An Economic Analysis of Carp Culture Production Cost in Iran

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Abstracts: Although carp is still widely sold and used in its fresh form, a range of value additions may also be observed. It is essential to know the development and management of a carp farm production costs and their evolution. In Iran, warm-water fish farming is based on common, silver, grass, and bighead carps. The carp is easy to rise in hatcheries in very large numbers at little cost, and is distributed to farmers to grow out in cultivation ponds. The common carp and the three Chinese species are often reared in polyculture. Since, the 1970_s carp farming has spread around the Caspian coasts, and farmed production reached a peak in 2001 with production of more than 28,500 tonnes. The characteristics of the carp farming industry in the three main fish farming provinces of Iran, Guilan, Mazandran[1] and Khuzestan are quite different. A study of production, costs and profitability was carried out to help clarifying carp production costs and their differences with location and farm size. Over the years 1996-97, a total number of 153 farms from the three main provinces were randomly selected, classified and studied. The results of the survey showed that the various producer provinces have different cost structures. Overall, feed and fertiliser with the highest level of variation accounted for 45% of total costs (60% of variable costs). On average, benefit-cost ratio and the rate of farmer income were closely related to location. This result suggests that farmers practice more efficiently and have better conditions in Guilan, resulting in higher farm income per ha and per kg, followed by Mazandran and Khuzestan.

Key Words: Carp culture, Production costs, Benefit-cost ratio

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[1] - In this paper, Mazandran includes Golestan province too.

Introduction

The Islamic Republic of Iran (henceforth referred to as Iran) covers an area of about 1.6 million square kilometres (Anon, 1994), and has a population of about 65 million in 2002 (Anon, 2002), distributed across the 29 provinces. Per commercial fish consumption is almost 5 kg per capita per year, less than the global average and the average for developed and developing countries. However, the limited supply from marine capture fisheries is unlikely to meet growing demand. The FAO review (1992) proposed that for the fisheries sector, this would mainly come from aquaculture, which has the largest potential for further production increase. Shehadeh (1996) has proposed the direction of effort towards the development of freshwater aquaculture and the enhancement of fish stocks (culture-based fisheries) in inland water bodies. Since carp is the predominant species in aquaculture in Iran (> 75% of production in 2001), the present study will analysis current and changing of farmed carp production specially in the main producer provinces. The objectives of this paper are:

(I)   To determine the costs and returns to farmers,

(II) To find the cost contribution of the inputs,

(III) To determine the profitability of carp farming by farm size and location,

(IV) To determine the differences in carp culture method by farm size and location.

Carp culture and its potential

The carp is a freshwater bony fish belonging to the family Cyprinidae. There are 3,000 species of cyprinids, which make up the second most important group and the most important freshwater fish species; they are found in very diverse habitats (e.g. streams, rivers, lakes, and ponds) and have a wide geographic distribution due to the intervention of man (Billard & Marcel, 1986). According to Jhingran & Pullin (1985) this group includes major species such as: The common carp (*Cyprinus carpio*), the grass carp (*Ctenopharyngodon idella*), the silver carp (*Hypophthalmichthys molitrix*), the bighead carp (*Aristichthys nobilis*) and the black carp *(Mylopharyngodon piceus)* commonly referred to as "Chinese carps"; and the catla (*Catla catla*), the rohu (*Labeo rohita*), the mrigal (*Cirrhina mrigala*) and the calbasu *(Labeo calbasu)* commonly referred to as "Indian major carps".

Other cyprinids of importance for aquaculture are the Crucian carp (*Carassius carassius*), the mud carp (*Cirrhina molitorella*), and the tench (*Tinca tinca*) (Hulata, 1995). Indian minor carps; *Labeo bata, Labeo angra, Cirrhinus reba* and *Puntius sarana* are also of importance (Jhingran, 1978). The carp is one of the most widely cultivated warm-water fishes, and has been introduced into some 81 countries (Welcomme, 1988; Holcik, 1991; Csavas, 1993&1994 and Michaels, 1994), particularly in developing countries, where, various species are grown in fertilised ponds or with low-level supplementary feeding. Common, Chinese and Indian major carps are cultured wherever traditional markets exist. However, according to Pullin (1986) their culture potential elsewhere is limited by market acceptability and lack of culture experience.

The carp occur in a wide range of freshwater habitats from clear mountain lakes to degraded rivers (Sharifpour, 1997). They are found in lakes, large and small rivers, large reservoirs, shallow ponds, still pools, swamps and bogs, large slow-moving rivers, fast-flowing streams and even some tidal and torrential rivers, creeks, underground water sources, and estuaries (Panek, 1987 ; Michaels, 1988). Pillay, 1990 & 1992; New, 1991; Horvath *et al.*, 1992; Rath, 1993; New & Csavas, 1993; Biro, 1995; Billard & Gall, 1995; Jeney & Jeney 1995; Billard, *et.al.*, 1995 and Varadi, 1995 noted world-wide progress in the culture of carp spieces. Rusydi and Lampe (1990) indicated that the basic inputs of feed and seed constitute the principal cost of operating a carp farm. According to Pillay (1990) the economic viability of carp culture has never been in doubt, in areas where there is a market for carp and appropriate technologies are used. According to Hoq *et al.* (1993) polyculture of grass, silver and mirror carp with (*Macrobranchium rosenbergii)* is more profitable.

