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VALUE CHAIN ANALYSIS OF EGYPTIAN FISH SEED PRODUCTION

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ABSTRACT

Expansion of Egypt's aquaculture industry has been matched by the development of a large number of tilapia hatcheries all producing sex-reversed all-male fry and fingerlings. In order to map the fish seed value chain in Egypt, operators of fifty tilapia hatcheries in four governorates (Kafr el-Sheikh, Behera, Sharkia and Fayoum) were interviewed. Tilapia hatcheries use a range of technologies, from simple hapa-based systems in open ponds to heated, greenhouse-covered, tanks systems to advance and lengthen the spawning season. Most of the tilapia seed production (>95%) is sold as fry rather than fingerlings and sold directly to production farms 88%, while only 12% of seeds sold through fry/fingerling traders. Some of the hatcheries are part of an integrated fish farm with both hatchery and production systems.

The average size of hatchery was 4.1feddans. Almost half of the hatcheries used some form of heating (solar or fuel-fired boiler) to extend the spawning season. The surveyed 50 hatcheries hold over 0.5 million broodstock and sold a total of 474 million fry in 2011 at an average price of LE 30 /1000 fry. Hatcheries also sold 21 million fingerlings at an average price of LE 114/1000. These prices are significantly lower than current prices in comparable countries and have dropped gradually over recent years in Egypt indicating that there is a high degree of competition in the market.

The average surveyed Egyptian tilapia hatchery produces around 10 million seed and employs 4.5people Full-Time Equivalent (FTE), with 59% of the employees under 30 years old. Despite low seed prices,

hatcheries appear to be highly profitable with an average total value added of LE 28,055 per million fry. Tilapia fry and fingerling traders play a limited role linking tilapia hatcheries with producers. Fry/fingerling traders generate relatively few jobs (0.55 FTE per million fry sales) but generate reasonable profit levels. The main subsector constraints were identified by hatchery operators and suggested solutions were discussed in detail in the current study.

Keywords: Tilapia hatchery, Seed value chain, fry traders, critical factors, analysis, Egypt.

INTRODUCTION

Egyptian fisheries production grew from 724,300tons in 2000 to 1.3 million tons in 2010 (**GAFRD, 2011**) primarily due to increased aquaculture production which increased its share of total fisheries production from 47% in 2000 to 70% in 2010 (**Macfadyen *et al.,* 2012**).Aquaculture activities have become more sophisticated and diverseand are supported by the development andexpansion of a large number of tilapia hatcheries (**Saleh, 2007**).

The Egyptian fish seed sector started in the 1980s when the General Fisheries Authority decided to establish 14 freshwater hatcheries to produce carp seed for stockingpublic and private fish farms as well as to support the integration of aquaculture into rice fields and the stocking of natural reservoirs and lakes (**Saleh, 2007**). Private freshwater hatcheries started producing Nile tilapia fry (*Oreochromisniloticus*)in the early 1990s to satisfy growing demand from private fish farms andto stock their own farms. The number of private hatcheries had increased from seven by 1996 (**Radwan, 2008**) to some135 licensed plus around 500 unlicensed hatcheries in 2010 (**GAFRD, 2011**). All commercial tilapia hatcheries in Egypt produce sex-reversed all-male Nile tilapia fry (0.2-0.5 g) and fingerlings (1-5 g), in a range of systems, including earth ponds, hapas in ponds and concrete tanks (**Saleh, 2007**).

One of the main challenges faced by Egyptian aquaculture is the seasonality of the climate seasonality. While summer temperatures are very suitable for growth and reproduction of the main farmed species, Nile tilapia, winter temperatures fall below optimal levels for growth and propagation (25-30 °C). In order to meet the high demand for seed by fish farmers early in the season (**Saleh, 2007and Macfadyen *et al.*, 2012**), an increasing number of tilapia hatcheries in Egypt advance and extend their breeding season by warming the water in their systems (**Saleh, 2007; Radwan, 2008; Abou-Zied and Ali, 2007; Eldokla *et al.,* 2011; and Naiel *et al.,* 2011**).

Although the hatchery sub-sector in Egypt has developed over fifteen years, the financial and operational performance of hatcheriesis not well understood. Value-

chain analysis is potentially a useful tool to address this research gap. Value chain analysis has become increasingly prominent as a form of analysis in the fisheries and aquaculture sectors (**Veliu *et al.,* 2009; and Christensen *et al.*, 2011; Macfadyen *et al.*, 2012**). The increasing interest in value-chain analysis is due to the fact that it provides an excellent means to:

- Assess the relative importance of factors affecting competitiveness;
- Understand the costs and earnings profiles and financial performance of the different sub-sectors/links of the value-chain, and compare the financial performance of the sub-sectors in different geographical locations;
- Consider the employment generated by the sector; and
- Identify the key constraints and problems impacting different actors in the value-chain.

The current study is designed to provide more information on one of the main inputs for the Egyptian aquaculture value chains, i.e., the supply of fish seed. The study focused on the four selected governorates, namely Behera, Fayoum, Kafr el Sheikh and Sharkia which together account for 74% of pond aquaculture production in Egypt in 2010 (**GAFRD, 2011**).

The main objective of the study is to better understand the freshwater fish seed industry in Egypt. In particular the study aims to:

- map the typical Egyptian fish seed value chain;
- consider the employment generated by the sub-sector;
- understand the costs and earnings profiles at different stages of the such value chain;
- identify constraints and problems impacting different actors in this value chain;
- andidentify potential interventions to address such problems.

MATERIALS AND METHODS

Study area

This study is based on collecting production and financial filed information from freshwater tilapia hatcheries operators in the four main fish production governorates; Kafr el Sheikh, Behera, Fayoum and Sharkia. According to official statistics, 90% of licensed private tilapia hatcheries are located within the study area (**GAFRD, 2011**).

Field work

A desk review of recent statistics on fish seed supply in terms of numbers of hatcheries, fry and fingerling production, and geographical distribution was carried out by the study team prior to the field work. Secondary data sources (official statistics, previous studies) were validated with key contacts across the country and were used to decide on the number of interviews to be carried out in each

governorate on a stratified basisaccording to estimated number of hatcheries in each governorate(Table 1).

