Analysis of factor costs contribution change for fingerling production of Kutum fish (*Rutilus frisii kutum* Kamensky, 1901) in Iran

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Abstract

Contribution change of factor costs analysis may help managers in decision making and in adjusting to changes. Over the last two decades, production and enhancement of kutum fingerlings have increased in Iran, reaching to more than 229 million fingerlings by 2005, but declined to 187 million from 2005 to 2008. Over the years 2002-2006, a study of fingerling production costs for kutum fish was carried out. For this purpose, a questionnaire was prepared and filled out by an expert team using data available in kutum hatcheries for fingerling production and other related departments in Iranian Fisheries Organization. Among various expenditures, the contribution cost of labor with the greatest share averaged almost 40% of total costs, followed by feed and fertilizer which averaged more than 15%. Results show, in average, the production cost of a single kutum fingerling was 100 IR Rials (US$ 0.01), which varies from almost 37 IR Rials in 2001 to 130 IR Rials (US$ 0.014) in 2004 and 157 IR Rials (US$ 0.017) in 2005. Yearly growth of a single fingerling was averaged more than 50% from 2001-2005. The results clearly indicated that over the years 2001-2005 the contribution cost of labor and "feed and fertilizer" declined, but it increased for "water and energy" and Miscellaneous. Overall, the costs sensitivity analysis of hatcheries production of kutum fingerling shows labor is the most sensitive, and a 50% decrease of this item, decreases the total cost by almost 20%.

Keywords: Kutum fish, Factor costs, Stock enhancement, Caspian Sea, Iran

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Introduction

It is essential to the successful management of a hatchery farm to know the production costs and their evolution, showing the main items on which the cost reduction is worth effort. Factor costs analysis may also help the manager in decision-making and in adjusting to changes. Basically, the production cost comprises all expenses incurred during the production process (Yasemi and Nikoo, 2010). According to Jolly and Clonts (1993), production may be defined as the process of combining resources and forces in the creation of some valuable goods to satisfy human wants and needs. The primary interest in most fisheries sectors is directed toward establishing viable industries for the purpose of stock enhancement, domestic consumption, export, employment opportunities, income distribution, or a combination of these objectives (Shang, 1981, Pillay, 1994). As Shang (1990) noted, elements such as biology, technology, feed and nutrition, engineering, fish pathology, and institutional factors all affect the economics of production. From a micro-economic view point the primary motivation of a fish farm may be profit making, but sometimes these can be other considerations such as stock enhancement (Lorenzen et al., 2001; Garaway, 1999; Pillay, 1994; Salehi, 2003_b' 2005_b, 2006). Research on the economics of hatchery production for kutum fish plays an important role in its future development (Abdolhay et al., 2010). It is clear now, to overcome the problem of declining kutum fish (*Rutilus frisii kutum)* stocks the promotion of hatcheries to produce large quantities of fingerlings for stock enhancement is certainly going to be an important strategy. Stock enhancement is practiced in many countries with different methods and various objectives, not the least of which is the reconstruction of stocks of economically important species. For example, Japan has a long history in using stock enhancement to support and rehabilitate almost 80 species (Matsuda, 2000) with varying results. Iran contributes to these efforts through the reproduction and enhancement of more than thirteen main native species, releasing more than 250 million fingerlings into the Caspian Sea and the Persian Gulf annually (Bartley, 1995; Shehadeh, 1996; Bartley and Rana, 1998; Abdolhay, 1998; Tahori, 1998; Salehi, 2003_a, 2003_b, 2005_b; PDD, 2007, 2009). As Fushimi, 2001 noted, the main issue that should be considered in any stocks enhancement plan is economic aspects. The economic advantages of stock enhancement like other aspects of population rehabilitation have been considered in recent years (Bartley, 1995, 1999; Sreenivasan, 1998; Hansson, et al., 1997; Ahmed et al., 1998; Lorenzen et al., 1998; Garaway, 1999, Salehi, 1999, 2003_a, 2005, 2008; Kitada, 1999). Some researchers emphasized the profitability of stock enhancement and stressed that in some species the rate of return of investment can be very high (Hansson, et al., 1997; Ahmed, et al., 1998; Lorenzen et al., 1998; Lorenzen et al., 2001; Garaway, 1999 ; Salehi, 2006). The natural maturation of all bony fish such as kutum fish in the Caspian Sea has faced serious problems. As noted by Razavi Sayyad (1995, 1999) the contribution from hatchery production in the Caspian Sea