Carp culture and its market in Iran

In Iran, carp farming was started about 30 years ago (Azari Takami, 1984), initially as an attempt at hatching of Chinese carp, for which the first generation was imported from Romania. Carp culture initially focused on the Caspian Sea littoral, where the local farmers constructed fish ponds beside their paddy fields. Activities expanded quickly into Guilan and Mazandran provinces.

It has undoubtedly seen great success over the last decade, production rising from less than 12,000 t in 1986 to more than 53,000 t in 2001 (Anon., 1997$_a$ and Anon., 2002). Though, the potential of carp culture to expand may be apparent, it may be constrained by market demand and producer profitability. How then can its expansion be guided in an effective manner to avoid wasting resources? In terms of total production, the aquaculture sub-sector is as yet relatively unimportant in comparison with capture fisheries, and small in comparison with many other Asian countries. However, the share of aquaculture and inland fisheries to total fishery production in Iran has increased from 6% in 1973 to 9% in 1986, to more than 15% by 1995 (Anon., 1996 & 1997 and Anon., 1997$_b$) and 19% by 2001(Anon., 2002). In 2001, national production, from both aquaculture and inland fisheries, was 73,465 t of which 25,785 t derived from natural and artificial water bodies and 28,060 t from warm-water fish farming, mostly carp, consisted of 25% common, 7% grass, 5% bighead and 63% silver carp and 12,170 t from coldwater fish farming, mostly rainbow trout, and 7,630 t from cultured shrimp (Anon., 2002). According to the recent statistics (Anon., 1997$_b$ and Anon., 1998 & 2001) production has grown from 1,414 t in 1973 to 33,680 t in 1988, to 52,980 t in 1995 and to 73,465 t in 2001.

In Guilan and Mazandran harvesting starts in September, but in Khuzestan it may be two or three months later. The standard marketable size for carp is about 1 kg in weight, and some farmers may delay their harvesting up to November, or even December to achieve larger sizes and potentially better prices. However, this delay is constrained by additional cost, and most farmers, except a few with large farms and high capital investments, are unable to do so. Harvesting is by draining water from the pond or by using a net, and is usually carried out by the farmers. Buyers are usually responsible for transporting the fish into the market. The majority of farmers harvest only once annually per pond, or even once per farm, but very large ponds or large farms may require more than one harvest (Salehi, 1999).

A variety of market outlets ranges from local fish markets, wholesalers within each province, the co-operatives or wholesalers at Tehran are excluded the wholesalers within the provinces, mostly in Guilan and Mazandran, have often provid credit to the farmers (Salehi, 1999). As Figure 1 shows, in Guilan province,

overall, 50% of carp production is sold to wholesalers at Rasht, 15% to the Langarod fish market, 10% to the Anzali and the balance is sold to local market at Tehran. The wholesalers at Rasht transport and sell some 50% of their carp to wholesalers in Tehran (Salehi, 1999).
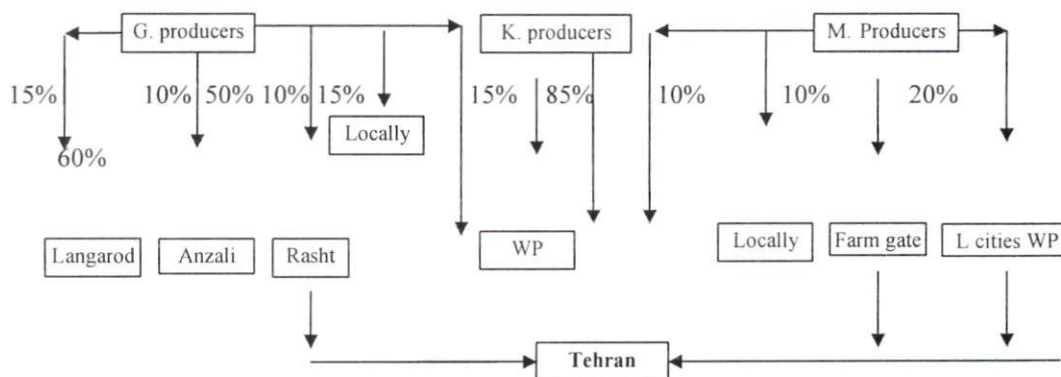

Figure 1: Carp marketing outlets in main provinces of Iran

WP: Within province, L cities WP: Large cities within province
G: Guilan province, M: Mazandran province, and K: Khuzestan province
Sources: Caculated from sample data; Salehi, 1999 and completed
from FAO, 1992,

In Mazandran province, more than 60% of cultured carp is sold to wholesalers in the large cities of the province, though small farmers may sell their fish in the local market, and 20% of cultured carp is sold in auction at the farm gate. A small amount of the fish sold by auction in wholesalers or at the farm gate are, transported to Tehran. In Khuzestan province more than 85% of carp production is sold to wholesalers in Tehran, less than 10% sold at Ahwaz, and the balance is sold in local market.

