# Estimated Costs and Returns for Commercial Cage Production of Fingerlings and Table-Size Mullet (Mugil cephalus) in Dakhlia Governorate, Egypt



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## Abstract

Field data for commercial mullet cage culture inside Manzala Lake in Dakhlia Governorate were used in this study. Forty one cage owner and operators were interviewed. Mullet cages culture identified into three production stages fingerlings, juvenile and table-size mullet. The three stages were applied in two volumes, small (300m$^3$) and large (600m$^3$). The questionnaire gathered quantitative data on capital costs, operational costs, mullet yield and sales prices, for the different mullet cages types and volumes. Costs, returns, and performance indicator of this activity were estimated through budgeting procedure. Effects of cage volume in different growth stages on the economics of the culture system were explored. Sensitivity analyses with respect to changes in output price and production level were performed. Results indicated the economic viability of the fingerlings and table-size systems. Cage volume had positive effects on the economic performance of mullet cage culture in Manzala Lake. Cage culture operators in Manzala uses extruded fish feed for feeding their stock in cages to minimize the impact of mullet cage on the environment. The study revealed that growing mullet in large size volume cage is economically viable and sustain moderate financial shock.

**Keywords**: Mullet, cage, Manzala, aquaculture, Egypt.

## Introduction

Fish cage culture dates back many centuries in China (**Bao–Tong, 1994**), and recently, this practice has expanded throughout the world because of its advantages. Several researchers have pointed out the advantages of cage culture (**Beveridge, 1984; 1996; Campbell, 1985; Swann et al., 1994; EL-Sayed, 2006; De Silva and Phillips, 2007**). Cages major advantages over other methods of fish culture include: the anticipated high profitability levels, the use of existing water bodies thus reducing the pressure on land; the requirements of relatively low capital outlay; the ease of movement and relocation; the flexibility of management.

Mullets are important species in Egypt with total production of 147594 Mt among which 116029 Mt come from aquaculture. In Egypt, the number of fish cage operations, in 2010, was estimated at 25017 with an estimated production level of 160288 Mt representing about 17.4% of total aquaculture production (**GAFRD, 2011**). Major cage culture producing areas in terms of quantity are: Kafr EL Sheikh (74.86%) and Behera (22.45%). Main species used for cage culture include silver carp (68.21%), mullet (16.84%), and tilapia (14.91%).

The profitability of cage culture depends, among other things, on cultured species, production level, input costs, and selling prices. **Hebicha and Azazy (2007**) estimated rates of return on investment and operating capital for different production systems of silver carp cage culture to be in the range of 21.7% to 334%. **Hambry (2002)** estimated the rates of return on investment for cage culture of snakehead and sex reversed tilapia at 500% and over 100%, respectively. Snakehead and tilapia seeds were purchased and commercial pellets were used for feeding tilapia, while purchased fresh or semidried fish were used to feed snakehead.

Large scale cage culture of mullet is new practice in Egypt and have not economically evaluated. The aims of this study are: to assess the economic potential of the actual practices of private mullet cage operations in Manzala Lake; estimate costs, returns and performance indicators based on growth stage (initial size) and cage volumes; test sensitivity of mullet cage culture to changes in selling price combined with change in production levels or production costs.

## Data and Methods

### Study area

Fish culture in cages is common practice in Manzala Lake within Dakhalia Governorate boarders. Water quality parameters measured in the study area are suitable for fish farming (**Khalil *et al.*, 2011**). Cages are placed in Southern part of Manzala parallel to El-Salam Canal. Mono-culture of mullet (*Mugil cephalus*) in cages is new growing practice in the study area. Fish farmers rely on wild sources to get mullet seeds from El-Gamel fry collection station in (Port Said) between September to December.

