Centre for Development Innovation

Integrating fish farming with growing olives in Wadi Natrun, Egypt.

a pre-feasibility study done for EMCCO

Peter G.M. van der Heijden (Centre for Development Innovation) and

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Wageningen UR Centre for Development Innovation
Wageningen, The Netherlands
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1. Introduction

At Wadi Natrun a large dessert area is being developed into olive plantations. The first plantations have been started three years ago. The water for irrigation is drawn from a 200 – 300 m deep well and pumped directly to a system of pipes and hoses that irrigate the young olive trees by means of a drip system. EMMCO is considering the possibility to use (part of) the water that is pumped up for fish farming. The proposal is to include a water reservoir: the ground water will first be pumped in a reservoir before it is pumped into the drip irrigation system that irrigates the olive trees. The advantage of such a system would be that water is used twice (for growing fish and for growing olive trees). In addition there is the fertilising effect of the fish: while in the reservoir the fish manure and fish feed fertilise the water with plant nutrients. This may result in reduced need of fertiliser for the olive trees.

The question to be answered for EMCCO management was if fish can be grown in such a system from a *technical and biological* point of views. If the answer is yes: under what conditions can fish be grown *profitably* in such a system?

2. Will fish thrive and grow under the conditions at Wadi Natrun? – Technical and biological aspects

On April 23, 2010, a request was made to Dr Khairat to send a report of the analysis of the ground water. No reply to the question was received, so the question whether the water contains dangerous or lethal concentrations (lethal for fish) of harmful elements such as cadmium, lead etc can not be answered. Installing a small aquarium and keeping a few fish in the water that is pumped from underground will give a first indication. When the fish eat and grow well than a first indication that the water is suitable for fish farming has been obtained. But a more detailed look by an expert at the report of the water analysis is advised: fish may not show signs of poisoning on the short tem but if harmful elements are present in the water the danger of accumulation in the fish exists, making the fish unsuitable for human consumption when it has reached market-size.

The general salt content and temperature of the water are suitable for tilapia farming. The water coming from underground contains no oxygen, so it should enter the reservoir by means of a spray or a fountain. This will enable maximum contact of the anoxic water with the air to enable a maximum amount of oxygen to dissolve in the water. In addition paddle wheels can be installed in the reservoir for extra aeration of the water (see photo 1). Whether instalment of paddle wheels is necessary will have to be established by measuring the oxygen content in the water of the reservoir. Instalment is recommended when the levels drop below **4 mg Oxygen**/l.

3. Under what conditions can the fish be grown profitably? – Economic aspects

Several farms in Egypt grow already fish (mostly tilapia, but also carp, mullet, catfish) in water storage reservoirs. The water from these reservoirs is used to irrigate crops and

fruit trees. Besides from sufficient pump capacity installation of mechanical filters that remove particles from the water is recommended, especially when a drip irrigation system such as present at the EMCCO farm at Wadi Natrun is used. Besides from construction of a water-proof reservoir of sufficient size (see later) the purchase and installment of an extra pump plus filters will most likely be the largest investments that are necessary for the start of fish farming. In addition investments for an aeration system (paddle wheels) and fish harvesting equipment will be needed. Besides from fluctuating market prices for fish, the recovery of these investments plus making some profit is possible determine whether growing fish at EMCCO's olive farm will be feasible. This pre-feasibility study will therefore focus on the question if the investments can be recovered and profit can be expected. In addition we will just mention the other factors that will determine success in case a fish farm is constructed on the premises of the olive tree plantation. Advise regarding these other factors can be obtained when a more detailed and complete feasibility study is made.

3.1 Fixed costs

We obtained the following prices for a suitable type of pump and filters:

- pump, Siemens 15 hp, pumps 42 -45 m^3/h, heavy duty , including switch board , electricity cable and installation. **20000 LE**
- self cleaning filter, made in USA, filter capacity 40-50 m^3/h , including installation, per unit **7000 LE**

- Paddle wheels (2Hp): **4800 LE**
  Paddle wheel cable, switch board **900 LE**

- Harvest equipment **1000 LE**
  (to be depreciated over 3 years)

Partial drainage of the pond and application of seine nets is the most common method to harvest fish from ponds and reservoirs. For easy harvest it can be considered to keep the fish in several cages that are hanging in the reservoir. Partial harvest by way of lifting a cage is made easier this way and does not require partial draining of the reservoir.

The pump that is at present used to draw water has a capacity of 85 m^3/hr and is operated 4-5 hrs in winter and 7-8 hrs during the summer months. A schedule has to be worked out of what part of this water will be pumped directly into the irrigation system and which part indirectly, via the water storage reservoir. Timing of pump operation will depend whether the generator can support enough capacity for both the well pump plus pump that will draw water from the reservoir, or whether the 2 pumps can only be operated in sequence and not at the same time).

Recovery of these costs within the depreciation period of this equipment (which is assumed to be 7 to 10 years, and 3 years for the harvest equipment) is necessary for a profitable enterprise. If we set the depreciation period at 7 years than the income from growing fish should yearly result in at least (32700 : 7) + (1000 : 3) = **LE 5004.**

Other important fixed costs: depreciation of reservoir construction. Cost of labour, of hiring heavy ground-moving equipment and for pond lining will determine the costs. We

have not enough knowledge to be able to give a cost estimate of digging the reservoir or of applying a reservoir lining with cement/concrete. Under the paragraph 'Reservoir construction' an estimate of costs is given in case the reservoir is lined with thick plastic sheet. In case of plastic lining an additional LE 2500 should be added to the costs for depreciation of plastic lining (LE 2250) and to cover pond maintenance costs (LE 250). This would result in