Two detailed questionnaires for freshwater fish hatchery operatorsand fry traderswere drafted in English and then translated into Arabic. The questionnaires were revised, discussed and modified by the study team, then piloted at the WorldFish research center in Abbassa with a hatchery manager before being finalized and printed.

Individual interviews and focus group discussions were held with hatchery operators and fry traders. In order to maximize the number of interviews, small groups of stakeholders met at a central location in each governorate. This provided an opportunity to introduce the study and to hold a focus group discussion in plenary before individual interviews were then conducted with the participants. The number of interviews per governorate was decided on stratified basis according to the available statistics on the number of farms in the target governorates. The introductory comments and focus group discussions, which concentrated mainly on key stakeholder problems and potential solutions, generally lasted around sixty to ninety minutes, as did the individual interviews. Tables 1, provides information on the number of individual questionnaires completed in each governorates and the number of participants at the same meetings that were involved in the focus group discussions.

Data entry and analysis

Data from the questionnaires were entered into a Microsoft Excel spreadsheet file and checked for accuracy with the interviewers. The data collected during the field study allowed the estimation of a number of key indicators for each link in the value chain. The indicators were calculated both separately for each of the four governorates by taking averages of the data provided by the respondents in each governorate, and for the sample frame as a whole.

The questionnaires generated data on sales volumes and values, and on operational and fixed costs, which allowed for the construction of costs and earnings models for each respondent.The interviews included questions on the number of people employed and on the nature of that employment (full-time, part-time or seasonal). The data collected were converted into Full-Time Equivalent (FTE) jobs. The financial indicators calculated included: gross output values per million fry; operational profits (sales value-operational cost) in Egyptian Pounds (LE) per million fry (LE1=$5.96) and as a percentage of sales; net profits (revenue- (operational + fixed cost)) in LE per million fry produced or sold and as a percentage of sales; total value-added (net profit + wages) per million fry sold; and the percentage of the total operational profits, net profits, and value-added made throughout the chain derived from the different links in the value-chain.Value added was used as a

measure of the wealth created by the activity (fish hatchery or fish fry trading) **Macfadyen *et al.* (2012).** The usual definition is:

Value added = Total sales value (price x volume) - value of intermediate goods (raw materials + finished products + services)

In our case 'value added' = wages + operational profits.

Fixed costs do not vary depending on production volumes. For the seed value-chain, fixed costs typically include government licenses, repair and maintenance costs, rents paid for land and buildings, and the depreciation costs of assets. Calculation of depreciation costs for equipment was computed using the straight line method (**Jolly and Clonts, 1993**), where annual depreciation = (Cost – Salvage Value) / Useful life and the salvage value for all equipment was assumed to be zero (**Asmah, 2008**).

Table 1.Number of hatcheries in selected governorates and study sample frame

Governorate	Behera	Fayoum	Kafr El-Sheikh	Sharkia	Total
Number of hatcheries	42	35	160	60	297
Number of hatcheries surveyed*	8	8	24	10	50
Fry/fingerling traders surveyed	1	2	4	1	8
Number of participants in focus group discussions**	12	20	19	10	61

* Number of operational hatcheries (licensed and unlicensed)

** One focus group discussion was held for each governorate

RESULTS AND DISCUSSION

Mapping the fish seed value-chain

The Egyptian aquaculture value chain stages from production to retail were analysed in **Macfadyen *et al.* (2011).** Figure 1 adds an 'Input Supply' stage/node to the Egyptian aquaculture value chain and shows the relationships between the main actors in the seed value chain as revealed by the field work for the current study. Public hatcheries have concentrated mainly on producing carp fingerlings to stock public farms and water bodies whereas most private hatcheries have concentrated on producing all-male tilapia seed for the private farms. As shown in figure 1, private hatcheries fall into two main types; independently operated hatcheries and on-farm hatcheries operating as part of a vertically integrated hatchery and production farm.

Egyptian tilapia seed producers have specialised in the production of sex-reversed, all-male fry and fingerlings. Nile Tilapia (*Oreochromisniloticus*) is the common tilapia in hatcheries and there is great demand for tilapia seed by private farmers (***Macfadyen et al.,* 2012**). Many hatcheries are advancing and extending

their breeding season by warming the water in their systems. The most common technique is to use solar heating (enclosing breeding tanks or ponds in greenhouse tunnels), but this may be augmented by heating using a boiler or using underground water which has a higher temperature than surface water. This allows the hatchery to meet high demand for seed at the start of the season.

Integration of Egyptian seed value chain into Egyptian aquaculture value chain reported by **Macfadyen *et al.* (2012)** is illustrated in Annex 1. The main tilapia seed market in Egypt is for fry rather than fingerlings as fry are much cheaper and are easily transported, although some hatcheries also sell advanced fry (around 1 g). There are significant seasonal variations in supply and prices. At the start of the season, farmers will pay high prices for over-wintered fingerlings. The first new season's fry, produced by hatcheries with heating systems, also command high prices. However, prices drop as the season progresses and more seed becomes available.

The other main actors in the fish seed value chain are the fry and fingerling traders who purchase seed from hatcheries and sell to farmers. In some cases, traders sell the fish directly. In others, they stock fry into nursery ponds and grow the fish for a period, perhaps buying cheaply at the end of one season and over-wintering to benefit from strong demand at the start of the next growing season.