### Cage description

Three or four parallel rows with a maximum of 20 cages were placed perpendicular to the shore, with a distance of 20 m from the shore. The distance between a cage complex and another was about 50 m. Cages were built using wooden frames. The body of the cage was made of 18 mm black plastic mesh. Cage dimensions were either 10x10x3 m for a total volume of 300 m$^3$ or 10x20x3 m for a volume of 600 m$^3$. A protective plastic net used to protect fish from predators and to prevent fish from jumping out of cages. The floating devices used were black plastic drums. The numbers of drums used were 38 and 75 for the small and large cage, respectively. Each ten cages were grouped and anchored in place using one iron anchor. Each cage complex owns service boat for transport people and various inputs to cage location.

A total number of 41 cages, at El Manzalh Lake (Dakhlia Governorate), were surveyed on random basis to obtain information regarding a typical mullet cage operation in the study area. The surveyed operations covered different cage sizes and activities in the area, fingerlings, juvenile and table-sized fish production.

The information obtained included data on: cage size, construction materials, fingerling stocking size and density, production levels, daily and harvest labor, input costs and output prices, and any other inputs or investments involved in the operation.

Growth performance was determined and feed utilization was calculated as follows:

WG (g) = mean final fish wt (g) - mean initial fish wt (g).

Specific growth rate (SGR, %/day) = 100 (ln W2 – ln W1) / T

Where W1 and W2 are the initial and final fish weight, respectively, and T is the number of days in the feeding period,
Apparent feed conversion ratio (AFCR) = feed intake (g)/weight gain (g);
Survival rate % = Nt x 100 / NI
Where: Nt = Number of fish at t days; NI = Number of fish initially stocked.
Gross yield of fish: = harvested fish weight (kg)/ Cage volume
Net yield (kg/cage) = harvested fish weight (kg) – initial fish stock biomass (kg) / cage volume (cage).
TC = (TVC + TFC) = Px. X
Px = Unit Price of Input
X = Quantity of Input
GR = Gross Return / cage = Py. Y
Py = Unit Price of Output
Y = Quantity of Output
TC = Total Cost (LE)
TFC = Total Fixed Cost (LE)

Budgeting technique can be used to test the profitability of an enterprise. An enterprise budget is a listing of all estimated income and expenses associated with the enterprise to provide estimates of its profitability and performance (**Boehlje and Eidman, 1984; Kay and Edwards, 1989; Bernard and Nix, 1994**). The straight line method was used for estimating annual depreciation costs (**Jolly and Clonts, 1993**). The useful life was estimated to be three years for nets and wooden frames, two years for ropes and floatation devices, ten years for the boat, and 15 years for metal anchors. A charge for the opportunity cost of investment was estimated based on initial investment.

To facilitate profitability analysis, the budget requires numerical estimates of production, direct costs, and indirect costs. The typical budget format contains three sections: total returns, variable costs, and fixed costs.

## Results and Discussion

### Operational characteristics

Practice of production of market size mullet in cages in Manzala Lake is achieved over three growing stages namely, fingerlings, juvenile and table-size (grow-out). Summary of operational characteristics of the three production phases of mullet is shown in table (1). The two size volume (300 $m^3$ & 600 $m^3$) of fingerling cages stocked with 0.15 g mullet fry for a rearing period of 12 month. Smaller volume cages (300$m^3$) were stocked at the rate of 333 / $m^3$, while larger volume cages were stocked at the rate of 250 / $m^3$. Stocking rate of Juvenile cages was similar (30 fingerlings/$m^3$) in the two cage size volumes (300$m^3$ or 600$m^3$) and average stocking size is 6 g. While in grow out cages mean weight of mullet at stocking was 130 g and the stocking rate is around 15 fish/$m^3$. During fingerlings stage farmers use two cage sizes and reduce stocking rate from 333 to 250 fry $m^3$ in large size cages. Variations in the stocking rate contribute to increase mean harvest weight from 6 g to 10 g, respectively. Fingerlings cages produce mullet at an average size 6 – 10 g, from small and large volume cages, respectively. Mean harvest size of mullet in juvenile cages was at an average weight 127.7-141 g, from small and large size volume cages, respectively. While table-size cages produce mullet at an average weight 290-353.6 g/fish (Table 1). Tilapia production in cage in the surrounding area is stocked at rate of 48 Fish/$m^3$ at an average initial size 26 g (**Kahlil *et al.*, 2011**).

