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The Milkfish Broodstock-Hatchery Research and Development Program and Industry: A Policy Study

Danilo C. Israel

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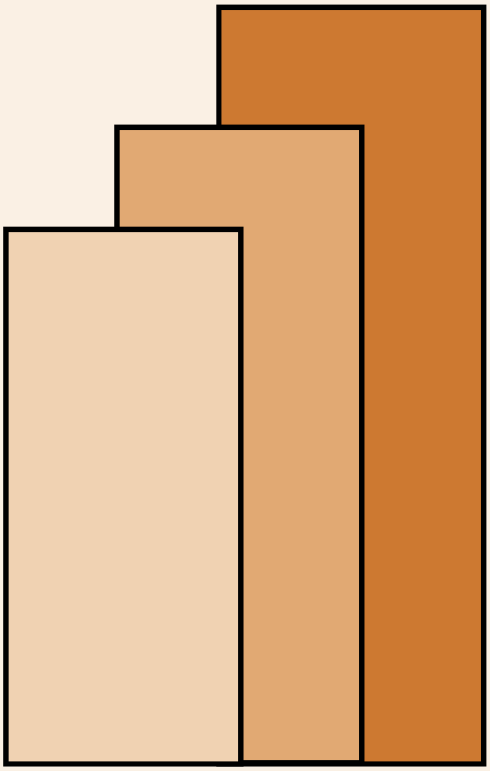

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For comments, suggestions or further inquiries please contact:

The Research Information Staff, Philippine Institute for Development Studies
3rd Floor, NEDA sa Makati Building, 106 Amorsolo Street, Legaspi Village, Makati City, Philippines
Tel Nos: 8924059 and 8935705; Fax No: 8939589; E-mail: publications@pidsnet.pids.gov.ph
Or visit our website at http://www.pids.gov.ph

ABSTRACT

This paper looks into the national R&D program for the production of hatchery-bred milkfish fry and the fledgling industry it has spawned with the end purpose of recommending courses of actions that the national government can pursue for their furtherance. The study concludes that hatchery-bred fry is necessary for milkfish culture to attain sustainable growth and international competitiveness in the coming years. Therefore, the government should continue to strongly support the R&D program and industry by exerting concrete measures to address the various technical, market, institutional and other problems which hinder them from fully becoming a vehicle of growth in the fisheries sector.

The Milkfish Broodstock-Hatchery Research and Development Program and Industry: A Policy Study

by

Danilo C. Israel*

I. Introduction

Milkfish is the national fish of the Philippines not only because it is a favorite viand of the entire population. The milkfish industry is also an important component of the fisheries sector and the national economy, contributing significantly to output, employment, public revenues and nutrition.

While milkfish is important, however, its production has been hindered by various problems in recent years. Among the most critical of these is the limited supply of fry. Milkfish production comes mainly from aquaculture and the availability of fry for stocking determines to a large extent the achieved levels of national production. In the past decade or so, the supply of fry, which comes mainly from the wild, has been declining rapidly (Ahmed et al. 1999). In contrast, the demand for fry has been growing steadily, brought about by the gradual intensification of culture practices and the shift in production toward milkfish farming in reaction to the decline of the prawn industry.

*Ph.D. in Resource Economics and Research Fellow, Philippine Institute for Development Studies (PIDS), NEDA sa Makati Bldg., 106 Amorsolo St., Legaspi Village, Makati City.

While the problem of limited fry supply constrains the milkfish industry, it was actually already foreseen more than two decades ago. Back then, the national government commenced a research and development (R&D) program aimed at finding a technical solution to the problem. The specific objective was to develop a milkfish broodstock-hatchery technology that can produce significant quantities of hatchery-bred fry (The broodstock component of this technology involves the rearing in controlled conditions of both male and female juvenile milkfish to produce the mother milkfish or Sabalo and the spawning of eggs by the Sabalo. The hatchery component covers the hatching of the eggs and the rearing of the hatched larvae to nursery or grow-out stocking age, also in controlled conditions). Once commercialized, the technology was expected to significantly increase the domestic supply of milkfish fry in the short-term and become its major source over the long-term.