Production subsectors

It is necessary to identify and distinguish different types of carp farm economies. According to FAO (1992), the characteristics of the carp farming industry in the three main fish farming provinces, Guilan, Mazandran and Khuzestan are quite different. For almost 20 years, carp has been considered a

subsistence food, particularly in Guilan, but also in Mazandran, and is a preferred food item by a majority of people in these provinces. Induced by the decline of fish availability from the Caspian Sea, and supported by the Government, carp culture initially developed in Guilan, followed by Mazandran during the last decade. The number of farms in the three main provinces, based on size and location are shown in table 1. More than 95% of farms are located in the Caspian area, in Guilan 67% of farms are less than 1 ha and 95% are less than 5 ha, while in Mazandran 59% of farms are less than 1 ha and 86% of farms less than 5 ha, and almost 3% of farms are larger than 20 ha. In contrast, more than 90% of farms are larger than 5 ha and 33% larger than 20 ha in Khuzestan.

Table1: Percentage share and number of farms in provinces and farm size.

Province	<1 ha		1 to 5 ha		5 to 20 ha		>20 ha		Total
	% p	% c	% p	% c	% p	% c	% p	% c	
Guilan	80	67	77	28	41	4	24	1	75
Mazandran	20	59	22	27	32	11	26	3	22
Khuzestan	0	0	1	9	27	58	50	33	more than 3
Total	63		27		7		almost 3		100

% p : as % in province, % c : as % in farm sizes,
Sources: Salehi, 1999

Fish yield can be increased with inorganic or organic fertiliser and/or supplementary feeding. The quantity, quality and methods of feed used makes a significant difference in efficiency. Polyculture is now the most common practice in carp culture in Iran.

Methodology and data
A. Study structure and methods

A study of production costs and profitability was carried out to help to clarify carp production costs and their probable differences with location and farm size. According to Shang (1981 & 1990) ; Cnningham et al. (1985); Jolly & Clonts (1993) and Salehi (1999) key production costs are not only useful for fish farmers but also for economics and policy making.

The study was developed to indicate the following elements:

(I) The characteristics of carp farms in three main provinces of Guilan,
    Mazandran and Khuzestan,

(II) Costs: including fixed and indirect operating costs, such as salary,
     insurance, maintenance, interest, and depreciation[2], which are independent
     of the level of production. Variable costs[3]: including direct operating costs
     such as seed, feed, fertiliser, chemical and drugs, labour, water and energy,
     harvesting and post-harvest, and miscellaneous costs.

(III) Income: total production, total cost of production, gross revenue,
      net return, benefit-cost ratio (net return/ total cost), cost of input per unit
      of output (kg), value of unit of output, amount of output (kg) per unit of
      land (ha), and costs of input per unit of land (ha),

(IV) Assessment of key factors affecting production costs and productivity and
     profitability of existing farming carp.

B. Study data

In designing the study, two major aspects were combined to provide a comprehensive perspective of recent years and future development. The methods used were farm surveys, supplemental questionnaires and specific case studies. Two sources of data were used. Primary data was obtained through personal interviews of fish farmers, which were conducted to obtain information on resources used and the quantity of output. The farms for questionnaire in each province were selected by stratified random sampling. Wherever core data was not sufficient, additional surveys, face to face interviews with farmers and experts, and other available data was used to ensure a representative perspective on the sector. A total of 153 farms from the three main provinces were selected. Of these, 153 farms, 81 from Guilan, 48 from Mazandran and 24 from Khuzestan were classified into four categories, $0.1 << 1$ ha, $1 << 5$, $5 << 20$ and $20 << 50$, and studied. Data on pond structure, stocking rate, species, labour, fertilisation, feeding, water and

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[2] - Depreciation and interest were calculated based on Agriculture Bank and Aquaculture Department methods for ponds, buildings and machineries and completed from Salehi, 1997 & 1999.

[3] - Imputed opportunity costs of owned inputs, such as family labour and land use are not included, but are discussed relative to comparative returns.

energy, transportation, maintenance, facilities on farm, surface area, stocking time, harvesting time, individual production of species, sale price of species, various fish production activities, market channels, and miscellaneous were recorded. Data were entered into a Borland Quattro-Pro for Windows Version 5 spreadsheet and methods for classification, summarising, averaging, and other functions were used for analysis.