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landings were estimated to be more than 95% for kutum fish. By considering the background data on stock enhancement of kutum fish and the results of fishing data, it seems the increase of the contribution of kutum fish in total catch was most probably affected by stock enhancement in Iran (Danesh khoosh Asl 1998; Salehi, 2003_a, 2003_b, 2005_b). To help the manager in decision making and in adjusting to changes, a study of fingerling production costs and their contribution change was carried out. The result of this study may play a key role in improving the productivity of hatchery production of kutum fish and its stock enhancement program.

Materials and methods

A study of fingerling production of kutum fish, input costs and the contribution of cost factors was carried out to help clarify factor cost contribution change for production of kutum fingerling. Overall, specific objectives are:

(I) To determine the costs and production of kutum fingerlings,

(II) To find the cost contribution of the input factors,

(III) To determine the cost sensitivity of main operating cost factors for hatchery production of kutum fingerlings, and

(IV) To analyze factor cost contribution change for production of kutum fingerling.

Attention is directed to addressing questions such as: which input is significant in explaining outputs? What constraints inhibit increased productivity and production of existing kutum hatchery system? The study covers the kutum hatcheries over the years of 2001-2005 in north of Iran, including Gilan, Mazandaran, and Golestan provinces. For this purpose, a questionnaire was prepared and filled out by an expert team comprising of an economist, a statistician and an aquaculturist using data available in kutum hatcheries for fingerling production and other related departments of Iranian Fisheries Organization (IFO) over the years 2001-2005. Data collection, classification and analysis cover the production years of 2001, 2002, 2003, 2004 and 2005. Two sources of data were used, primarily data were obtained through personal interviews of the manager and related experts in hatcheries, which were conducted to obtain information on resources used and the quantity of output. Other relevant documents available in different sections of Iranian Fisheries Organization specially accounting, budgeting and stock enhancement offices were also consulted. These data were supplemented with other data maintained by other affiliated departments of IFO, affiliated provincial offices of Fisheries and Iranian Fisheries research Organization (IFRO). Data were entered into a Microsoft Excel 2003 spreadsheet and methods for classification, summarizing, averaging, and other functions based on Shang, 1981, 1990; Jolly and Clonts, 2003 and Salehi, 1999, 2004, 2006 were used for analysis.

Results

Total fingerling production of kutum fish increased from 2.8 million in 1982 to more than 225 million in 2002, and then declined to 179 million by 2004. The fingerling production increased to more than 229 million in 2005. Fingerling production of kutum fish declined to 174

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million by 2006 and to 187 million by 2008 (Fig. 2). Over the years 1991-2008, in average, the contribution of kutum fish landing was more than 55% of total bony fishes landing in Iranian reach of the Caspian Sea, ranging from the highest level of more than 74% in 2008 to the lowest level of 40% in 2002 (Table 1). Yearly landing of kutum fish averaged more than 9,209 tones over the years 1991-2006, ranging from the highest level of 16,118 tons in 2006 to the lowest level of 6,417 tons in 2002 (Fig. 1). Over the years 2000-08, yearly productions of kutum fingerlings were averaged more than 186 million fingerlings. The trend line of fingerling releasing of the kutum fish shows steady growth over the period (Fig. 2).

Table 1: Total bony fishes landings and the contribution of kutum fish in the Caspian Sea over the 1982-2006

year	Total bony fishes landing (mt)	Contribution of kutum fish to total bony fishes landing (%)
1982	7924	7
1986	6296	56
1991	16335	67
1992	17260	58
1993	17629	57
1994	18638	60
1995	17981	53
1996	17638	53
1997	16698	50
1998	15611	44
1999	12804	51
2000	16863	53
2001	16378	44
2002	16200	40
2003	16573	54
2004	15665	45
2005	21845	44
2006	23802	68
2007	23538	73
2008	20046	74
Average 1991-2008	17439	55

Sources: Developed from Salehi, 2003$_a$ and PDD, 2009.