Largely as a result of the above-mentioned R&D program, a fledgling milkfish broodstock-hatchery industry exists in the country at present. So far, however, this industry has not yet fully taken off as its output is still too low and inconsistent to significantly impact on total production. Nevertheless, expectations are high that given the right conditions, the industry will eventually produce at levels sufficient enough to fully meet the fry needs of milkfish culture.

As its primary patron and at this juncture of development, the national government is facing important policy decisions related to the milkfish broostock-hatchery R&D program and industry. First and foremost, given the current state of affairs, should the government continue to invest public

resources into the program? If so, at what levels should this investment be and into which priority areas should it be focused to attain the desired maximum impact?

Beyond R&D, equally important questions need to be addressed. Since the milkfish broodstock-hatchery industry is still in the infantile stage, should the government get more actively involved in it to ensure survival and growth? If so, what courses of actions can the government do? More specifically, what necessary programs should the pertinent fisheries agencies implement to assist the industry? These and other related questions need answers for the government to decisively complete its mission of finding a lasting solution to the problem of limited availability of milkfish fry.

II. Objective, Organization and Data

This paper looks into the national milkfish broodstock-hatchery R&D program and industry with the end purpose of recommending policies and courses of actions that can be pursued by the national government for their furtherance. The observed lack of policy-oriented studies which can be utilized as reference in relation to the R&D program and industry motivates this effort.

The paper is organized as follows. The next section reviews the milkfish industry vis a vis the entire fisheries sector and the national economy. This portion is intended to highlight the economic importance of the milkfish industry to the sector and the economy. The third section reviews the milkfish fry supply and demand situation and provides estimates of the future fry requirements. The purpose is to emphasize limited supply of fry as a major

factor constraining milkfish production and evaluate the relevance of the development of the milkfish broodstock-hatchery technology as solution. The history and status of the milkfish broodstock-hatchery R&D program and industry are presented in the fourth section while the fifth section discusses the problems associated to them. The intention is to pinpoint important concerns in the program and industry and determine where national government action is required. The penultimate section develops the recommendations for addressing the problems while the last section provides the summary and conclusions.

The paper utilizes secondary data gathered from the published indexes of fisheries agencies and the available relevant literature. It also uses primary information generated through interviews with key informants, including those from government fisheries agencies and the milkfish fry and grow-out industries.

III. The Milkfish Industry

3.1 Production Impact

The fisheries sector has been stagnating in recent years (Tables 1 and 2). For the 1979-1997 period, the average annual growth rate of total fisheries production has been low, particularly in quantity terms. Furthermore, growth has been negligible or negative during a substantial part of the period. By individual subsectors, commercial fisheries generally performed in a similar way as total fisheries while municipal fisheries did worse.

Table 1. Annual fisheries production, by subsector, Philippines, 1979-1997

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Thousand Metric Tons)																				
All sectors	1,581	1,672	1,773	1,897	2,110	2,080	2,052	2,090	2,213	2,268	2,371	2,503	2,599	2,626	2,632	2,721	2,784	2,769	2,767	2,290
Commercial	501	489	495	526	519	513	512	546	591	600	637	701	760	805	824	859	893	879	885	660
Municipal	839	895	939	978	1,146	1,089	1,045	1,072	1,061	1,069	1,105	1,132	1,147	1,084	1,014	993	972	909	925	1,022
Aquaculture	241	289	340	392	445	478	495	471	561	600	629	671	692	736	794	869	919	981	957	608
Value (Million Pesos)																				
All sectors	10,537	11,644	13,954	15,064	18,982	25,650	31,297	37,332	37,349	42,118	45,094	52,177	60,033	65,444	70,216	80,192	83,057	83,139	80,745	45,475
Commercial	3,512	3,785	4,125	4,355	4,643	6,521	7,857	9,248	9,821	10,270	11,033	12,411	15,245	16,801	18,021	20,715	23,065	24,555	25,935	12,206
Municipal	5,364	6,018	6,964	7,316	9,540	11,863	14,716	17,252	16,108	16,633	18,388	19,300	22,133	22,656	22,031	24,475	26,464	25,373	27,393	16,841
Aquaculture	1,660	1,842	2,866	3,393	4,799	7,266	8,724	10,832	11,421	15,213	15,673	20,467	22,656	25,987	30,163	35,003	33,527	33,211	27,417	16,427