Total fixed costs: LE 7504 /yr

2.2 Variable costs:

From interviews with several fish farmers we know that the production (variable) cost of producing tilapia in ponds or reservoirs ranges between 6 and 7 LE/kg. This includes the cost for:

- fingerlings
- feed
- Labour
- electricity

However, these costs can differ very much between farms, depending on management quality and expertise, whether all-male or mixed sex tilapia is used, whether home-grown or purchased fingerlings are used, brand of feed that is bought, etc. It is noted that not all fish farms count all the costs that occur when growing fish. It is important to realise that fish feed costs are often the biggest variable cost item in fish farming. The cost of the feed depend on the type of feed that is used (compressed or extruded; protein content; imported or local brand), and the costs ranges between from 2200 to 3500 LE/ton. Due to varying quality of the feed some farms prefer to mix their own feed, but this requires considerable expertise knowledge plus extra equipment.
The amount of feed that is needed to grow 1 kg of tilapia (= Feed Conversion Ratio) differs also per farm, depending on the feed quality, fish growth rates that are achieved and farm management. In Egypt the FCR ranges in general between 1.0 and 2.0 .

For our calculation a general production cost of LE 7.50/kg can be assumed; this can be achieved when some fish farm management experience has been obtained and good advise is followed. This cost does not include the depreciation costs of the pump, filters, paddle wheel and harvest equipment.

Fish farmers also receive widely varying prices when they sell their crops. According to the reports we received, in the past 3 years the price of 1 kg of tilapia (size 3 to 4 fish/kg) has fluctuated between 7.50 and 16 LE/kg, but has recently been between 10 and 13 LE/kg. Fluctuations are caused by: season, availability of cheap alternative fish on the market, demand (is stronger when avian flue is a hot news item), and other factors. For our calculation an average selling price of LE 10.00 seems safe and reasonable. Experience of Egyptian fish farmers has shown that sometimes the prices drop below this level, but are in the favourable season often at least at this level. This would mean an average profit of 10 – 7.50 = 2.50 LE/kg fish sold.

To recover the depreciation costs for reservoir construction plus one pump, one filter, a paddlewheel (in 7 years), plastic lining (in 10 years) and harvest equipment (in 3 years) an amount of at least LE 7504 has to be earned. It depends on EMCCO management what

minimum profit margin they consider acceptable. If a minimum profit margin of LE 1.90/kg is considered attractive enough than LE 0.60 could be accepted to cover the depreciation costs. This would mean that per year at least 7504 : 0.60 = 12.5 tons if tilapia is sold.

We estimate that a **minimum production of 12.5 tons tilapia/year** is needed to cover the initial investments and make a modest profit.

4. Reservoir construction

4.1 Some technical considerations

In the dessert a higher than usual evaporation rate exists. To minimize water loss due to evaporation a deep water reservoir (> 4.5 m) is recommended.

The reservoir needs to be made water proof. This can be done with a lining made of cement/concrete, or with thick plastic PE sheet. Advantage of the first type: strong, scratch and shock resistant. Advantage of the PE lining: cheap, flexible, easier to replace/repair. Danger of punching holes in the plastic can be reduced by putting a layer of sand on the bottom, especially where equipment or people are expected to touch the basin side or bottom.

4.2 Reservoir size

Minimum reservoir size: we estimated that a minimum annual production of 13.0 tonnes of tilapia would allow cost recovery plus a modest profit. Assuming that this amount is raised in one growing season the reservoir has to be large enough to keep 13 tons of grown fish. In Egyptian farms that raise fish in irrigation water storage basins the production ranges between 0.5 and 2.5 kg/m^3. Because a significant part of the water in the reservoir will be flushed (replaced) every day a density of 2.0 kg (6 – 8 fish) per m^3 is possible. This would mean a minimum reservoir size of 6250 m^3. If a minimum depth of 4.5 m is maintained the reservoir should have a surface area of 6250 : 4.5 = 1389 m^2, or 37.3 x 37.3 m. (Assuming a slope of 1 : 1 at the sides the surface area will be 40 x 40 m).

In case the reservoir is lined with thick plastic a sheet of approx 2250 m^2 will be needed. The price of such a sheet is LE 22 500. Depreciation over 10 years means annual added fixed costs of LE 2250.

Note: a more intensive fish production in well-flushed basins and reservoirs has been achieved, but this is possible when water replacement and aeration can take place when needed and as long as is needed. In the case of EMCCO the generator may run only when electricity is needed to irrigate the trees, and electricity will not be available continuously. Therefore fish densities should be modest (not be too high) to assure fish survival in periods when no water is flushed through the reservoir and no electricity is available to run paddle wheels.

5. Additional remarks

The estimate we made for minimum production, possible profits and fish densities are modest and careful because it is our intention to be realistic more than to be convincing. After all, the authors are in no way affected by EMCCO's decision to start fish farming at the olive tree plantation at Wadi Natrun.

During the fish production sludge will accumulate on the reservoir bottom. The sludge is pumped out regularly, normally after a complete harvest during winter. This sludge is excellent fertilizer for the olive trees and for other crops.

Because well water (with zero oxygen) is used to fill the reservoir, addition of sufficient oxygen and maintaining a level of 4 mg oxygen / litre is crucial. Tilapia can survive in water with lower oxygen levels but growth rates will be affected.

EMCCO management is recommended to give a small number of the staff that is based on the plantation sufficient training in fish farming before fish culture is started. Exposure to other (integrated) fish farms is also recommended. Contracting the services of an experienced consultant especially during the first year of operation is also advised.

Photo 1. Paddle wheel

Photo 2. The deep well at EMCCO olive farm. Behind the pump are the young olive trees.

Photo 3. Drip irrigation at EMCOO farm. In front onions and other vegetables for the workers, at the rear olive trees.