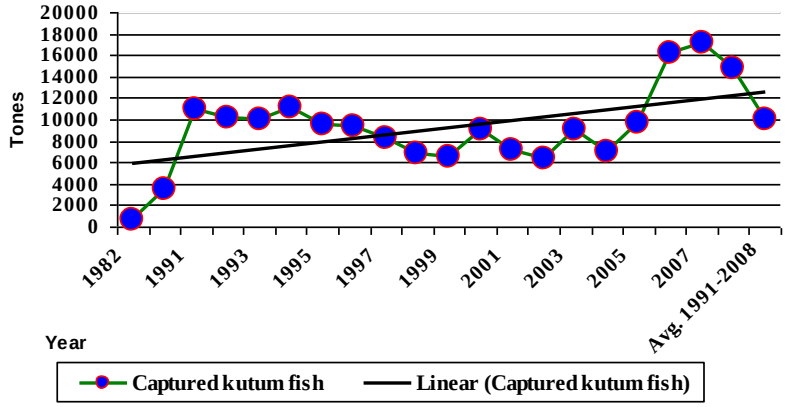

Figure 1: Total landing of kutum fish over the years 1982-2006 in Iran
Sources: Developed from Salehi, 2003$_a$ and PDD, 2009.

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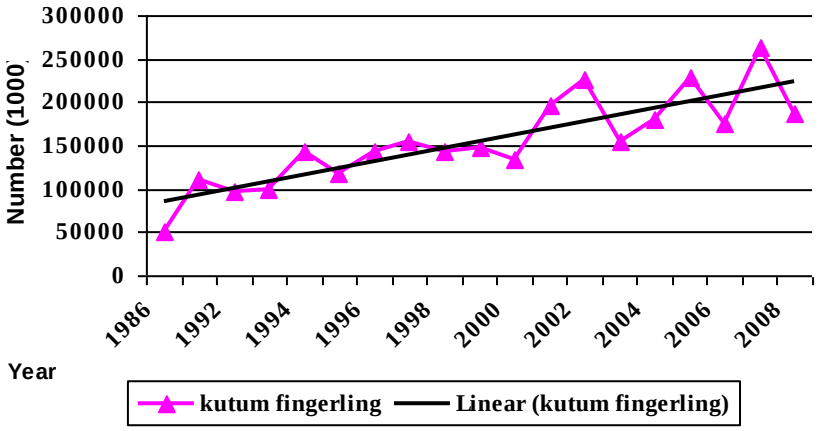

Figure 2: Number of kutum fingerling releasing over the 1982-2006 in the Iranian reach of the Caspian Sea

Sources: Developed from Salehi, 2003_a and PDD, 2009

Recent data clearly indicates, over the years 2000-08, the contribution of kutum fish to total bony fishes landing was almost 55% and its yearly fishing was averaged more than 10,710 tons. However, kutum fish landings ranged from 7,036 to 17,196 tons over the same period. Considering the stock enhancement background of kutum fish and the result of fishing data, as Table 1 shows, it seems the increase of the contribution of kutum fish in total catch in Iran was affected by stock enhancement. Over the years 1995-2008, the steady growth of fingerling enhancement for kutum fish in the South Caspian Sea is shown in Figure 2, fish landing data along the Iranian parts of the Caspian Sea clearly indicates the success of stock enhancement programs over the period (Figs. 1 and 2). Over the years 1995-2006, total captured fish of kutum was averaged 8,758 tons, however, the result of estimated captured kutum fish was averaged 9,637 tons, though difference between the two statistics are negligible and less than 10% (Fig. 3).