Cage gross yield varied from 454 kg/cage to 2910 kg/cage according to cage size and production phase. Productivity per cubic meter varied between different cages systems (fingerlings, juvenile and table-size) and volumes and result reported were (1.51:1.69; 3.5:3.7; and 4.07:4.85) respectively. **Kahlil *et al.* (2011),** reported productivity of 7.58 kg/$m^3$ of Nile tilapia in cages in Manzala lake using pellet fish feed.

The common feeding practice in mullet cages in Manzala Lake area vary according to growth stage. Fingerlings cages were fed powder fish feed 30% protein, while juvenile cages fed powder feed 30% protein first then fish fed 1mm floating feed 25% protein and finally fish fed with 2mm floating feed 25% protein. Table-size cages uses commercial 3 mm floating fish feed 25% protein till fish harvest. Apparent food conversion ratio (AFCR) varied between cages type and ranged from 1.1 in juvenile stage to 2.56 in grow out cages. The study revealed that large cages in the three system achieved better AFCR compared to small cages.

Average number of fingerling produced from small and large volume cages were 252.2 and 168.3 fish/$m^{-3}$ (1.5 and 1.7 kg/$m^{-3}$), respectively. Both juvenile cages system stocked at the same rate and produced similar number of fish 26.9 and 26.3 fish/$m^{-3}$ (3.3 and 3.5 kg/$m^{-3}$) for small and large volume cage, respectively. Number of fish harvested in table-size cages were similar 14 and 13.7 fish/$m^{-3}$ (4.1 and 4.8 kg/$m^{-3}$) in small and large volume cages, respectively.

The study result shows that higher survival rate in table-size cages 93.5:91.6% and the lowest survival rate result was noted in fingerlings cages 67:75.6%, while survival in juvenile cages ranged between 88 and 89.5%. Slight lower survival rate in large cage compared to small cages but fish weigh at harvest was higher in large cages compared to small cages.

## Budget Analysis

Enterprise budgets were estimated for various mullet cages production systems (fingerlings, juvenile and table-size) in details in (Table 2). Annual fixed costs include depreciation and the opportunity cost of investment. While variable cost components include: fingerlings, feed, labor, and a charge for the opportunity cost of operating capital. The charge for the opportunity cost of operating capital was estimated based on the average variable costs for the production period.

Differences in fixed costs were mainly due to cage size, and the number of net cage bags used during the production cycle. For example, three different net cage bags were used in fingerlings cages for the production cycle of one year, while only one size net cage bag was used for the table-size cages. While differences in operating costs across the production systems were due to feed and fingerling costs which varied according to stocking rate, fry or fingerling mean weight at stocking and unit price, and production duration. In addition, harvest labor costs varied according to production level. Seed cost represent 80% of total cost in fingerlings cages, while seed costs in juvenile and table-size cages represents 42 and 51%, respectively. Feed cost represents 5% of total cost in fingerlings cages and represented higher percentage 33-37% in grow-out cages. Total variable costs (TVC) represent about 95% of total costs in fingerlings and table-size systems while in juvenile cages TVC represent only 90% of total cost.

Returns above variable costs shows high return in large volume fingerling cages (37,688 LE/cage) followed by large volume table-size cages (28,196 LE/cage) and the lowest return is in small volume juvenile cages (594 LE/cage). It is clear for comparing the small and large size cage volumes in net return above variable costs that large size volume is better than small size volume cages. Similar trend observed in net return where also large volume cages generate higher net return compared to small cages. Juvenile cages generated the lowest income compared to other production phases and even small cages in juvenile phase showed negative net return. An only small juvenile cage generates negative net return while all the others generated positive net return. The highest net return recorded in large table-size cages 26,675 LE/year.