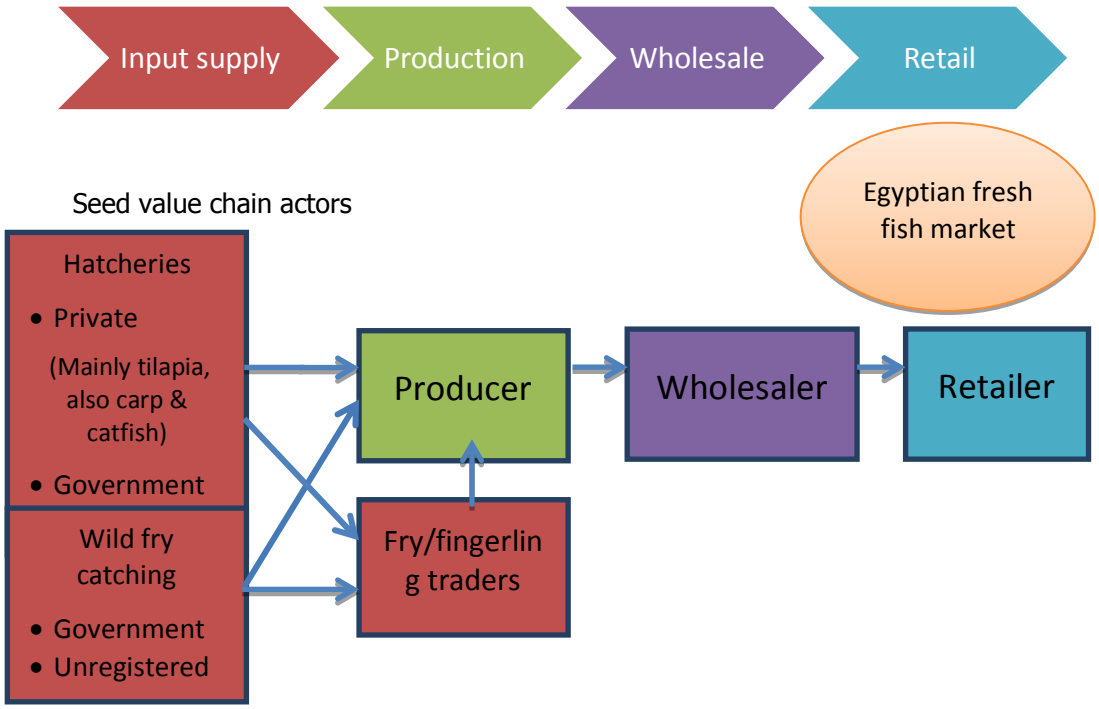

Figure 1. The Egyptian aquaculture value chain

Value chain stages/nodes

The carp hatchery system operates almost entirely within the public sector with government hatcheries supplying fingerlings to stock government fish farms and public water bodies. Market demand for carp is low and retail prices reflect this (**Macfadyen *et al.,* 2011**).

Interest in African catfish production is growing in Egypt and is at present based mainly on wild-caught fingerlings. There is also limited production by hatcheries. However, it is a more difficult fish to breed than tilapia. A number of hatchery technologies have been developed for this species ranging from induced spawning in tanks to semi-natural spawning methods developed at WorldFish, Abbassa (**El-Naggar *et al.,* 2006**). There should be potential for significant development in the future as the requisite hatchery skills and facilities become established.

The supply of mullet fry to the value chain is through licensed fishing stations and unlicensed fishermen operating along the Mediterranean coastline. This is a valuable part of the aquaculture sector as mullet retail prices are significantly higher than those for other species and is reflected in the value of the mullet fry which are worth much more than tilapia or carp seed. There is a quota system controlling the supply of mullet seed from licensed catching stations to licensed production farms, however much of the trade is unregulated and illegal. It appears that fry and fingerling traders play a key role in the transfer of mullet fry and fingerlings to the much larger unlicensed production farm sector.

Fish hatchery operational characteristics

All the 50 hatchery operators interviewed by the study team were private hatcheries (both licensed and unlicensed) and concentrated on the production of all-male tilapia fry and fingerlings. The average time that they had been in business was 11 years and the interviewees were a mixture of owners and managers of hatcheries. Table 2 shows the basic operational data grouped by Governorate. This shows that hatcheries interviewed in Behera and Fayoum were smaller than those in Kafr el Sheikh and Sharkia. However, fry and fingerling prices were higher in Fayoum than in the other governorates. This is in accordance with the results of **Macfadyen *et al*. (2012**) which found that prices through the value chain were higher in Fayoum.

The usual tilapia hatchery cycle is to stock breeding systems with broodstock in February/April and start collecting fry within two weeks. The fry are then fed hormone-treated food for 3-4 weeks before they are sold as 0.2 g all-male fry. It takes another 4-6 weeks (or longer if they are being over-wintered) before these fish can be sold as 3-5 g fingerlings.

All the hatcheries used surface water as their main water source, while 4 of the 50 also had access to ground water. Seventy six percent said that they had mains electricity supply for their facility, while 54% had a household water supply and

56% were accessed via a paved road.The average size of hatchery was 4.1feddans. Twenty two of the hatcheries were based on land that they owned, while 28 were on rented land.

The most common hatchery system used was hapa (40 hatcheries, total 4053 units) while 36 farms had concrete tanks (total 1831 units) and 17 hatcheries used earth ponds (total 80 units). Forty six percent of hatcheries used water heating and greenhouses to increase production, while 18% used only greenhouses and 6% used groundwater. Most (90%) of the farms had additional ponds to hold broodstock and 54% had fry nursery ponds.

The average annual period for spawning tilapia was 6.5 months and hatchery operators expected on average to sell tilapia fry and fingerlings over 5.7 months of the year. The 50 hatcheries hold a total of 535,900 broodstock (422,000 female and 113,900 male) at an average female to male ratio of 2.9:1 and average broodstock size of 276g and 307g for females and males respectively. Broodstock are stocked in spawning units at an average density of 3.8 fish per m^2. The average number of fry collected in each spawning batch is 1016/m^2 with an average spawning interval of 13.9 days resulting in 6 spawning cycles per season.

The estimated total number of tilapia fry produced by the 50 hatcheries was 474 million sold at an average price of LE 30.4/1000 fry. Fingerling production by the 50 hatcheries totalled 21 million at an average price of LE 114.3/1000 fingerlings. A small number (9700) of broodstock were also sold at LE 2.6 each. Thus, the average hatchery sold just fewer than 10 million fish seed (fry and fingerlings) per year and 95% of sales were in the form of fry.

The hatcheries had mixed perspectives on historical trends. Fifteen hatcheries said production had increased in 2011 compared to the previous year whereas 10 said it had gone down, and the rest said it was much the same. Three hatchery operators claimed prices were higher in 2011 while 9 said they had gone down, and 14 said their annual sales value had gone up, while 15 said it had gone down.

Most of the hatcheries said they were able to sell all their production and of the 19 who said they experienced problems, all but one said this was because of mortalities, not because of market demand. The average loss of fry at different stages was estimated as 11%, 12% and 39% during hormone treatment, nursery and fingerling stages (usually overwintering fingerlings), respectively.