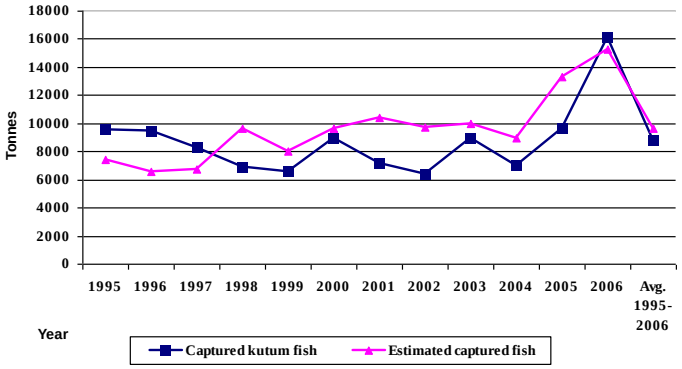

Figure 3: Total landing and estimated capturd fish of kutum over the years 1995-2006 in Iran.

Sources: Developed from Salehi, 2003_a and PDD, 2007.

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In 2005, of 9,631 tons of kutum fish landings, 56% belongs to the province of Gilan, followed by 39% in the province of Mazandaran, and the balance was produced by Golestan province (Table 2). Over the years 2000-06, yearly fishing of bony fishes was averaged more than 18,500 tons. 45%of those landings belong to the province of Gilan, followed by 38% in the province of Mazandaran, and the balance was produced by Golestan province (Table 2).

Table 2: Total landing of bony fishes in the north provinces of Iran over the years 2000-2006.

Year / Province	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*Average yearly*	*Provinces contribution %*	*SD*
Gilan	10110	8410	8320	6686	5704	9211	10342	**8398**	**45**	**1873**
Mazandaran	5840	4837	5280	7983	6046	8316	11025	**7047**	**38**	**2242**
Golestan	3050	3253	2600	1903	3914	4318	2435	**3068**	**17**	**1031**
All	19000	16500	16200	16572	15664	21845	23802	**18513**	**100**	**3737**

SD: Standard deviation.
Sources: Developed from Salehi, 2003_a and PDD, 2009

As Table 3 shows, in 2005, total costs per kutum fingerling production was averaged 157 IR Rials ($US 0.017) in Iran, though compared with 2004, in average, total costs per kutum fingerling production increased to more than 20%. The average cost for labor was 59 IR Rials and was averaged 38% of total costs. The other main costs are the cost of 'feed and fertilizer', ‘maintenance’ and ‘depreciation’ averaging 15%, 11% and 8% of total costs respectively. The cost of harvesting and post harvest averaged only 8% of total costs.

Table 3: Average factor costs for kutum fish fingerling production over the 2001-2005 in Iran.

Year / Factor cost	*2001*		*2002*		*2003*		*2004*		*2005*		*Mean*	
IRRials	IRR	*% of total cost*	IRR	*% of total cost*	IRR	*% of total cost*	IRR	*% of total cost*	IRR	*% of total cost*	IRR	*% of total cost*
Labor	16.5	*45.1*	24.8	*46.4*	41.7	*34.4*	54	*41.5*	58.9	*37.6*	39.2	*39.4*
Feed & Fertilizer	5.9	*16.1*	7.6	*14.2*	20.3	*16.7*	18	*13.8*	24.3	*15.3*	15.2	*15.3*
Harvesting & Post harvest	3	*8.2*	4.4	*8.2*	10.7	*8.8*	10	*7.7*	12.8	*8.3*	8.2	*8.2*
Water & Energy	0.7	*1.9*	1.2	*2.2*	10.3	*8.5*	7	*5.4*	9	*5.7*	5.6	*5.6*
Maintenance	3.5	*9.6*	5.6	*10.5*	19.9	*16.4*	13	*10*	18.7	*11.4*	12.1	*12.1*
Miscellaneous	2.2	*6*	4.2	*7.9*	11.9	*9.8*	16	*12.3*	20.6	*13.4*	11	*11.1*
Depreciation	4.8	*13.1*	5.6	*10.5*	6.5	*5.4*	12	*9.2*	12.6	*8.3*	8.3	*8.3*
Total cost	36.6	*100*	53.4	*100*	121.3	*100*	130	*100*	156.9	*100*	99.6	100
% growth	-	-	-	*46*	-	*127*	-	*7*	-	20.7		
Average yearly growth over the 2001-2005	-	-	-	-	-	-	-	-	-			*50*