In Salmon cage farming in Norway, TVC represent 84% and fixed cost represent 16% of TC (**Bjorndal, 1990**). For mono-culture of silver carp cages in Nile river in Egypt, TVC ranged from 41 % to 69% of total costs according to stocking rate, while FC varied between 59 to 31 according to stocking density /$m^3$ (**Hebicha and Azazy 2007**).

## Performance Indicators

Table (3) shows performance indicators extracted from the budgets of mullet cage production. The data revealed substantial variation in both gross return and net return for the three growth stage cages, and even variation was clear between small and large cage in each cage type. The highest gross return per cage is 126,250 LE in fingerlings cages and the lowest is 19,896 LE in juvenile cages. Comparing of gross return/m3 indicate that there is variation in revenue per m3 of production unit between the different cage types. Both variable cost VC/m3 and total cost TC/m3 show similar pattern, as they were higher in fingerlings cages and lower in juvenile and grow-out cages. Average total cost (ATC) and average variable cost (AVC) per thousand/kilogram of fish produced from the different production systems are lower in large cages compared to small cages. Net return/m3 varied between different cage types and ranged between 55 LE in small fingerlings cages and -5 LE in juvenile cages. Growing in large cages (600m3) generates higher net return /m3 in various production stages compared to small cages (300 m3) (Table 3).

Break even quantity (BEQ) is the output quantity required to cover total production costs so that there will be no profit or losses. BEQ per cubic meter increased with increasing stocking rates in fingerlings cages because of the additional costs of fry, feed, and labor. BEQ / m3 shows similar figures in small and large volume grow-out cages, while in small juvenile cages it is higher than large volume cages. Production safety margin (PSM) is the percentage by which production can be decreased before the business begins to run at a loss. The estimated coefficients of PSM were positively related to stocking rates. PSM coefficients were 17.6% and 26.3% for fingerling production in small and large cages, respectively. In Both juvenile and table-size cages PSM increased in large volume cages compared to small volume cages. The estimated average rate of returns on investments and operating capital (ARRIO) increased in large volume cages in the three growing stages. The highest ARRIO is in large volume table-size cages (71%) and the lowest is in juvenile cage (-1.3%).

**Sensitivity Analysis**

Table (4) shows sensitivity analysis undertaken to demonstrate the effect of changes in selling price, production level and variable cost on net returns of different cage systems. Sensitivity analysis tested reduce selling price by 10% and 20% combined with decrease of production by the value or twice the value of the standard error of the mean (S.E.) or increase variable costs by 10% and 20%. Results of the indicated changes on the selected performance indicator are shown in Table 4. Net return in all cages systems and volumes did not change with reduction in selling price 10%, while both volume of juvenile cages and small fingerlings cage system started to generate negative net return when selling price decline 20%. The analysis shows that all cages still able to generate positive net return, except small juvenile cages, even though production level decrease by 1SE or 2SE. Similarly at current selling prices, all cages generate positive net return when variable costs increase 10% or 20%. But when selling price decreases by 10%, increasing variable costs 10% or 20%, juvenile cages generates negative net return.

Small size fingerlings cages and juvenile cages are sensitive to strong financial shock in selling price and reduce selling price 20% as they became unprofitable systems. Combined increase in variable cost and decrease in selling price 20% lead to generate negative net return in both fingerlings and juvenile. Comparison of financial performance of the three mullet cage culture systems (fingerlings, juvenile and table-size) indicate that grow-out cages are able to tolerate stronger financial shock and generate positive net return even though selling price decreases 20% and variable costs increase 20%. Sensitivity analysis revealed that generally small volume cages are more sensitive to financial shock compared to large volume cages. **Green *et al.* (2002)** reported that for Egyptian earthen pond farming, a reduction 20% of fish selling prices resulted in negative net returns for ponds received fish feeds.

## Summary and Conclusions

This study developed enterprise budgets utilizing field data for different production systems of commercial mullet cage operations in Dakhlia Governorate, Egypt. Production systems were based on fry/fingerlings stocking size and cage volume. Costs, returns, and performance indicators were estimated and analyzed. Sensitivity analysis to evaluate, how returns and performance indicators change in response to changes in selling prices combined with change of production levels were performed. The total production costs per kilogram of mullet produced varied from 14.9 to 12.8 L.E in small and large volume cages, respectively, depending on the production system.

