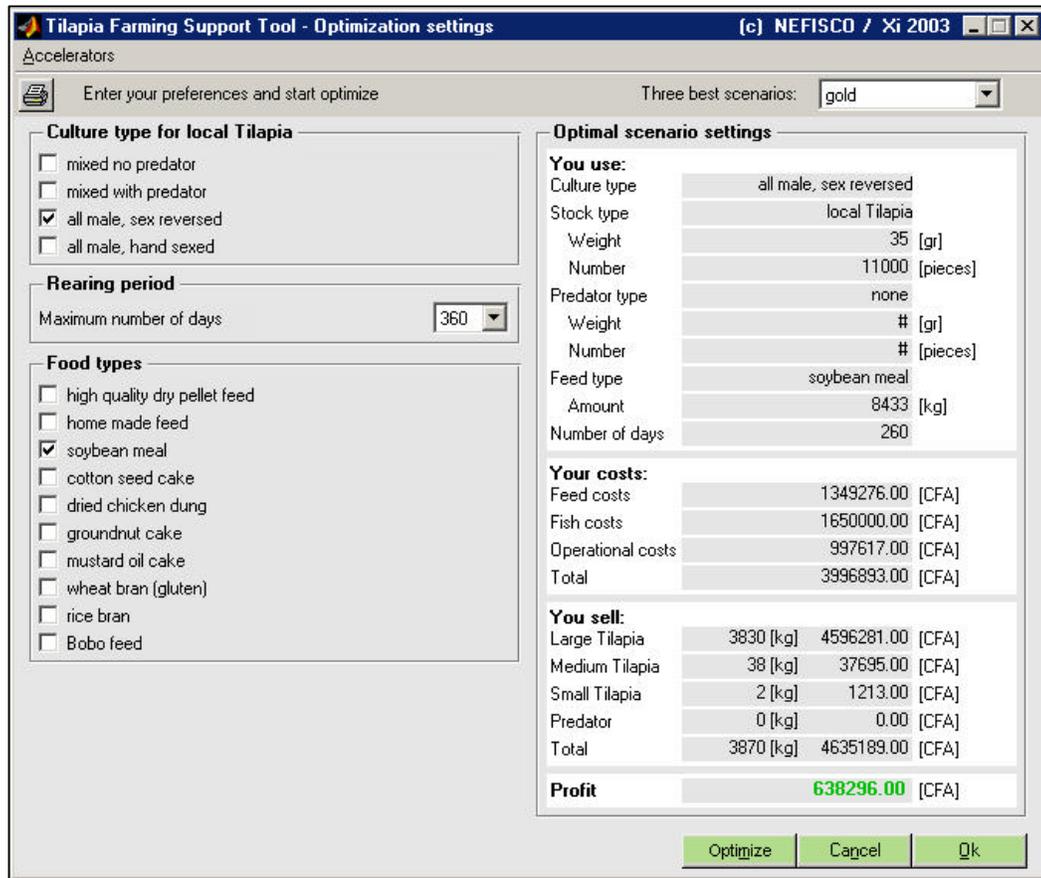


Figure 37: results of optimising with all male sex reversed fingerlings

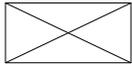
## THE SCIENTIFIC VERSION OF TFST

The development of TFST was based on the Individual Based Tilapia Farming model developed by Nefisco and Xi (de Graaf *et al.*, in press). This scientific version has more options, this as the standard settings can be changed, it can be adapted to use it for other species, or it can be used for prey-predator modelling in fisheries.

For more information on the scientific version please contact Nefisco or Xi

[Info@Xi-advies.nl](mailto:Info@Xi-advies.nl)

[Info@Nefisco.org](mailto:Info@Nefisco.org)



## **ACKNOWLEDGEMENTS**

First, we would like to thank GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit, German Technical Cooperation) for their financial support to develop this user friendly version of the original Tilapia Simulation Model, and offer special thanks to Mrs. Maike Walthemath of GTZ for making this happen.

Further, we would like to thank Mr. Jean Pierre Marquet and Mr Joris Colman from the PAPPE project in Ivory Coast for providing data for the examples and Mrs. Tami Brunk for editing of this manual

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**de Graaf, G.J., Galemoni, F. and Huisman, E.A., 1999.** The reproductive biology of pond reared Nile tilapia (*Oreochromis niloticus*), *Aquaculture Research*, 30, 25-33.

**de Graaf, G.J. Dekker, P., Huisman, E.A. and Verreth, J.,** in press. Simulation of the pond rearing of Nile tilapia (*Oreochromis niloticus*) through Individual Based modelling, based on population dynamics, *Aquaculture Research*.

## ANNEX 1: BASIC SETTINGS

For the scientists/experts using TFST, major basic settings are:

Growth according to the von Bertalanfy growth curve:

	Linfinitif (cm)	K ( year <sup>-1</sup> )
Tilapia ,males	32.5	1.73
Tilapia females	23.0	1.28

Feed conversion according to crude protein level of feed:

$$CV = 0.523*(\% \text{ protein}) + 19.015$$

Based on the data below:

Feed type	Conversion factor	Crude protein (DM)
High Quality Tilapia dry pellet feed	1.7	30
Home made Tilapia feed	3	30
Soybean meal	4	35
Cotton seed cake	5	26
Dried chicken dung	5	24
Groundnut cake	5	23
Mustard oil cake	5	30
Wheat bran gluten	6	25
Rice bran	10	12

Growth adaptation according to crude protein level of feed:

$$K=K_{\max} * \ln(\% \text{ protein}) - 0.0821$$