Results

A. The role of location

Area and production

There is a significant difference in average area of farms. As table 2 shows, the area of farms averaged almost 6.7 ha, varying from less than 3.4 ha in Guilan to 6.7 ha in Mazandran and 19 ha in Khuzestan. The average yield was 2,873 kg ha^{-1} and there is a marked difference between the provinces. Farmers in Mazandran and Guilan produced an average 2,159 and 2,543 kg ha^{-1}, respectively, but farmers in Khuzestan produced 3,572 kg ha^{-1}. Though, in Khuzestan, production (kg ha^{-1}) is higher than the average (+24%), but in Mazandran is less than the average (-25%).

Table 2: Number of sampled farms, average area and production of farms.

Province	Guilan	Mazandran	Khuzestan
Number of sampled farms	81	48	24
Average area (ha)	3.35	6.72	19
Production (kg ha^{-1})	2543	2159	3572

Source: Calculated from sample data.

Cost structure

Costs per ha

As table 3 shows, total costs for ha were 150% greater in Khuzestan than in Mazandran and 79% more than in Guilan. Costs in Guilan were 40% more than in Mazandran.

Table 3: Annual variable and fixed costs ha^{-1} of sampled farms and their share in the representative provinces of Iran in 1996-97.

Province	Guilan		Mazandran		Khuzestan		All	
	Rial (1000)	% of total costs	Rial (1000)	% of total costs	Rial (1000)	% of total costs	Mean[a]	SD
Seed	153	5	301	14	336	6	278	97
Feed	947	31	443	20	2075	39	1283	836
Chemical fertiliser	147	5	98	5	142	3	130	27
Animal fertiliser	217	7	59	3	518	9.6	299	233
Chemical and Drugs	84	3	19	1	56	1	52	32
Fuel	28	1	35	2	54	1	42	13
Water and electricity	261	9	131	6	288	5	233	84
Harvesting & post harvest	264	9	132	6	511	9.5	331	192
Labour	91	3	89	4	153	3	117	36
Miscellaneous	58	1.9	50	2	79	1	65	15
TVC	2250	74.9	1357	63	4212	78.1	2830	1461
Salary	232	7.9	209	10	324	6	265	61
Maintenance	36	1	89	4	267	5	153	121
Interest	19	0.6	10	0	43	0.9	27	17
Depreciation	469	15.6	482	22	483	9	479	8
Tax	0	0	0	0	0	0	0	0
Insurance	0	0	17	1	44	1	25	22
TFC	756	25.1	807	37	1161	21.9	949	221
TC	3006	100	2164	100	5373	100	3779	1663

[a] - To Accounted the mean, the area of farms were also affected. SD: Standard deviation, TVC: Total variable cost, TFC: Total fixed cost, TC: Total cost.
Source: Calculated from sample data.

Variable costs averaged 75% of total costs, from 63% in Mazandran to 75% in Gilan and 78% in Khuzestan. As table 3 shows, among the variable costs, feed and fertiliser dominated all other costs averaging 45% of total cost (60% of variable costs), varying from 28% in Mazandran to 43% in Guilan and 52% in Khuzestan (44%, 58%, and 65% of variable costs respectively). Average cost of seed are 7% of total costs (10% of variable costs), varying from 5% in Guilan to 6% in

Khuzestan and 14% in Mazandran (7%, 8%, and 22% of variable costs respectively). Farmers in Khuzestan paid 60% more than the average for feed and fertiliser, while their counterparts in Mazandran paid almost one-third the average. In Mazandran and Khuzestan, farmers paid 8% and 21% more than the average for seed respectively, but their counterparts in Guilan paid 45% less than the average. Cost for labour and salary are also 25% higher than the average in Khuzestan. While cost for harvesting and post harvest in Mazandran and Guilan respectively are 60% and 20% less than the average, in Khuzestan is 50% more than the average. All operating costs per ha in Khuzestan are higher than the average, while this the case only for seed in Mazandran and water and energy in Guilan.

Costs per kg

As table 4 and Figure 2 Show, the cost per kg of carp production in Khuzestan is higher than in the two other provinces, at R 1,505 kg^{-1} followed by Guilan with R 1,183 kg^{-1}, and only R 1,001 kg^{-1} in Mazandran. Of these costs, feed and fertiliser averaged R 766 kg^{-1} in Khuzestan, R 516 kg^{-1} in Guilan and only R 277 kg^{-1} in Mazandran, while in contrast seed costs amounted to R 139 kg^{-1} in Mazandran followed by Khuzestan and Guilan R 94 kg^{-1} and 60 kg^{-1}, respectively. There is little difference in costs per kg of labour and salary. As shows, other major inputs costs are 'water and energy' and 'harvesting and post harvest'. Per kg of carp production, in Khuzestan, feed and fertiliser and harvesting and post harvest is much higher than the average, while this was the case only for seed in Mazandran and water and energy in Guilan. Though, variability of feed is higher than other operation costs, followed by fertiliser, 'harvesting and post harvest' and seed respectively.