Source: BAS (various years)

Table 2. Annual growth rates of fisheries production, by subsector, Philippines, 1980-1997

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Percent)																			
All sectors	5.76	6.02	6.99	11.25	-1.42	-1.36	1.82	5.91	2.49	4.55	5.58	3.82	1.03	0.24	3.38	2.32	-0.54	-0.10	3.21
Commercial	-2.44	1.29	6.37	-1.33	-1.16	-0.25	6.68	8.24	1.49	6.17	9.98	8.45	5.94	2.42	4.23	3.95	-1.58	0.63	3.28
Municipal	6.59	4.92	4.23	17.13	-4.95	-4.02	2.58	-1.07	0.72	3.38	2.47	1.32	-5.44	-6.49	-2.11	-2.08	-6.46	1.68	0.69
Aquaculture	19.90	17.39	15.55	13.46	7.37	3.52	-4.81	19.11	6.88	4.97	6.64	3.17	6.35	7.77	9.51	5.74	6.74	-2.40	8.16
Value (Percent)																			
All sectors	10.51	19.83	7.96	26.01	35.13	22.02	19.28	0.05	12.77	7.06	15.71	15.06	9.01	7.29	14.21	3.57	0.10	-2.88	12.37
Commercial	7.76	8.98	5.59	6.60	40.46	20.49	17.70	6.19	4.58	7.43	12.48	22.84	10.21	7.27	14.95	11.35	6.46	5.62	12.05
Municipal	12.18	15.72	5.05	30.40	24.35	24.05	17.23	-6.63	3.26	10.55	4.96	14.68	2.37	-2.76	11.09	8.13	-4.12	7.96	9.92
Aquaculture	10.94	55.57	18.42	41.43	51.40	20.07	24.16	5.44	33.20	3.02	30.59	10.70	14.70	16.07	16.04	-4.22	-0.94	-17.45	18.29

Source: Table 1

In contrast to the commercial and municipal fisheries, aquaculture registered impressive average annual production growth rates for the 1979-1997 period. In terms of volume and value of production, it also surpassed the other subsectors as the leading producer of fish by the second half of the nineties. This development highlights the increasing role of the aquaculture subsector as the main source of production growth in the entire fisheries sector.

Despite its rosy performance, there are foreboding signs that the aquaculture subsector is also facing tough times like the rest of fisheries. The value of aquaculture production has dropped since 1995 while volume has decreased in 1997. This warns that aquaculture may follow in the way of commercial and municipal fisheries and worsen further the already difficult situation in the entire fisheries sector if nothing is done to effectively address its various problems.

As mentioned, milkfish production comes mainly from aquaculture. This is reflected by the production figures for the 1979-1997 period which show the dominant contribution of aquaculture to total mikfish production (Tables 3 and 4). Commercial fisheries contributes almost nothing to total production while municipal fisheries has a positive but minimal contribution. The data suggests that any significant growth in milkfish output in the future can be realized practically only through aquaculture.

As in the case of aquaculture and fisheries in general, the milkfish industry is confronting serious challenges. In both quantity and value terms, the production of milkfish has greatly declined during several years