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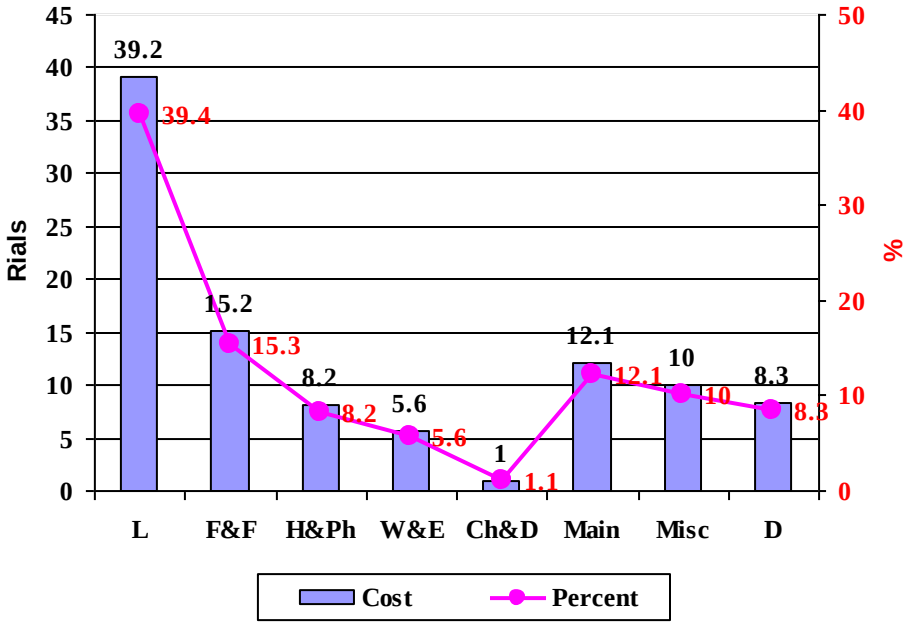

Figure 4: Average costs (IR Rials per fingerling) of kutum fish fingerling production over the years 2001-2005 in Iran

L: Labor, F&F: Feed & Fertilizer, H&Ph: Harvesting & Post harvest, W&E: Water & Energy, Ch&D: Chemical & Drugs, Main: Maintenance, Misc: Miscellaneous and D: Depreciation.

As Figure 4 shows, over the years 2001-2005 among the various expenditures, contribution cost of labor with the greatest share averaged almost 40% of total costs, followed by feed and fertilizer which averaged more than 15%. Results show, in average, the cost of production of a single kutum fingerling was 100 IR Rials (US$ 0.01), which varies from almost 37 IR Rials in 2001 to 157 IR Rials (US$ 0.017) in 2005, however, its yearly growth was averaged more than 50% over the years 2001-2005 (Table 3). While total fingerling production of kutum fish decreased from 229 million in 2002 to 155 million in 2003, total cost per fingerling production increased to more than 127% from 53.4 IR Rials in 2002 to 121.3 IR Rials in 2003. Overall, the contribution cost of labor and "feed and fertilizer" were declined, but for "water and energy" and Miscellaneous were increased over the period.

The cost sensitivity of hatcheries production of kutum fish shows labor is the most sensitive, and a 50% decrease of this item, decreases the total cost by almost 20%, followed by feed and fertilizer cost (Fig. 5). This result suggests that, the productivity of fingerling production of kutum farm is closely related to the productivity of labor, followed by feed and fertilizer.