Profitability

Profitability per ha.

Table 5 summarises the profitability of carp culture farming per ha in the provinces, as defined by following measures:

- Net return, defined as gross revenue minus total costs;
- Benefit-cost ratio, defined as net return for the farm divided by total costs,

• Rate of farm income[4], defined as net return divided by gross revenue, times 100.
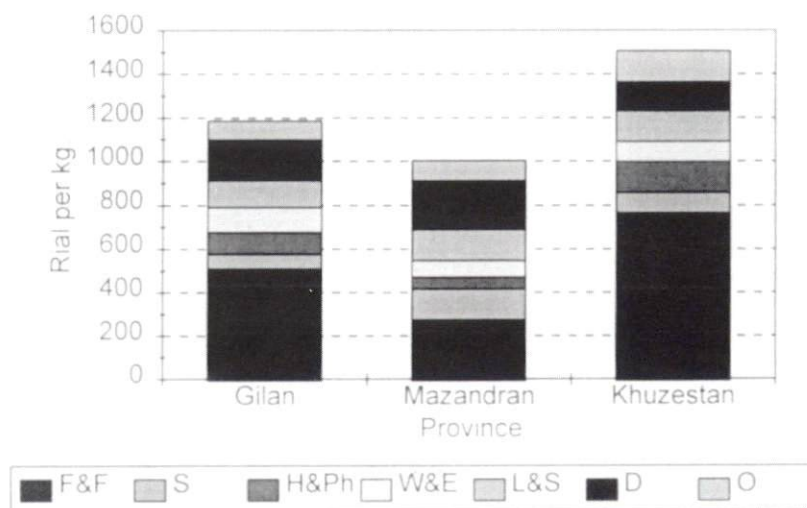

Figure 2: The major costs per kg of carp culture production in the studied provinces

F&F: Feed and fertiliser, S: Seed, H&Ph: Harvesting and post harvest,
W&E: Water and energy, L&S: Labour and Salary, D: Depreciation, and O: Others.

The net return per unit of land is higher in Guilan; at R^5 1,446,000 ha^{-1} compared with R 885,000 ha^{-1} in Mazandran and R 683,000 ha^{-1} in Khuzestan. As Table 6 shows, the benefit-cost ratio in Guilan is also higher than elsewhere; at 0.48 compared with 0.41 and 0.13 in Mazandran and Khuzestan respectively. The average rate of farm income for carp rearing is 20%; 32% for Guilan, 29% for Mazandran and only 11% for Khuzestan. Per ha variability of total costs within the Khuzestan is higher than other areas, showing differences in use of major inputs per ha, particularly feed and fertiliser, and cost of harvesting and post harvest.

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[4] - The rate of farm income is also an indicator of production efficiency, based on rate of farm income, we can see that the larger the rate of farm income, the greater the production efficiency (Lee. 1981).

[5] - USS 1 = R 3,000 at 1997 rates.(Anon., 2000)

Table 4: Annual variable and fixed costs (Rial kg^{-1}) of carp production in the studied provinces

Province	Mazandran	Khuzestan	Guilan	Mean	SD
Seed	139	94	60	97	40
Feed	205	581	373	447	188
Chemical fertiliser	45	40	58	45	9
Animal fertiliser	27	145	85	104	59
Chemical and Drugs	9	16	33	18	12
Fuel	16	15	11	15	3
Water and electricity	61	81	103	81	21
Harvesting & post harvest	61	143	104	115	41
Labour	41	43	36	41	4
Miscellaneous	23	22	23	23	1
TVC	627	1180	886	986	275
Salary	97	91	91	92	3
Maintenance	41	75	14	53	31
Interest	5	12	8	9	4
Depreciation	223	135	184	167	44
Tax	0	0	0	0	0
Insurance	8	12	0	9	6
TFC	374	325	297	330	39
TC	1001	1505	1183	1316	254

Source: Calculated from sample data.

Table 5: Production costs and returns per ha of farms in the provinces

Province	Guilan	Mazandran	Khuzestan	Average
Total costs (R 1000)	3006	2164	5373	3779
Gross revenue (R 1000)	4452	3049	6056	4719
Net return (R 1000)	1446	885	683	940

Source: Calculated from sample data.

Profitability per kg.

As table 6 shows, profitability per kg of fish culture in Guilan is also higher, followed by Mazandran, farmers in Guilan and Mazandran respectively having benefit-cost ratio of 92% and 64% more than the average.