Table 3. Annual milkfish production, by subsector, Philippines, 1979-1997

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Metric Tons)																				
All sectors	133,244	134,754	236,331	252,157	245,258	238,039	193,837	184,910	199,246	191,982	195,648	213,751	237,071	170,459	152,198	161,486	158,324	153,759	159,948	190,126
Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.06	0.01	0.05	0.02	0.01	0.01	0.03	0.06	0.22	0.05
Municipal	982	163	11,305	12,412	6,699	364	187	5,405	1,719	4,105	2,752	2,869	2,948	3,394	3,233	5,135	7,466	3,608	175	3,943
Aquaculture	132,262	134,591	225,026	239,745	238,559	237,675	193,650	179,505	197,527	187,877	192,896	210,882	234,123	167,065	148,965	156,351	150,858	150,151	159,773	186,183
Value (Million Pesos)																				
All sectors	1,190	1,373	2,475	2,887	3,199	3,936	4,481	4,827	4,494	5,106	5,395	7,187	7,953	7,648	6,887	8,715	9,908	12,486	8,992	5,744
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	693	330	447	1,710	3,738	-	1,384
Municipal	0	0	0	0	0	0	0	0	0	97	62	68	70	119	86	157	96	-	-	94
Aquaculture	1,190	1,373	2,475	2,887	3,199	3,936	4,481	4,827	4,494	5,009	5,333	7,120	7,883	6,836	6,471	8,111	8,102	8,748	8,992	5,340

Source: PCAMRD (1998)

Table 4. Annual growth rates of milkfish production, by subsector, Philippines, 1980-1997

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Percent)																			
All sectors	1.13	75.38	6.70	-2.74	-2.94	-18.57	-4.61	7.75	-3.65	1.91	9.25	10.91	-28.10	-10.71	6.10	-1.96	-2.88	4.03	2.61
Commercial	0.00	0.00	0.00	0.00	0.00	0.00	-100.00	0.00	0.00	0.00	-90.63	750.00	-62.75	-47.37	0.00	200.00	100.00	270.00	56.63
Municipal	-83.40	6,835.58	9.79	-46.03	-94.57	-48.63	2,790.37	-68.20	138.80	-32.96	4.25	2.75	15.13	-4.74	58.83	45.39	-51.67	-95.15	520.86
Aquaculture	1.76	67.19	6.54	-0.49	-0.37	-18.52	-7.30	10.04	-4.89	2.67	9.32	11.02	-28.64	-10.83	4.96	-3.51	-0.47	6.41	2.49
Value (Percent)																			
All sectors	15.33	80.31	16.63	10.81	23.03	13.85	7.72	-6.90	13.62	5.66	33.22	10.65	-3.83	-9.95	26.53	13.69	26.02	-27.98	13.80
Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-52.38	35.45	282.55	118.60	0.00	21.35
Municipal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-35.81	8.72	3.36	70.52	-27.51	81.51	-39.10	0.00	0.00	3.43
Aquaculture	15.33	80.31	16.63	10.81	23.03	13.85	7.72	-6.90	11.46	6.47	33.51	10.72	-13.28	-5.34	25.34	-0.11	7.96	2.80	13.35

Source: Table 3

in the nineties. The problem of falling output of the milkfish industry also requires the serious consideration of the various problems it is presently confronting.

By individual species, milkfish has been the most important fish produced through aquaculture for the period 1981-97 (Table 5). However, in volume, it has been surpassed by seaweeds as a cultured aquatic species since 1987. For the 1979-1997 period, in quantity and average terms, milkfish ranks among the most important species produced by the fisheries sector, third only to roundscad and tuna (Table 6). On the downside, milkfish production has the lowest average annual growth rates of the fish species considered (Table 7).

Based on the total fisheries production data presented in Table 1 and the milkfish production data shown in Table 3, it is estimated that milkfish contributes 8.6 percent annually on average in quantity, and 13.32 percent in value, to total fisheries production (Table 8). Because numerous species are produced by the entire fisheries sector, these individual shares of milkfish to total production are highly significant and highlights again the leading role that it plays in the entire fisheries sector.