All the hatcheries used commercially available feeds for broodstock (average 30.4% protein), while a mix of commercial and farm-made feeds was used for fry (45.1% protein) and fingerlings (29.6% protein). Average feed prices ranged from LE 4000 per tonne for broodstock feed to LE 4433 per tonne for fingerling feed and LE 7139 per tonne for fry feed.

Sixteen of the 50 hatcheries were selling over 50% of their production to their own farm; that is, they are an integral part of a production fish farm. On average 30% of the fry and fingerlings produced by all the hatcheries were sold to their own production farm, 58% to other production farms and 12% to fry traders. On average, 56% of production was sold for cash and 44% as credit sales that took an average of 6 months for reimbursement. However, hatcheries usually charge an average of 3% for credit sales.

There are also significant seasonal variations. Tilapia fry prices tend to be highest at the start of the season (April/May) when farmers are keen to stock their ponds as early as possible but the supply can only be met by hatcheries that have invested in water heating systems or those which have overwintered fingerlings. Supply from unheated hatcheries coupled with reducing demand results in lower prices in the middle and at the end of the season. In the current study, hatcheries were asked to give an average price across the season.

A summary of the data collected on employment in Egyptian fish hatcheries is shown in Table 2. The result indicates that employment levels were similar across different governorates and averaged 1.6 full-time equivalents (FTEs) per feddan of hatchery area. When expressed in terms of fry production, employment varied from 0.4 FTE per million fry in Sharkia to 0.81 FTE per million fry in Fayoum with an overall average of 0.45 FTE per million fry. **Macfadyen *et al.* (2012)** reported that overall employment was 13.8 FTE per 100 tonnes fish in Egyptian aquaculture value chain from production to retailing. While none of the fish hatcheries employed women, an average of 59% of the FTE jobs were for people under 30 years old.

Table 2. Operational data for Egyptian fish hatcheries.

Operational data	Behera	Fayoum	Kafr el Sheikh	Sharkia	Sample
# hatchery interviewed	8	8	24	10	50
Years involved in the sector	10.3	9.6	11.5	10.8	11.0
Total area (feddans)	23	18	122.5	41	205
Average area (feddans)	2.9	2.3	5.1	4.1	4.1
Number of broodstock	9,344	5,281	11,373	14,600	10,719
Female:Male ratio	3.0	3.0	2.9	2.9	2.9
Average male tilapia (g)	291	225	368	240	307.1
Average female tilapia (g)	240	191	346	205	275.8
Tilapia fry price (LE/1000)	29.21	34.25	29.87	29.50	30.43
Tilapia fingerling price (LE/1000)	80.00	200.00	96.25	116.67	114.29
Seed Production (Million/year)	7.46	4.07	11.84	12.0	9.9
Average FTE per Hatchery	3.5	3.3	5.2	4.7	4.5
Average FTE / feddan	1.75	1.78	1.58	1.35	1.60
Average FTE / million fry	0.47	0.81	0.44	0.40	0.45
FTE under 30 years old	37%	54%	65%	66%	59%

The financial performance of the hatcheries is summarised in Table 3. Obviously, the cost base of hatcheries is quite different to production farms. In the aquaculture value chain study, **Macfadyen *et al.* (2012)** found that feed costs represented 67% of operating costs in production farms whereas feed costs are only 29% of hatchery operating costs. On the other hand, the relative cost of labour is higher in hatcheries than in production farms. From this analysis it appears that hatcheries achieve significantly higher profit levels than production farms profits reported by **Macfadyen *et al.* (2012**). Average operating profits per million fry were very consistent ranging from LE 21,283 in Kafr el Sheikh to LE 27,062 in Fayoum and averaging LE 22,485 across all 50 hatcheries.

When fixed costs were taken into account, average net profits ranged from LE 14,613 per million fry in Kafr el Sheikh to LE 22,332 in Fayoum with an overall average of LE 17,720 per million fry. This is equivalent to an average net profit of 44% of sales, or twice the average profitability of production farms recorded in the aquaculture value chain analysis (**Macfadyen *et al.,* 2012**).

Fry and fingerling trader analysis

It was surprisingly difficult to identify fry traders to interview. The hatchery analysis indicated that only 12% of their sales, which were all tilapia, were to traders. However fry and fingerling traders also supply fingerlings from other sources such as wild-caught mullet fry.The average length of time that the traders had been involved in the business was 7.4 years. The traders represented a range of types and scales of business from a simple operation where the trader had a transport tank and plastic bags and used hired transport, to traders who owned ponds, vehicles and oxygen cylinders.The average amount of fish seed soldwas 4.3 millionper trader per year.

Two of the operators only bought and sold fry and fingerlings, selling them immediately to fish farmers while all the others rear fry in ponds before selling the fish as fingerlings to farmers. While most of the traders sold more tilapia fry and fingerlings than any other type, 3 of the 4 traders in Kafr el Sheikh sold more mullet than tilapia. Mullet seed are wild-caught either through the official catching stations or through 'black market' fry catchers. Mullet fry and fingerlings are also much more expensive than tilapia. There were also significant sales of carp by 2 of the 8 traders. On average, tilapia fry and fingerlings sales represent 77% of fry traders sale volume. Mullet fry sales represent 21% of the traders' sales volume and catfish came as the third accounts for 10% of trader sales volume.

The traders said the preferred size of fingerlings for their customers was around 1 g for tilapia, 100 g for catfish, 3 g for carp and 2.5 g for mullet. The peak supply period for tilapia fry to traders (from hatcheries) is June-August while the peak demand from farmers is in March/April. The traders said that the most important

issue for their customers was the quality of fry, followed by prices and fingerling size. The study found that tilapia fry and fingerling prices were highest at the start of the season (April) and dropped from June onwards, while the annual trend in mullet prices was the opposite of this, rising through the season.On average, 90% of fry trader operating cost was the purchase of fry and fingerlings and most traders said that these costs were rising. The second most important operating cost was labour (6%).