ATC and AVC per kg of fish were negatively related to cage volume. Production, total returns, net returns, and ARR were positively affected by cage size, and growth stage, however growth stage seemed to have greater effect than cage size. Production (Kg/m$^3$) ranged from 1.51 to 4.85 in various studied cage systems. Estimated net returns varied from -5.1 to 55.3 L.E./m$^3$ according to production system employed. Production safety margin estimates were positively related to cage size and varied from -7.7% to 41.7%. Results of the sensitivity analyses revealed that operations with small cage size are generally more sensitive to reductions in selling prices or production level. Also juvenile cages types are not performing as good as either fingerlings cages or table-size cages. All performance indicators from this study support the use of large size cages in mullet production. Furthermore the study finding revealed that performance of juvenile cages is low compared to fingerlings cages and table-size cages. So selling product of juvenile cages is not economical and may be merging this stage with grow-out stage is more feasible.

The results indicated sufficient incentives for the expansion of mullet cage culture system. The economics of such system are attractive, as it uses the existing water bodies, it requires low capital investment, no land surface area, optimal use of artificial fish feeds, and it has moderate production levels. **Khalil, et al. (2011)** recommended the use of high quality fish feed for enhance production of tilapia cages in Manzala Lake.

However, few points should be considered regarding mullet cage culture. First, mullet cage culture is positively related to water primary productivity therefore, cage production may be decreased and its economic viability be impaired if large number of cages are placed in one area. Hence, there is a need to estimate the carrying capacity of the selected site for cage culture. The second point is related to cage culture impact on the environment. **Beveridge (1996)** reported that uneaten fish feed remains and fish feces from cage culture are the main sources of the negative effects on the environment. Even though high quality fish feeds are used in mullet cage culture, its environmental impact should be quantified in water quality terms before banning or discouraging this activity.

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Table 1. Operational characteristics of different mullet cage culture system in study area (mean±SE).

| | **Nursery Cages** | | **Juvenile Cages** | | **Table-size Cages** | |
|---|---|---|---|---|---|---|
| **Cage size** | (10x10x3 m) | (10x20x3 m) | (10x10x3 m) | (10x20x3 m) | (10x10x3m) | (10x20x3 m) |
| **Cage volume $m^3$** | 300 | 600 | 300 | 600 | 300 | 600 |
| **Number of cages** | 6 | 6 | 7 | 7 | 7 | 8 |
| **Culture period (month)** | 12 | 12 | 12 | 12 | 6 | 6 |
| **Stocking** | | | | | | |
| **Stocking rate (#/cage)** | 100,000 | 150,000 | 9,000 | 18,000 | 4,500 | 9,000 |
| **Stocking rate (#/$m^3$)** | 333.3 | 250.3 | 30 | 30 | 15 | 15 |
| **Initial weight (g)** | 0.15±0.016 | 0.15±1.015 | 6±0.48 | 6±0.38 | 130.3±2.7 | 130.6±1.8 |
| **Stocking weight (kg/cage)** | 15.17±1.64 | 22.75±2.24 | 54±4.28 | 109.3±6.92 | 586.3±12.13 | 1,175.6±16.5 |
| **Stocking weight (kg/$m^3$)** | 0.05±0.006 | 0.038±0.004 | 0.18±0.014 | 0.18±0.01 | 1.95±0.04 | 1.96±0.03 |
| **Harvest** | | | | | | |
| **Gross Yield (Kg/cage)** | 454±14.25 | 1,010±34.64 | 1,047±68.13 | 2,228±87.48 | 1,220±70.37 | 2,910±171.3 |
| **Mean weight (g/fish)** | 6±0.18 | 10±0.35 | 127.7±8.3 | 141.0±5.54 | 290.5±16.75 | 353.6±20.08 |
| **Net yield (Kg/cage)** | 439±14.3 | 987±35.5 | 993±69.1 | 2,119±86.4 | 634±74.6 | 1,734±163.2 |
| **Net weight gain (g/fish)** | 5.85±0.19 | 8.44±0.36 | 121.7±9.41 | 134.9±5.48 | 160.2±17.68 | 223±19.9 |
| **Yield per unit (Kg/$m^3$)** | 1.51 ±0.05 | 1.69 ±0.06 | 3.5 ±0.23 | 3.7± 0.14 | 4.07± 0.23 | 4.85± 0.29 |
| **Net Yield (Kg/$m^3$)** | 1.47±0.05 | 1.66±0.06 | 3.31±0.23 | 3.53±0.14 | 2.11±0.25 | 2.9±0.27 |
| **Prod. C.V. (%)** | 7.69 | 9.12 | 17.2 | 9.88 | 15.19 | 16.66 |
| **AFCR** | 1.73 ± 0.06 | 1.27 ± 0.05 | 1.56± 0.12 | 1.1± 0.05 | 2.56± 0.38 | 2.25± 0.24 |
| **AFCR C.V. (%)** | 7.9 | 9.6 | 20.3 | 12.4 | 38.8 | 29.7 |
| **Number at harvest** | 75,667±2,376 | 101,000±3,464 | 8,055±524 | 15,800±620 | 4,206±242 | 8,244±485 |
| **Harvest #/m3** | 252.2±7.92 | 168.3±5.77 | 26.86±1.75 | 26.3±1.04 | 14.01±0.82 | 13.74±0.81 |
| **Survival rate (%)** | 75.67±2.38 | 67.3±2.31 | 89.5±5.82 | 87.78±3.45 | 93.5±5.39 | 91.6±5.4 |