3.2 Employment Impact

Moving on from production to employment, the importance of milkfish in terms of people provided work cannot be directly measured because of the lack of disaggregated labor data for the fisheries sector from the published institutional sources. Nevertheless, some rough figures can be used to indirectly estimate the employment effects of the milkfish industry. For 1996, the total employment in the entire fisheries sector was estimated at about

Table 5. Annual aquaculture production of major fishery commodities, Philippines, in MT, 1981-1997

Year	Seaweeds	% Share	Milkfish	% Share	Tilapia	% Share	Shrimps/ Prawns	% Share	Mussel	% Share	Others	% Share	Total Aquaculture Production	% Share
1981	82,983	24.44	225,026	66.28	16,951	4.99	1,704	0.50	5,659	1.67	7,178	2.11	339,501	100.00
1982	108,711	27.71	239,745	61.11	16,777	4.28	1,805	0.46	6,308	1.61	19,002	4.84	392,348	100.00
1983	132,204	29.70	238,559	53.60	30,772	6.91	12,061	2.71	18,506	4.16	12,971	2.91	445,073	100.00
1984	142,088	29.73	237,675	49.73	32,003	6.70	28,857	6.04	20,306	4.25	16,958	3.55	477,887	100.00
1985	182,946	36.98	193,650	39.14	43,780	8.85	29,037	5.87	22,680	4.58	22,649	4.58	494,742	100.00
1986	168,868	35.86	179,505	38.12	55,836	11.86	31,081	6.60	12,114	2.57	23,489	4.99	470,893	100.00
1987	220,839	39.37	197,527	35.21	75,769	13.51	35,640	6.35	11,644	2.08	19,551	3.49	560,970	100.00
1988	256,405	42.77	187,877	31.34	75,046	12.52	44,957	7.50	15,502	2.59	19,767	3.30	599,554	100.00
1989	268,701	42.70	192,896	30.65	81,675	12.98	47,861	7.60	16,403	2.61	21,809	3.47	629,345	100.00
1990	291,176	43.39	210,882	31.42	76,142	11.35	53,989	8.04	17,515	2.61	21,412	3.19	671,116	100.00
1991	283,783	40.99	234,123	33.81	76,570	11.06	51,434	7.43	17,345	2.51	29,146	4.21	692,401	100.00
1992	349,505	47.46	167,065	22.69	91,177	12.38	78,396	10.65	20,459	2.78	29,779	4.04	736,381	100.00
1993	401,548	50.60	148,965	18.77	96,339	12.14	95,816	12.07	25,070	3.16	25,882	3.26	793,620	100.00
1994	481,495	55.40	156,351	17.99	94,322	10.85	92,647	10.66	11,355	1.31	32,913	3.79	869,083	100.00
1995	558,270	60.74	150,858	16.41	81,182	8.83	90,456	9.84	14,688	1.60	23,587	2.57	919,041	100.00
1996	631,387	64.37	150,151	15.31	79,509	8.11	78,067	7.96	21,027	2.14	20,777	2.12	980,918	100.00
1997	627,105	65.50	159,773	16.69	91,831	9.59	41,454	4.33	11,658	1.22	25,579	2.67	957,400	100.00
Average	305,177	47.03	192,390	29.65	65,628	10.11	47,957	7.39	15,779	2.43	21,909	3.38	648,840	100.00

Source: PCAMRD (1998)

Table 6. Annual production of major fish species, Philippines, in MT, 1979-1997

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Tuna	194,311	200,805	203,754	21,604	242,286	225,799	261,607	266,211	270,526	274,702	302,244	313,371	339,074	285,803	243,306	306,730	319,541	284,635	303,063	295,937
Roundscad	146,206	132,129	149,947	183,253	165,023	131,583	131,708	175,855	184,411	178,687	209,821	249,300	277,330	269,979	270,110	233,177	259,768	223,924	228,878	200,057
Milkfish	133,244	134,754	236,331	252,157	245,258	238,039	193,837	184,910	199,246	191,982	195,648	213,751	237,071	170,459	152,198	161,486	158,324	153,759	159,948	190,126
Sardines	106,403	117,348	136,871	147,746	151,484	109,027	81,927	73,303	98,694	96,405	122,465	156,748	158,622	191,670	240,299	246,998	261,507	254,365	298,695	160,557
Tilapia	6,122	9,104	26,800	27,326	62,179	54,298	61,836	79,717	93,593	95,006	101,647	97,424	96,330	110,631	120,297	111,971	102,426	108,905	100,887	77,184
Tiger Prawn	2,652	2,716	2,168	2,989	10,752	27,422	27,592	29,347	34,750	45,499	47,076	49,426	47,266	76,968	87,513	91,363	90,015	77,357	40,693	41,767
Others	992,262	1,075,444	1,017,029	1,261,825	1,233,318	1,294,232	1,467,878	1,280,157	1,331,780	1,385,719	1,392,199	1,423,380	1,443,307	1,520,190	1,518,277	1,569,275	1,592,619	1,666,255	1,634,336	1,522,772