Table 3. Financial performance in Egyptian fish hatcheries

Financial performance	Behera	Fayoum	Kafr el Sheikh	Sharkia	Sample
Sales revenue (LE)/ hatchery /year	237,594	172,750	379,875	445,526	337,100
Operational costs (LE)/ Year	91,301	59,158	154,182	167,783	131,637
Feed costs (% operational costs)	28.3%	25.6%	29.8%	30.1%	28.9%
Labor costs (% operational costs)	51.8%	48.9%	41.4%	47.2%	45.4%
Labor costs (LE)/ million fry	7156	7599	6507	6129	6710
Operational profit (LE)/year	146,293	113,592	225,693	277,743	205,463
Operational costs (LE)/ million fry	13,817	16,437	16,373	13,355	15,371
Operational profit (LE)/ million fry	21,848	27,062	21,283	22,219	22,485
Average operational profit (% sales)	59.4%	60.9%	58.9%	57.2%	59.0%
Fixed costs (LE)/hatchery	33,667	21,603	66,497	68,804	53,563
Total production cost (LE)	124,968	80,761	218,679	236,586	185,200
Production cost (LE/million fry)	18,628	21,167	22,798	18,678	21,045
Net profit (LE)/ hatchery	112,626	91,989	161,196	208,939	151,900
Net profit (LE)/million fry	17,037	22,332	14,613	16,897	17,720
Average net profit (% of sales)	46%	49%	40%	41%	44.0%
Average value-added (LE)/million fry	27,762	34,126	26,403	28,324	28,055

While most of the traders sold more tilapia than other species, traders concentrating on mullet generated much higher revenues (and had higher operating costs) than those that dealt mainly in tilapia. This is because mullet fingerlings have a much higher value, LE 400-1200 per 1000 fingerlings compared to average tilapia prices of LE 38 per 1000 fry and LE 166 per 1000 fingerlings. Traders said that while their sales volumes of tilapia were relatively constant (compared to previous years), the volume of mullet sales had fallen (because of poor supply) and prices had increased as a result. Half of the traders said that they are the most important link in the value chain for setting fish seed prices. There appear to be few problems with mortalities and good demand for fingerlings.

Most of the traders' sale (77%) are conducted in cash while credit sales take around 12 months to be paid and cost 4% extra for their customers. All the traders said their businesses were self-financed. Only one of the traders has received training in the past. Most of the traders employed few staff, except for the larger operations that hold fry in ponds for an extended period. As shown in Table 4, the average employment level was 0.55 FTEs per million of fry sales. Operating and net

profits averaged 31.7% and 29.2% respectively indicating that seed trading is a profitable enterprise, even for smaller operations such as the traders in Fayoum.

Table 4. Operational and financial data for fry/fingerling traders

	Behera	Fayoum	Kafr el Sheikh	Sharkia	Sample
No. of traders interviewed	1	2	4	1	8
Sales number (million/year)	2.8	2.3	4.0	10.6	4.3
Sales value (LE)/year	938,000	235,825	1,064,688	810,000	809,800
FTE per million of fry sales	0.18	0.72	0.65	0.19	0.55
Labour costs (LE)/year	30,000	19,200	39,850	38,400	33,275
Operational costs (LE)/year	726,100	165,125	667,094	678,400	550,391
Operational profit (LE)/year	211,900	70,700	397,594	131,600	259,409
Operational profit as % sales	22.6%	27.1%	40.2%	16.2%	31.7%
Fixed costs (LE)	830	2,700	33,570	13,500	19,251
Net profit (LE)/year	211,070	68,000	364,024	118,100	240,158
Net profit as % of sales	22.5%	25.8%	36.3%	14.6%	29.2%
Average value-added (LE/million)	85,486	38,465	99,907	14,764	64,103

Benchmarking

Comparing the financial performance of Egyptian fish hatcheries and fry/fingerling traders with their past performance and with operators in other countries is difficult. There appear to be few other value chain studies focussed specifically on fish seed production. A recent study was carried out for WorldFish in Bangladesh, however, which concentrated solely on carp seed in southern Bangladesh (**Innovision, 2010**).As already noted in this study, seed prices vary greatly depending on the product being sold. However, prices also vary greatly according to seasonal demand; the first tilapia fry at the start of a new season will cost more than fry purchased in the middle or end of the season, while overwintered fingerlings will cost even more.

The average selling price for all-male tilapia fry and fingerlings reported by hatchery operators in this study were LE 30/1000 and LE 114/1000 respectively. Meanwhile, fry/fingerling traders said their average selling prices for all-male fry and fingerlings were LE 38 / 1000 and LE 166 (US$ 27.5) / 1000 respectively. Table 5 shows fry and fingerling prices from GAFRD's hatcheries. Their tilapia prices have not changed over the years (tilapia seed production is a relatively minor part of their activities) whereas mullet prices have risen substantially.

Table 5. GAFRD official fingerling selling prices (LE per 1000)

Year	Tilapia Fingerlings (Monosex)						Grey Mullet*		Thinlip Mullet**	
	0.5 g	2 g	2-5 g	5-10 g	10-15 g	15-30 g	0.5 g	0.5-2 g	0.5 g	0.5-2 g
2012	30	70	90	120	180	230	150	300	40	150

Source: GAFRD
* Grey Mullet (*Mugilcephalus*).
**Thinlip Mullet (*Liza ramada*).

During the interviews for this study, declining mono-sex tilapia fry prices was voiced as a common problem. The manager of the first private-sector tilapia hatchery (developed in 1990-1991) said that he sold 0.2-0.5 g mono-sex tilapia fry, (post hormonal treatment) at LE 120/1000 fry, which was equivalent to US$ 36-40 at that time. He also reported that he maintained his prices for five years. After 5 years as a result of establishing another hatchery he started to sell fingerlings (1-2 g) at the same price (LE 120/1000) as an extra service for his customers. Table 6 shows tilapia seed prices from private hatcheries in Egypt collated from a range of sources over the last 10 years. These indicate that mono-sex tilapia fry prices have declined over this period of time from around LE 90 to LE 30/1000 fry.

Table 6. Seed prices from Egyptian private hatcheries from 2002 : 2011

Year	Species (Area)	Average price per 1000		Reference
		LE	US$*	
2002	Tilapia mono-sex fry (Sharkia and Kafr el-Sheikh)	90	20	**Azazy(2003)**
2003	Tilapia mono-sex fry	80	15	**MSSP (2003)**
2006	Tilapia mono-sex fry (Behera and Sharkia)	70	12.2	**Azazy*et al.*(2008)**
2010	Tilapia mono-sex fry	50	9	**Naziri(2011)**
2009-2010	Tilapia mono-sex fry (Kafr el-Sheikh and Sharkia)	37	6.7	**Rasha*et al.*(2011)**
2011	Tilapia mono-sex fry	30.4	5.0	This study

*LE value against US$ derived from CAPMAS record series.