Table 6: Costs and returns per kg of carp production in the studied provinces

Province	Guilan	Mazandran	Khuzestan	Average
Total costs (R)	1183	1001	1505	1316
Gross revenue (R)	1751	1412	1695	1643
Net return[a] (R)	568	411	190	327
Benefit-cost ratio[b]	0.48	0.41	0.13	0.25
Rate of farm income[c] (%)	32	29	11	20

[a] Equals gross revenue minus total costs, [b] Equals net return on farm divided by total costs, and [c] Equals net return divided by gross revenue
Source: Calculated from sample data.

Thus, farmers in Mazandran, although having a lower return per unit of land (ha) and per quantity of fish (kg), can produce carp at least cost. Compared with those in the northern provinces, farmers in Khuzestan produce carp at highest cost, and have the lowest return per ha of farm and per kg of fish.

B. Role of farm size
Production

The size of farm may play an important role as it may reflect the availability of capital, access to credit, and managerial ability, and the potential to operate efficiently and use resources efficiently. In the four categories used to define size, there are 58 farms between 0.1 ha to 1 ha, 44 farms from 1 ha to 5 ha, 33 farms of 5 ha to 20 ha, and 18 farms of 20 to 50 ha. As table 7 shows, there is little difference in yield between the four categories.

Table 7: Number of sampled farms and their average areas in four categories in the studied provinces

Categories	0.1<<1ha	1<<5 ha.	5<<20 ha.	20<<50 ha.	Mean
Number of farms	58	44	33	18	-
Average area in category (ha)	0.59	2.71	12.15	27.51	6.8
Average production (kg ha^{-1})	2668	2558	2969	2883	2874

Source: Calculated from sample data.

Cost structure

Costs per ha.

Major operation costs included obtaining fry or fingerling, feed and fertiliser, and labour and salary, and these varied in magnitude between the four categories. Total costs significantly increased while the size of farm increased. As table 8 shows total production costs averaged R 3,782,000 ha^{-1}, varying from R 2,751,000 in the farms between 0.1 to 1 ha, to R 4,039,000 in the farms between 20 to 50 ha. On average, the rate of feed and fertiliser was highest in the larger groups (> 5 ha), but rate of seed was highest in the smaller groups (< 5 ha).

Table 8: Annual variable and fixed costs per ha in four categories in the studied provinces
Unit: Rial 1,000

Categories	0.1<<1 ha	1<<5 ha	5<<20 ha	20<<50 ha	Mean	SD
Seed	478	428	191	299	276	129
Feed	698	666	1281	1473	1288	410
Chemical fertiliser	158	128	132	127	130	14
Animal fertiliser	158	105	225	416	301	136
Chemical and Drugs	103	83	50	42	51	28
Fuel	86	51	34	43	42	23
Water and electricity	90	179	273	224	233	77
Harvesting & post harvest	359	262	412	280	331	70
Labour	59	156	95	130	117	41
Miscellaneous	80	36	61	74	65	20
TVC	**2269**	**2094**	**2754**	**3108**	**2834**	**464**
Salary[a]	0	272	304	250	265	139
Maintenance	53	71	177	159	153	62
Interest	15	28	32	22	27	7
Depreciation	414	542	481	467	478	52
Tax	0	0	0	0	0	0
Insurance	0	7	22	33	25	15
TFC	**482**	**920**	**1016**	**931**	**948**	**241**
TC	**2751**	**3014**	**3770**	**4039**	**3782**	**611**

[a] Farms less than 1 ha are located in Guilan and Mazandran provinces and opportunity cost for manager is based on family labour, that was not accounted here.
Source: Calculated from sample data.

Costs per kg.

As table 9 shows the major cost in all categories is feed and fertiliser, which averaged R 699 kg^{-1} in the largest group and R 351 kg^{-1} in farms between 1 to 5 ha. Fry/fingerling cost averaged from R 179 kg^{-1} in the small group to R 64 kg^{-1} in farms between 5 to 20 ha. Labour and salary cost averaged R167 kg^{-1} in the farms between 1 to 5 ha to R 22 kg^{-1} in small farms. The other main costs are 'harvesting and post harvest', ' depreciation' and 'water and energy', which show little differences between the studied groups.

Table 9: Annual variable and fixed costs per kg of sampled farms in four categories in the main provinces   Unit: Rial kg^{-1}

Categories	0.1<<1 ha	1<<5 ha	5<<20 ha	20<<50 ha	Mean	SD
Seed	179	167	64	104	96	54
Feed	262	260	431	511	448	126
Chemical fertiliser	59	50	44	44	45	7
Animal fertiliser	59	41	76	144	105	45
Chemical and Drugs	39	32	17	15	18	12
Fuel	33	20	11	15	15	9
Water and electricity	34	70	92	78	81	25
Harvesting & post harvest	134	102	139	97	115	22
Labour	22	61	32	45	41	17
Miscellaneous	30	14	20	26	23	7
TVC	851	817	926	1079	987	116
Salary	0	106	102	87	92	50
Maintenance	20	28	60	55	53	20
Interest	6	11	11	8	9	2
Depreciation	155	212	162	162	166	26
Tax	0	0	0	0	0	0
Insurance	0	3	7	11	9	5
TFC	181	360	342	323	329	82
TC	1032	1177	1268	1402	1316	156

Source: Calculated from sample data.