Table 2. Budget estimation (in LE/Cage) for various mullet cage types and volumes in Manzala Lakes.

| | Nursery Cages | | Juvenile Cages | | Table-size Cages | |
|---|---|---|---|---|---|---|
| **Cage Volume ($m^3$)** | 300 | 600 | 300 | 600 | 300 | 600 |
| **1. Return** | | | | | | |
| **Fingerlings sales** | 75,666 | 126,250 | | | | |
| **Mullet sales** | | | 19,896 | 42,329 | 26,840 | 64,020 |
| ***Total Return*** | 75,666 | 126,250 | 19,896 | 42,329 | 26,840 | 64,020 |
| **2. Variable Costs** | | | | | | |
| **Fry (0.1– 0.2 g)** | 50,000 | 75,000 | | | | |
| **Fingerlings (6 g)** | | | 9,000 | 18,000 | | |
| **Fingerlings (130 g)** | | | | | 9,000 | 19,000 |
| **Feeds** | | | | | | |
| **Powder 30%** | 3,375 | 5,652 | 1125 | 2250 | - | - |
| **Floating 1mm 25%** | - | - | 3000 | 4600 | - | - |
| **Floating 2mm 25%** | - | - | 2000 | 2600 | - | - |
| **Floating 3mm 25%** | - | - | - | - | 6,000 | 14,000 |
| **Labor & Guard** | 3,000 | 3,000 | 3,000 | 3,000 | 1,500 | 1,500 |
| **Harvesting Labor** | 300 | 450 | 300 | 450 | 300 | 450 |
| **Interest** | 2,484 | 4,217 | 921.3 | 1,545 | 420 | 873.8 |
| ***Total Variable Costs*** | 59,159 (95.4)* | 88,319 (94.8) | 19,346 (90.3) | 32,445 (90.2) | 17,220 (94.9) | 35,824 (95.9) |
| **3. Income above V. C.** | 15,947 | 37,688 | 549.4 | 9,884 | 9,620 | 28,196 |
| **4. Fixed Costs** | | | | | | |
| **Depreciation** | 2,430.5 | 4,112 | 1,780.5 | 3,029 | 784 | 1,295 |
| **Interest on Invest.** | 413.6 | 691 | 306 | 512 | 142 | 226 |
| ***Total Fixed Costs*** | 2,844 (4.6) | 4,803 (5.2) | 2,087 (9.7) | 3,541 (9.8) | 925.8 (5.1) | 1,522 (4.1) |
| **5. Total Cost (2+4)** | 62,363 | 93,095 | 21,433 | 35,986 | 18,146 | 37,345 |
| **6. Net Returns (1-5)** | 13,303 | 33,155 | -1,537 | 6,343 | 8,694 | 26,675 |