Table 7 shows current international prices for tilapia seed in a range of countries, some of which have mature tilapia aquaculture industries (Bangladesh, Cambodia and Thailand) whereas aquaculture industries in African countries are still developing. The prices were obtained through personal contacts (World Fish or www.sarnissa.org).

It shows the wide degree of variation in prices and product form between countries. As might be expected, seed prices in countries with a mature aquaculture sector tend to be lower than in countries where aquaculture is still developing.

However, it appears that all the international prices are significantly higher than Egyptian prices, suggesting that there should be opportunities for Egyptian hatcheries to export tilapia seed to other countries, as long as international protocols and certification for live fish movements can be satisfied.

Problem identification

Many issues that could not be captured by the questionnaires were brought up and discussed during focus group discussions. Table 8 provides a brief summary of the key issues impacting on the sector. Issues mentioned in the table represent potential areas of action by the value-chain actors themselves and by those relevant factors outside, to improve value-chain performance. Similar issues reported by **Macfadyen *et al.* (2012)** during their study of the Egyptian aquaculture value chain.

Table 7. International prices for tilapia fry and fingerlings (April 2012)

Country	Tilapia seed prices (US$ / 1000)	Reference
Bangladesh	$ 12-24 (2.5 cm monosex)	Belton, B. pers. comm.
Cambodia	$ 20 (1.5g)	Sammonn, M. pers. comm.
Kenya	$ 82 (2g)	Ngugi, C. pers. comm.
Mozambique	$ 70 (0.2-0.4g monosex)	Schnell, C., pers comm.
Thailand	$ 12 (0.25g monosex)	www.tilapiathai.com
Uganda (2011)	$ 140 (15g)	**Dickson and Macfadyen, 2011**

Analysis of critical factors

Seed availability and quality

The availability of seed of particular species determines the species that are grown, so the growth of the Egyptian tilapia industry has depended on the development of tilapia hatcheries. In contrast, the growth of African catfish farming is currently constrained by the poor performance of the few hatcheries that have been adapted for catfish production and inadequate supply of wild-caught catfish fingerlings, while mullet aquaculture depends solely on catches of wild mullet fry.

Many point to the introduction of all-male tilapia fry production by Egyptian hatcheries in the 1990s as a turning point for the aquaculture industry (Radwan, 2008). The use of hormones to sex-reverse tilapia was made illegal in Egypt in 2003 under a ministerial decree (Decree no. 2655) but its legal status was largely ignored. This decision was reversed in 2009 by another ministerial decree. Conditions were attached to the 2009 decree, such as hatcheries should be managed by a specialist, fry feed should be produced in a specialised (GAFRD) feed mill and hatchery water had to be disposed of safely by holding it in a drainage channel. However, it appears that very few hatcheries are aware of the 2009 decision and most continue to manufacture their own hormone-treated feeds.

Table 8.Summary of critical issues and factors constraining the sector.

	Critical issues
Input Factor	•Access to capital; lack of funds has stopped operators upgrading their facilities. They have to fund any developments themselves as they have difficulty in getting access to credit through banks. •Broodstock quality; producers only grow all-male sex-reversed tilapia so it is not easy to find mixed tilapia population to select brooders from. Pure strain wild fish are also difficult to find (overfishing, fish kills due to cold weather). •Water quality and availability; fish fry are more susceptible to poor water quality than larger fish. Also hormone treatment of fry should be done in clean water, not water that is polluted or rich in natural food such as algae. Some hatcheries use boreholes but many called for them to be given the legal right to use freshwater sources. •Power costs/availability; hatcheries which heat the water incur increased costs and many have encountered problems with short supply of heating fuel. Heating using electricity is cheaper however not all hatcheries have a reliable connection to the network. •Hormone quality; poor quality hormone results in mixed sex populations. Production farms ask for compensation from hatcheries for excessive feed costs and reduced revenue if too many females are discovered at harvest. However some commented the problem was due to poor hatchery management rather than hormone quality. •Land availability & tenure; hatcheries do require large areas of land; however some of the interviewees reported that short-term leases prevent them from investing in their hatcheries.
Production factor	•Fish health management; hatcheries said they lacked technical support to diagnose disease problems and decide on appropriate treatments. The most common problems were death of broodstock and poor fry survival during the rearing stage. The most common fish problems were with bacterial diseases, fungal diseases and parasitic diseases especially Trichodina and Monogenea. •Labor and management skills; there is a shortage of skilled workers during the breeding season. Hatchery managers have to spend time and effort training unskilled laborers and provide incentives for skilled workers. Meanwhile hatchery laborers are calling for improvements in their working conditions, such as being covered by national labor laws, getting pensions and being covered by medical health insurance.
Marketing factors	•Declining prices; many hatcheries noted declining fry prices over time caused by oversupply from the increasing number of tilapia hatcheries. Oversupply also leads to credit sales of fry which means they may not get paid for 8 – 12 months. •Permission to transport fry; hatcheries and fry/fingerling traders cannot transport seed from one governorate to another without a hatchery license and a fry transport permit however most cannot get the necessary documentation as they are unlicensed. Police or traffic officers take an action against any vehicle caught transporting fry without permission. •Fluctuating prices; fry prices are highest at the start of the season and decline gradually. Average prices for mono-sex tilapia fry in April start at LE 50-60 per 1000 and decline to LE 10-20 per 1000 in July and August.

Internationally it is now widely accepted that the responsible application of this technology poses no threat to consumers and it is allowed by the USDA and tolerated by EU authorities (**Macintosh, 2008**). The new Aquaculture Stewardship

Council tilapia standards stipulate the use of 95%+ male populations on the grounds of minimising the impacts of escapees on the environment.

Some farmers suggested that there were problems with the quality of hormone available, resulting in poor levels of sex-reversal. However others reported that the problem was usually with hatchery management rather than with the chemicals. This suggests a need for sourcing hormone from known suppliers and better training for hatchery operators.