Cost of feed and fertiliser per kg of production is 17% higher than average in the larger group, while on average in the two smaller groups is 40% lower than the average.

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Profitability

The highest cost per ha are found in the largest group, while the smallest group has the highest net return. As shown in table 10, the average net return is R 940,000 per ha, varying from R 2,207,000 in the smallest group to R 587,000 in the largest group.

Table 10: Production costs, gross revenue and net return per ha in sampled farms in four categories Unit: Rial 1,000

Categories	0.1<<1 ha	1<<5 ha	5<<20 ha	20<<50 ha	Mean
TVC	2269	2094	2754	3108	2834
TFC	482	920	1016	931	948
TC	2751	3014	3770	4039	3782
Gross revenue	4958	4036	5017	4626	4722
Net return	2207	1022	1247	587	940

Source: Calculated from sample data.

As table 11 shows, the costs of carp production per kg significantly increased while the size of farms increased. The average net return is R 327 per kg, varying from R 826 per kg in the smallest group to R 203 per kg in the largest group. The benefit-cost ratio and farm income are closely related to farm size (table 11). This means that the small farms practice more effective farming, which results in higher farm income per hectare and per kg. The benefit-cost ratio and the rate of farm income decreased as farm sizes grew (the difference between two middle groups are negligible).

Table 11: Benefit-costs ratio and rate of farm income per kg of carp production in four categories in the studied provinces

Remark/Category	0.1<<1 ha	1<<5 ha	5<<20 ha	20<<50 ha	Mean
TC R kg^{-1}	1032	1177	1268	1402	1316
Gross revenue R kg^{-1}	1858	1574	1690	1605	1643
Net return (Benefit) R kg^{-1}	826	397	422	203	327
Benefit-Cost Ratio	0.80	0.34	0.33	0.15	0.25
Rate of farm income (%)	44	25	25	13	20

Source: Calculated from sample data.

Discussion

In Iran, it appears that over the last decade demand for carp products is initially increasing as a result of a relative decline in the Caspian bony fish catch, and increasing in urbanisation, population and economic growth (Salehi, 1999). Nash (1997) noted that bony fish production appears to be levelling off, and according to FAO (992); Sehadeh (1996) and Nash (1997) aquaculture is a key factor in the national strategy for increasing fish production in Iran. The result from data obtained from the three studied provinces quite clearly demonstrate that carp farming is a profitable activity with an average of 20% rate of farm income. The results of the survey also showed that the various producer provinces have different cost structures, depending on availability and quality of inputs, farm management, climate, area of farms and other factors. The cost of inputs in Khuzestan (per ha and per kg) were higher than elsewhere, apparently due to higher cost of feed and fertiliser; use of animal fertiliser was more than fivefold that in Mazandran. As noted by FAO (1992) and Salehi (1999) apart from the absence of a well defined fertilisation programme, the farmers in Khuzestan flush water through their ponds and as a consequence additional feed and animal fertiliser has to be applied. In Guilan, where carp culture is older, and farmers have smaller farms and may manage ponds on an ad hoc basis, they usually use agricultural wastes as feed and fertiliser. In Khuzestan seed prices are much higher as most fry/fingerling come from Guilan hatcheries and thus include transport cost, as well as allowing for higher mortality combined with high stocking rate, thus increasing the cost. The relative higher cost of seed in Mazandran is due to the use of larger size seed, mainly coming from Guilan..

Increased cost of harvesting and post harvest in Khuzestan is likely to be due to the greater distance of potential markets.

Feed and fertiliser productivity is usually considered as important indicator of the level of efficiency of carp farming production. Feed and fertiliser productivity of farms in the Caspian Sea littoral is higher than that in Khuzestan (for feed more than twofold and for fertiliser almost fourfold). This suggests that, the productivity of carp farming in different locations is closely related to feed and fertiliser productivity. However, additional costs and reduced revenue per kg (due to single harvesting season and supplying large quantity of product in markets over a short