*Figures between brackets is % of total costs
LE 1=US$ 5.96.

Table 3. Performance indicators for different mullet cage production systems and volumes in Lake Manzala.

| | Nursery Cages | | Juvenile Cages | | Table-size Cages | |
|---|---|---|---|---|---|---|
| **Cage Volume ($m^3$)** | 300 | 600 | 300 | 600 | 300 | 600 |
| **Gross Return/Cage (L.E.)** | 75,666 | 126,250 | 19,896 | 42,329 | 26,840 | 64,020 |
| **Net Return/Cage (L.E.)** | 13,303 | 33,155 | -1,537 | 6,343 | 8,694 | 26,675 |
| **Gross Return/m3 (LE)** | 252.2 | 210.4 | 66.3 | 70.5 | 89.5 | 106.7 |
| **VC/m3 (LE)** | 198.4 | 147.2 | 64.5 | 54.1 | 57.4 | 59.7 |
| **TC/m3 (LE)** | 207.9 | 155.2 | 71.4 | 60.0 | 60.5 | 62.2 |
| **AVC/Kg. or Thousand (L.E.)** | 786.6 | 874.2 | 18.5 | 14.6 | 14.1 | 12.3 |
| **ATC/Kg. or Thousand (L.E.)** | 824.2 | 921.7 | 20.5 | 16.2 | 14.9 | 12.8 |
| **Return above VC/m3** | 53.8 | 63.3 | 1.8 | 16.5 | 32.1 | 47.0 |
| **Net Returns/m3 (L.E.)** | 44.3 | 55.3 | -5.1 | 10.6 | 29.0 | 44.5 |
| **Break-even price to cover VC (i.e. AVC/KG)** | 786.6 | 874.2 | 18.5 | 14.6 | 14.1 | 12.3 |
| **Break-even price to cover TC** | 824.2 | 921.7 | 20.5 | 16.2 | 14.9 | 12.8 |
| **Break -Even Quantity to cover TC (Kg or Thousand)/$m^3$** | 0.208 | 0.124 | 3.8 | 3.2 | 2.7 | 2.8 |
| **Safety Margin (%)** | 17.6 | 26.3 | -7.7 | 15.0 | 32.4 | 41.7 |
| **Degree of contribution (%)** | 21.3 | 30.1 | 2.8 | 23.4 | 35.8 | 44.0 |
| **A R R (%)** | 182 | 269 | -22 | 73.6 | 342.5 | 653.9 |
| **A R R I O (%)** | 25.7 | 39.3 | -1.3 | 20.9 | 47.8 | 71.1 |
| **Production C.V. (%)** | 7.7 | 8.4 | 17.2 | 10.4 | 15.3 | 16.7 |

Notes: ARR is the average rate of return; ARRIO is the average rate of return on investment and operating capital

Table 4. Sensitivity analysis of net returns to changes in selling price, production level, variable costs and combinations of the changes in selling price and production level and production costs.