Use of improved strain

Tilapia seed production is now almost entirely based in private hatcheries meaning that there are obvious opportunities to improve the genetic profile of the fish being farmed in Egypt. But, this has been restricted to using stocks from particular sources, such as farmers maintaining their own broodstock, or sourcing fish from other fish farms with a good reputation such as GAFRD's Barseek fish farm, or sourcing wild 'pure strain' fish from Upper Egypt or Lake Nasser. The development of improved Abbassa strain Nile tilapia by WorldFish offers a unique opportunity for the industry. Research trials indicate that 9th generation Abbassa stock grows at least 30% faster than the best Egyptian commercial strains (**Rezk *et al.,* 2009**).

The small-scale nature of hatcheries (average 10 million seed/year) could present problems for the dissemination strategy as the new strain will have to be introduced to many (several hundred) hatcheries and from there to several thousand fish farms to have a significant impact across the Egyptian industry. The study found that hatcheries aimed to replace around 30% of their broodstock each year but have difficulty replacing their broodstock. Thus, there is a clear window of opportunity for tilapia 'improved strain'broodstock to become the default supply of new broodstock as long the hatcheries can be convinced that they are the best choice and they can be supplied at a competitive price. Of course, the partner broodstock multiplication centres must also be able to make profits from supplying mixed sex broodstock, which will be a new business for them.

Catfish and mullet

Catfish aquaculture is constrained by the availability of catfish fingerlings, with the main current source being wild-caught fingerlings. Hatchery production of this species is more challenging and requires higher levels of investment than tilapia so will require dedicated facilities and staff.

At present, the sustainable supply of mullet fingerlings is at grave risk. It is almost totally dependent on catches by fishers who are operating illegally (**Saleh, 2008**), there is no control over quality and the stock may well be overfished, threatening the future supply of fingerlings for the industry and recruitment in the fishery. Although previous attempts at setting up mullet hatcheries were not successful, it

may be worth re-evaluating the situation in the light of the increasing price for mullet fingerlings.

The role of Producers' Organizations

The hatchery sector faces many problems that need to be addressed by legislators. This problem is also shared by the wider aquaculture sector and highlights the need for a representative organisation for Egyptian fish farmers that can address these issues at the highest level.If there are around 440 hatcheries and around 6000 farms, there will need to be several tiers of organisation between the producers and the apex body, starting with local groups (20-30 members) who provide representatives to regional committees (each representing 20-30 groups,) who in turn supply representatives to a national committee. This would ensure that the apex body truly represents the needs of its members and provides a committed membership base to sustain the activities of its representatives.

Of course the most difficult thing will be convincing producers that they stand to benefit from joining a producers' organisation and paying membership dues to fund its operating costs. In Fayoum, the main incentive for establishing the PO appears to be reducing input costs through collective purchasing of feed however there are a wide range of other benefits that could be provided by POs including political lobbying for the sector, collective marketing, providing market information, developing processing operations and providing professional services such as consultancy advice, insurance, pensions, etc.

Statistics, registration and licensing

It is impossible to plan the development of the aquaculture industry without reliable statistics. Unfortunately, current GAFRD statistics are based on estimates. One of the main problems is that most hatcheries and fish farmers are not officially registered or licensed so there is no way to collect information on their activities.Effective producer organisations could help in the process of registration and data collection. However, GAFRD must remain responsible for compiling official government statistics. It also appears that there is little enthusiasm from the authorities to enforce registration and licensing.It would be worth comparing the situation in Egypt with other countries that have managed to address this issue. There is need to promote the development of POs, from the local level through to the development of a representative national body. Lessons can be drawn from the experiences of the Fayoum aquaculture producers' organisation and producer organisations from other sectors.

CONCLUSIONS

Most tilapia hatcheries are not officially registered and the majority are producing all-male, sex reversed Nile tilapia. A typical hatchery produces 10 million seed per year and sells most of it as fry rather than as fingerlings. It employs around 5 staff,

over half of whom are below 30 years old, and generates revenues of LE 337,000 / year. Even though seed prices have dropped in recent years, they are still very profitable businesses with average net profits of 44% of sales and average value added of LE 28,055 per million fry sold. Most hatcheries sell tilapia seed directly to production farms, or are part of combined hatchery-production farm operations. However a proportion is sold through fry/fingerling traders whose main activity is often selling wild-caught mullet seed to production farms.

The economic significance of other types of fish hatchery operations is much less important as carp aquaculture operates mainly in the public sector, and Government-owned aquaculture operations have struggled during the recent period of instability while catfish and seabass and sea bream aquaculture have yet to expand to a significant scale.

Mullet aquaculture plays a very valuable role in Egypt's aquaculture sector. It is recommended to carry out a feasibility study on hatchery production of mullet fry. Catfish could play a very important role in Egyptian aquaculture however production is currently limited by fingerling supplies (both wild-caught and hatchery produced). There is need for capacity building on catfish spawning for both public and private hatcheries.

The Egyptian fish hatchery sector has expanded rapidly however there are few consultants or veterinarians provide advice and support in the field. Hatcheries and producers also need experienced specialists who can provide timely, on-the-spot advice during a crisis or to help fish farmers avoid problems in the future. It is recommended to develop a cadre of private-sector technical specialists (water quality, fish health, pond management) to assist producer organisations and fish farmers in the country.