Source: Table 3 and PCAMRD (1998)

Table 7. Annual growth rates of the production of major fish species, Philippines, in percent, 1979-1997

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Tuna	3.34	1.47	-89.40	1,021.49	-6.80	15.86	1.76	1.62	1.54	10.03	3.68	8.20	-15.71	-14.87	26.07	4.18	-10.92	6.47	53.78
Roundscad	-9.63	13.49	22.21	-9.95	-20.26	0.09	33.52	4.87	-3.10	17.42	18.82	11.24	-2.65	0.05	-13.67	11.40	-13.80	2.21	3.46
Milkfish	1.13	75.38	6.70	-2.74	-2.94	-18.57	-4.61	7.75	-3.65	1.91	9.25	10.91	-28.10	-10.71	6.10	-1.96	-2.88	4.03	2.61
Sardines	10.29	16.64	7.95	2.53	-28.03	-24.86	-10.53	34.64	-2.32	27.03	27.99	1.20	20.83	25.37	2.79	5.87	-2.73	17.43	7.34
Tilapia	48.71	194.38	1.96	127.55	-12.67	13.88	28.92	17.41	1.51	6.99	-4.15	-1.12	14.85	8.74	-6.92	-8.52	6.33	-7.36	23.91
Tiger Prawn	2.41	-20.18	37.87	259.72	155.04	0.62	6.36	18.41	30.93	3.47	4.99	-4.37	62.84	13.70	4.40	-1.48	-14.06	-47.40	28.52
Others	8.38	-5.43	24.07	-2.26	4.94	13.42	-12.79	4.03	4.05	0.47	2.24	1.40	5.33	-0.13	3.36	1.49	4.62	-1.92	3.07

Source: Table 6

Table 8. Annual contribution of milkfish production to total fisheries and subsector production, Philippines, 1979-1997

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Percent)																				
Milkfish to Total Fisheries	8.43	8.06	13.33	13.29	11.62	11.44	9.45	8.85	9.00	8.46	8.25	8.54	9.12	6.49	5.78	5.93	5.69	5.55	5.78	8.58
Milkfish to Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Milkfish Municipal	0.12	0.02	1.20	1.27	0.58	0.03	0.02	0.50	0.16	0.38	0.25	0.25	0.26	0.31	0.32	0.52	0.77	0.40	0.02	0.39
Milkfish to Aquaculture	54.88	46.57	66.18	61.16	53.61	49.72	39.12	38.11	35.21	31.31	30.67	31.43	33.83	22.70	18.76	17.99	16.42	15.31	16.70	35.77
Value (Percent)																				
Milkfish to Total Fisheries	11.30	11.79	17.74	19.16	16.85	15.34	14.32	12.93	12.03	12.12	11.96	13.77	13.25	11.69	9.81	10.87	11.93	15.02	11.14	13.32
Milkfish to Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.12	1.83	2.16	7.41	15.22	-	1.62
Milkfish Municipal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.34	0.35	0.32	0.53	0.39	0.64	0.36	-	-	0.18
Milkfish to Aquaculture	71.70	74.53	86.38	85.08	66.66	54.17	51.36	44.56	39.35	32.92	34.03	34.79	34.79	26.31	21.45	23.17	24.17	26.34	32.80	45.50

Source: Tables 1 and 3

990,872 people, of which 26 percent or 258,480 were in aquaculture (BAS 1997). Since the share of milkfish to total aquaculture output was about 40 percent, as an average of quantity and value figures (see Table 8), then it can be assumed that the entire milkfish industry employed about 103,392 people in that year.