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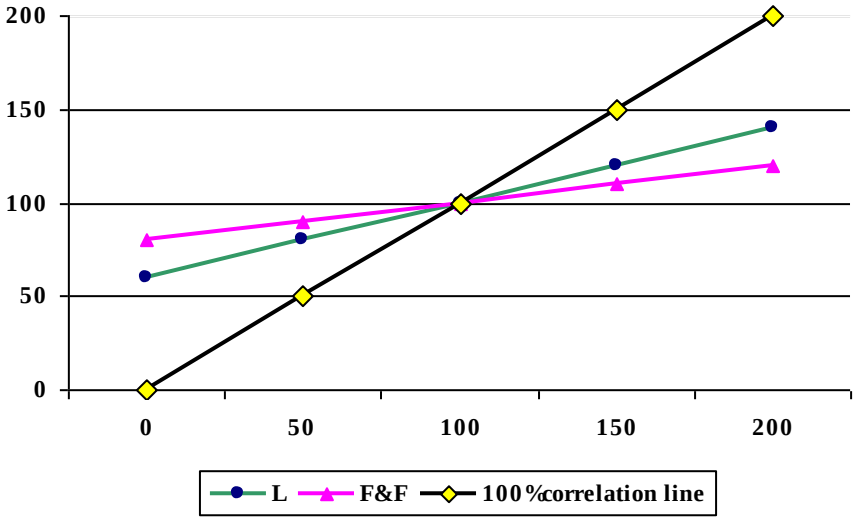

Figure 5: The cost sensitivity analysis for fingerling production of kutum fish in Iran

Discussion

Stock enhancement has many socio-economical and environmental advantages and many researchers have discussed the positive effects of stock rehabilitation for sturgeon and bony fish in Iran (Abdolhay 2006, Danesh khoosh Asl 1998, Ghaninejad et al., 1998, 1999, 2000, 2001, 2002, Hosseini, 1998, Pourkazemi, 1999, 2006, Keyvan, 2002, Abdolmaleki and Ghaninejad 2008 and Moghim et al., 2006). The importance as well as benefit return of hatchery enhancement and its opportunities for resource reconstruction were also discussed worldwide (Pillay, 1990; Bartley 1999; Sreenivasan, 1988; Salehi 2006, 2008; Ahmed et al., 1998; Lorenzen et al., 1998, Garaway 1999, Kitada, 1999 and Lorenzen et al., 2001 and Rosenthal et al., 2006). Over the years 1991-2006, fish landing data after the establishment of various hatcheries of kutum fish along the Iranian parts of the Caspian Sea clearly indicate the success of stock enhancement programs over the period (Figs. 1, 3). However, natural maturation of kutum fish in the Caspian Sea has faced serious problems, but the steady trend line of kutum fish landings over the last 15 years might the result of steady growth of its stock enhancement programs. As shown in this study, the major cost in kutum fish hatcheries was labor, which averaged 40 IR Rials (almost $US 0.004) for each fingerling, followed by feed and fertilizer, which were averaged 18 IR Rials in 2004. Compared with other farm production activities, the share of labor cost in kutum hatcheries was very high, which is for carp farming 12%, trout farming 13%, shrimp farming 17% and shrimp hatcheries due to using foreign experts 26 % noted by Salehi (Salehi, 1999, 2003_b, 2005_a, 2005_b). It seems, the main reason for this higher labor cost, could be justified by inactivity of hatcheries during the few months off season, which could be reduced by adopting extra activities in such hatcheries. However, the contribution change of production factors for Fingerlings of