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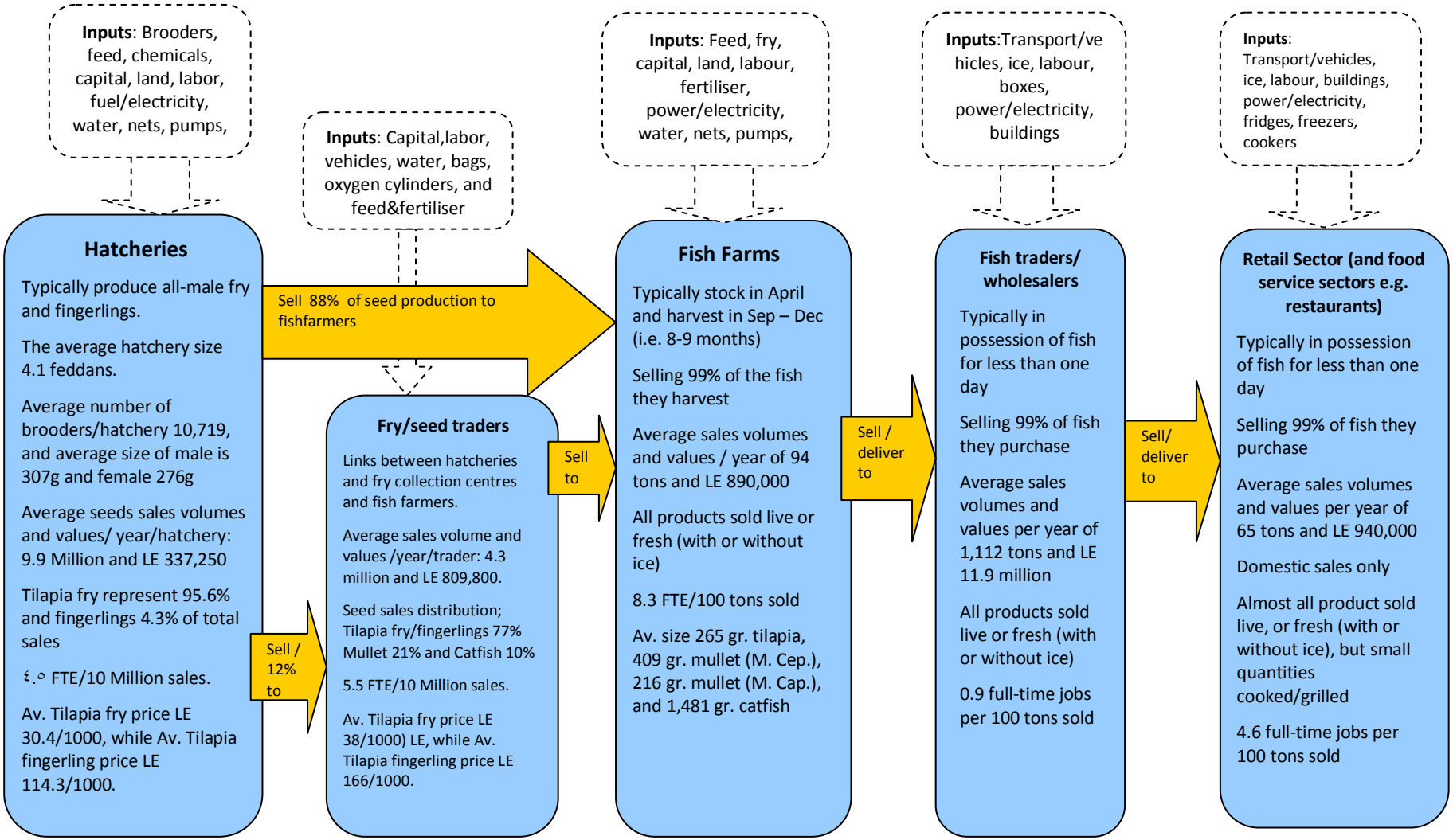
Annex 1: Integrating Seed Value Chain into the Egyptian Aquaculture Value Chain



Soure: Modified from Egyptian Aquaculture Value Chain (**Macfadyen *et al.*, 2012**).

تحليل سلسلة القيمة لمفرخات الاسماك المصرية

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ارتبط تطور الاستزراع السمكى في مصر بتوسع القطاع الخاص فى أنشاء مفرخات البلطى والتى تنتج زريعه البلطى وحيد الجنس. وللتعرف على سلسلة القيمة لزريعة الأسماك في مصر،تم عمل دراسة ميدانية تم فيها استبيان خمسين مفرخ بلطي في أربع محافظات (كفر الشيخ والبحيرة و الشرقية والفيوم). وتختلف تقنيات التفريخ المتبعة فى المفرخات، من التفريخ فى هابات فى احواض ترابية، او يتم تغطيها بالصوب البلاستيكية الى التفريخ فى تنكات خرسانية تحت صوب مع تدفئة المياه بهدف اطالة موسم التفريخ. يتم تسويق معظم انتاج المفرخ (>٩٥%) من الانتاج فى مرحلة الزريعه (بمجرد انتهاء المعاملة الهرمونية) بينما يتم تسويق (<٥%) من الانتاج فى مرحلة الإصبعيات، ويتم بيع الزريعه مباشرة الى مزارع الاسماك (وليس من خلال تجار الزريعة / الإصبعيات). بعض المفرخات تمثل جزءا من مزرعة سمكية وتنتج الزريعه بهدف توفير احتياجات المزرعة والبعض الاخر يهدف الى تسويق المنتج للمزارع المحيطة.

أظهرت الدراسة ان متوسط حجم المفرخ ٤.١ فدان . يستخدم ما يقرب من نصف عدد المفرخات شكلا من أشكال التدفئة (الشمسية تحت صوب فقط أو تدفئة المياه عن طريق غلايات تعمل بالوقود) بهدف اطالة موسم التفريخ . شملت الدراسة ٥٠ مفرخ تستخدم نصف مليون ام فى التفرخ وتنتج ٤٧٤ مليون زريعة بمتوسط سعر ٣٠ جنيه ٣٠ للالف زريعه. وبلغ انتاج المفرخات ٢١ مليون إصبعية بمتوسط سعر ١١٤ جنيه للالف. هذه الاسعار أقل بكثير من الأسعار الحالية بالمقارنة بالبلدان الأخري وانخفاض الاسعار تدريجيا خلال السنوات الأخيرة يشير الي أن هناك منافسة عالية في اسواق الزريعة.

كان متوسط انتاج مفرخ البلطي في مصر حوالي ١٠ مليون زريعة أو إصباعية ويوفر المفرخ ٤.٥ فرصة عمل (عمل كل الوقت) وكان ٥٩ % من العاملين أقل من ٣٠ سنة. وبالرغم من انخفاض أسعار الزريعة والإصباعيات وجد ان هامش الربح للمفرخات عالي نسبيا مع متوسط للقيمة المضافة ٢٨٠٥٥ جنيها لكل مليون زريعة. تجار الزريعة والإصباعيات يلعبون دورا محدوداً كحلقة وصل بين مفرخات البلطي والمزارعين. ويوفر تجار الزريعة والإصباعيات فرص عمل قليلة نسبيا (٠.٥٥ فرصه عمل كل الوقت لكل مليون زريعة مباعه) ولكن يوفر هامش ربح يعتبر مقبولا. وتم تحديد المعوقات الرئيسية للقطاع من قبل العاملين بالتفريخ ونوقشت الحلول المقترحة بالتفصيل في هذه الدراسة.