| | | Change in selling price | Change in Production | | | Change in VC | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | -1SE | -2SE | 0 | +10% | +20% |
| **Nursery Cages** | **small** | 0 | 13,303 | 10,927 | 8,551 | 13,303 | 7,351 | 1,399 |
| | **large** | 0 | 32,885 | 28,825 | 24,495 | 32,885 | 24,326 | 15,496 |
| **Juvenile Cages** | **small** | 0 | -1,537 | -2,832 | -4,126 | -1,537 | -3,472 | -5,407 |
| | **large** | 0 | 6,343 | 4,681 | 3,019 | 6,343 | 3,099 | -146 |
| **Table size Cages** | **small** | 0 | 8,694 | 7,146 | 5,598 | 8,694 | 6,972 | 5,250 |
| | **large** | 0 | 26,675 | 22,906 | 19,137 | 26,675 | 23,092 | 19,510 |
| **Nursery Cages** | **small** | -10% | 5,737 | 3,598 | 1,460 | 5,737 | -215 | -6,167 |
| | **large** | -10% | 20,530 | 16,633 | 12,736 | 20,530 | 11,701 | 2,871 |
| **Juvenile Cages** | **small** | -10% | -3,527 | -4,692 | -5,857 | -3,527 | -5,462 | -7,396 |
| | **large** | -10% | 2,110 | 615 | -881 | 2,110 | -1,134 | -4,379 |
| **Table size Cages** | **small** | -10% | 6,010 | 4,617 | 3,224 | 6,010 | 4,288 | 2,566 |
| | **large** | -10% | 20,273 | 16,881 | 13,489 | 20,273 | 16,690 | 13,108 |
| **Nursery Cages** | **small** | -20% | -1,830 | -3,731 | -5,632 | -1,830 | -7,782 | -13,734 |
| | **large** | -20% | 7,905 | 4,441 | 977 | 7,905 | -924 | -9,754 |
| **Juvenile Cages** | **small** | -20% | -5,517 | -6,552 | -7,588 | -5,517 | -7,451 | -9,386 |
| | **large** | -20% | -2,122 | -3,452 | -4,782 | -2,122 | -5,367 | -8,611 |
| **Table size Cages** | **small** | -20% | 3,326 | 2,088 | 849 | 3,326 | 1,604 | -118 |
| | **large** | -20% | 13,871 | 10,856 | 7,841 | 13,871 | 10,288 | 6,706 |

**تقدير التكاليف و العائد للإنتاج التجاري لأستزراع البورى بالأقفاص ببحيرة المنزلة فى محافظة الدقهلية – مصر**

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**الملخص العربي**

هدفت الدراسة الى تقييم انتاج البورى تجاريا فى الاقفاص العائمة ببحيرة المنزلة محافظة الدقهلية. اعتمدت الدراسة على بيانات ميدانية لعدد 41 قفص مقسمة الى نظم الانتاج المختلفة للبورى (زريعه، اصبعيات، احجام تسويقية). شملت الدراسة دراسة مراحل الانتاج المختلفة للبورى فى اقفاص مختلفة الحجم 300 م مكعب و 600 م مكعب. تم تقدير التكاليف والعائد ومؤشرات الأداء لهذا النشاط باستخدام أسلوب الميزانية . تم تقدير الميزانية لمراحل الانتاج الثلاثة فى حجمين اقفاص مختلفين. وتم دراسة تأثير اختيار حجم القفص فى مراحل الانتاج المختلفة على إقتصاديات هذا النظام من الاستزراع . كما تم إجراء تحاليل الحساسية الخاصة بتأثير التغيرات فى الأسعار ومستويات الانتاج على الأداء الإقتصادى لهذا النشاط . أكدت نتائج الدراسة الجدوى الاقتصادية لانتاج الاصبعيات وكذلك انتاج الحجم التسويقى للبورى. كما أكدت النتائج أن حجم الاقفاص لها أثر ايجابى على إقتصاديات استزراع البورى فى الأقفاص فى بحيرة المنزلة. ويستخدم مربى البورى فى الاقفاص اعلاف الاسماك المطبوخة فى تغذية البورى لتقليل الاثر البيئى للاقفاص على البيئة المحيطة. واستنتجت الدراسة ان تربية البورى فى اقفاص كبيرة الحجم اقتصادى وقادر على تحمل زيادة تكاليف الانتاج او انخفاض سعر بيع المنتج، وبالتالى الاستمرار فى النشاط فى ظل ظروف صعبة.