time period) reduced the profitability. As noted by Smith (1981); Cunnigham *et a.* (1985); Bjorndal (1987,1988 & 1990); Pillay (1990 & 1994); Hatch & Kinnucan (1993); Jolly & Clonts (1993); Muir (1995); Muir *et al.* (1995) and Nash (1995), development objectives of farmed production depends on its profitability, and increases in yield, reduction in costs and increases in price of product were the major means of increasing profit. However, many researchers such as Shang (1981 & 1990); Cunningham *et al.* (1985); Shaw (1988); Jolly & Clonts (1993) and Muir (1995) explained that economies of scale will confer the benefits of low-cost production on the large farms, by opposite, in Iran, comparing, farms < 5 ha with farms >5 ha, smaller farms due to their use of agricultural wastes, had smaller costs per unit of land and per quantity of fish. However, these were mainly located in the Caspian Sea zone with longer history and experience on carp farming. Comparing, farms < 5 ha with farms >5 ha, seed cost also declined as farm size increased. This appears to be mainly due to influence of farms in Mazandran, which had the highest cost. Except the farms between 0.1 to 1 ha which used family labour, the cost of labour and salary declined as the size of farm increased. Thus, it appears that the economies of scale for these inputs may be relevant. Except for the smallest farms, as noted, cost of labour and salary[6] declined as the size of farm increased, and productivity of human resource were positively related to size. Except for feed and animal fertiliser, water and electricity, economies of scale may be relevant, and, the lack of knowledge in farm management may have a more negative impact on feed and fertiliser productivity. It is evident that feed and fertiliser play a very important role in carp production and its profitability. It is expected that production of carp in the Caspian Sea area will become more intensive and will increase in the next few years, particularly in Guilan, where there is a good demand for carp products, farm profitability is higher than elsewhere, and there is a limitation for land to expand carp area. Other areas are also likely to commence production, but production growth in Khuzestan will depends on productivity growth of feed and fertilizer.

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[6]- The cost of labour and salary averaged R 149 kg^{-1} in farms of 1 to 50 ha. If this is added the costs of farms <1 ha, per kg costs of production are estimated at R 159 kg^{-1}, very near to those of farms between 1 to 5 ha (average R 167 kg^{-1}).

Conclusions and recommendations

Overall, the present level of using feed and fertiliser seems to be extremely high and it may need to be reduced (or product in kg ha^{-1} increased) in the coming years. Otherwise, future production vary widely and will be to a large extent dependent on the ability of producers to reduce production costs and on the potential for markets to be developed, as has been the case elsewhere, where development has arisen through on acceptable of market opportunities and technical feasibility (Muir, 1995; Roberts & Muir, 1994 and Muir *et al.*, 1995). In the short term, in order to expand cultured carp production, it may be necessary to increase technology and/or improve the management skills, developing and applying methods that can cope with restrictions of reduced resources, increased quality control and reduced resource quantity.

With regard to the government policy toward carp farms, the government should assist farmers, especially those in Khuzestan province and larger farms in Guilan and Mazandran, with high operating costs, particularly feed and fertiliser costs, insufficient knowledge and inadequate management. Appropriate short-term credit[7] schemes, applied research, an effective extension services related to the problems of share of each species for production, size and amount of seed per unit area, methods of rearing, feed and fertiliser use, farm preparation, diseases control and water management are initially necessary. It might be necessary to promote low-cost technologies for carp production as well as providing institutional and policy support to enable poor households to gain access to resources and adopt carp culture. These would be significantly important for small-scale production in most of the rural areas. The availability of natural resources in Khuzestan are most attractive for future expansion, and a development strategy may be focused here,

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[7] - According to Anon. (1999), national policy will help new co-operatives and investors to expand the number and area of farms. Considering financial conditions of co-operatives and other investors, particularly younger co-operatives and those small-scale operation in rural areas, based on Shilat suggestions, government was establishing credit facilities for carp farming enterprises through Governmental banks. However, at present, carp farming is profitable, but additional credit may still be required and this policy may help new enterprises to operate, particularly in the short term. Though, Government has made provision for loan funding by annual Plans under particular Articles with low interest rates. This policy may also be necessary to enable existing carp farming to increase production and become more efficient.

the main constraint being the higher cost of production and low profitability of farms.

Through improved feed quality and farm management, Khuzestan and the largest farms in Guilan may become more attractive. With moderate natural resources and profitability, development is also suitable in Mazandran. The choice of development strategy will depend on both location and profitability. However, it is expected, that increased hatchery production in Mazandran and Khuzestan will reduce the cost of seed. Though, reduction in major variable costs, such as feed and fertiliser, seed and labour, harvesting and post harvest and energy, as well as main fixed cost (construction[8]), increase production per unit of land, associated with increased stocking rate, survival rate, good pond management, growth rate, and increased price per quantity of fish by aiming at higher valued production may all increase carp farm profit. Despite higher production per unit of land, the present profitability of carp farming in Khuzestan may not be acceptable in the longer term.

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[8] - Investment required to establish a carp farm (almost 20 ha) increased from R 5 million per ha in 1992 to R 15-18 million per ha in 1996.

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