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Kutum Fish showed over the years 2001-2004 that the contribution cost of labor and "feed and fertilizer" were declined, but for "water and energy" and Miscellaneous it was increased. This result clearly indicates the improvement productivity for two main factor costs over the study period. The importance of stock rehabilitation in general, and kutum fish enhancement in particular as a means of biodiversity preservation, and as a source of socio-economic activity has been addressed in this paper. Current production and enhancement of kutum fingerling and a huge investment expended by IFO suggest that this sector might be expected to become increasingly important in the coming years. Future fingerling production of kutum fish vary widely and will be to a large extent dependent on the ability to obtain brood fish from the Caspian Sea as well as government potential investment. Overall, the kutum fish rehabilitation industry may benefit from research aimed at developing technically viable production and enhancement systems as did before, improved nutrition, genetic improvement, disease prevention, water quality and industry management. It seems, co-operation of beach seine net co-operatives could be engaged in the kutum fish industry chain and their roles might be expected to have an important effect on stock enhancement and biodiversity preservation of kutum fish in the coming years. Considering 8.3% fingerling return, (however, before 1998 it was more than 8.3%) aged 3.7 and with 815 gr. weight for each kutum fish (Razavi Sayed, 1995, 1999) it might be expected that more than 19, 016, 130 kutum fish will be returned by 2008 and total meat might be around 15,500 tones, with 15% growth rate per year for wholesale price of kutum fish as for the years 1993-2001 and 2001-2005 (PDD, 2002, 2005, 2006, 2007, 2009). The whole sale price of 15,500 tons of kutum fish might be accounted around 1,100 billion IR Rials (US$ 116 million). The results mean that this US$116 million came from less than US$ 320,000 which was only used for stock enhancement in the production year of 2004. The quantity return of kutum fish might be expected 9,637 tons for 2007 (Fig. 3). Other benefits of stock enhancement of kutum fish such as food security, employment, resource preservation and etc. must be added to the result. The questions are: is the sea safe and clean for kutum fish and what needs to be done to reduce all human affected pollution? Is it possible to stop illegal catching? Who will be responsible? Who will answer? Is 15,500 tons kutum fish attainable? Overall, from the economic point of view, the results of this study indicate that the hatchery production of kutum fish is profitable and could present a developing policy for increasing the productivity and breeding procedure of hatchery production in Iranian reach of the Caspian Sea including; Gilan, Mazandaran and Golestan provinces. However, for enhancements to achieve their full potential and provide benefits on a sustainable basis, improvements are required in both policy and research support, particularly on national and regional basis.

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تحلیل تغییر سهم نهاده های تولید بچه ماهی سفید *Rutilus frisii kutum* Kamensky, 1901 در ایران

حسن صالحی*

چکیده

تحلیل تغییر سهم عوامل هزینه تمام شده ممکن است در تصمیم سازی و تنظیم تغییرات به مدیر مزرعه کمک کند. در دو دهه گذشته تولید و رهاسازی بچه ماهی سفید در ایران افزایش یافت و به بیش از 229 میلیون بچه ماهی در سال 1384 رسید ، هرچند در سال 1387 به 187 میلیون عدد کاهش یافت. برای محاسبه هزینه‌های تولید و تغییر سهم عوامل هزینه و قیمت تمام شده هر عدد بچه ماهی سفید در سالهای 1381 الی 1384 پرسشنامه‌ای تهیه و توسط یک تیم کارشناسی اقدام به جمع‌آوری اطلاعات مورد نیاز از مراکز تکثیر و بازسازی ذخایر ماهی سفید در شمال ایران گردید . برای تکمیل اطلاعات از سایر واحدهای استانی و ستاد سازمان شیلات ایران نیز استفاده شد. در بین هزینه های مختلف ، نیروی انسانی با اختصاص حدود 40 درصد هزنیه کل بیشترین سهم و بعد از آن غذا و کود مصرفی با بیش از 15 درصد هزینه کل را به خود اختصاص می‌دهد. بطور متوسط قیمت تمام شده هرعدد بچه ماهی سفید 100 ریال می باشد که از 37 ریال در سال 1381 به 130 و 157 ریال در سالهای 1383 و 1384 افزایش یافته است. هر چند در طول دوره فوق قیمت بچه ماهی سالانه 50 درصد افزایش یافته است. نتایج حاصل از مقایسه عوامل هزینه درسالهای 1380 الی 1383 به روشنی نشان داد، سهم هزینه کارگر و "غذا و کود" کاهش یافت ، در صورتیکه سهم "آب و انرژی" و سهم هزینه های متفرقه در قیمت تمام شده افزایش می یابد. تحلیل حساسیت هزینه تولید بچه ماهی سفید نشان می دهد که هزینه نیروی انسانی بیشترین حساسیت را دارد و کاهش 50 درصدی هزینه نیروی انسانی می تواند هزینه کل را تا 20 درصد کاهش دهد.

واژگان کلیدی: ماهی سفید، عوامل هزینه، بازسازی ذخایر، دریای خزر، ایران.

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