On one hand, the above direct employment figure for the milkfish industry is relatively modest compared to other more labor-intensive sectors of the economy. On the other hand, it should be remembered that many other people are attached to the milkfish industry through a labyrinth of linkage industries, such as the backward-linked fish feed and other input providing industries and the forward-linked marketing and processing industries. Again, it will be tedious to measure exactly how many individuals belong to these industries but some rough figures can be utilized for estimation. For instance, it has been assumed that 12 percent of the national population are in one way or another dependent on fisheries for their livelihood (Trinidad et al. 1993). Taking the current national population of about 70 million people, this means that 8.4 million individuals generate their livelihood from fisheries and fisheries-related activities. Computing further, since the share of milkfish to total fisheries is about 10 percent, as an average of quantity and value (see Table 8), then the total number of people dependent on the milkfish industry is approximately 840,000 people. This number is definitely substantial and underscores that the milkfish industry is an important employment generator of the economy.

3.3 Public Revenue Generation Impact

In terms of public revenue generation, the income taxes, business taxes and other forms of taxes which can be collected from various milkfish-related economic activities are also not easy to estimate as it is impossible to generate disaggregated tax data on such activities from the concerned tax agencies. Suffice it to say that the total generated tax figures should be large given the significant number of people who are fully or partially dependent on and the various economic activities which are attached to the milkfish industry.

3.4 Foreign Exchange Generation Impact

A current drawback of the milkfish industry is that it is not a significant source of foreign exchange for the country. The industry caters mainly to the domestic market and its average share to total fisheries exports for the period 1979-1999 is less than 1 percent, in both quantity and value terms (Table 9). Positively speaking, this aspect of the industry may be taken as a potential area for expansion in the future. The countries where the Philippines exports milkfish have large markets for fishery products although the country has an insignificant share of these (Tables 10 and 11). There should be much room for the expansion of the exports of milkfish to these countries once the industry becomes fully developed and internationally competitive.

3.5 Nutritional Impact

Another important contribution of the milkfish industry beyond purely economic is in the area of nutrition. The fisheries sector provides about 75 percent of the total animal protein requirement of the country, which is much

Table 9. Annual exports of fishery products and milkfish, Philippines, 1979-1997

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average
Quantity (Metric Tons)																				
Total Exports	64,890	76,179	83,738	38,265	75,589	63,055	95,077	101,453	111,830	120,903	145,099	143,038	144,939	131,915	163,745	172,080	169,746	164,673	173,888	117,900
Milkfish Exports	340	565	528	908	1,241	1,158	n.d.	1,864	1,720	1,613	1,336	869	637	414	288	717	254	173	65	816
Value (Million Pesos)																				
Total Exports	782	939	1251	1120	1593	2179	3496	4883	6,442	9,599	10,248	11,529	14,049	11,090	14,074	15,027	15,657	15,110	16,337	8,179
Milkfish Exports	5	9	9	13	23	29	n.d.	88	76	76	86	62	45	29	23	55	23	14	6	37
Ratio of milkfish exports to fishery exports (Percent)																				
Quantity	0.52	0.74	0.63	2.37	1.64	1.84	n.d.	1.84	1.54	1.33	0.92	0.61	0.44	0.31	0.18	0.42	0.15	0.10	0.04	0.87
Value	0.64	0.96	0.72	1.16	1.44	1.33	n.d.	1.80	1.18	0.79	0.84	0.54	0.32	0.26	0.16	0.37	0.15	0.09	0.04	0.71

Source: BAS (various years)

Table 10. Philippine milkfish exports, by country of destination, 1996

Country of Destination	Quantity (in Net Kg)
Australia	4,787
Belguim	121
Brunei Darussalam	27
Canada	1,365
Hongkong	338
Japan	7,418
Netherlands	6,908
Palau, Rep. Of	290
Saudi Arabia	1,701
Singapore	5,202
Switzerland	149
United States of America	29,564

Source: PCAMRD (1998)

Table 11. Fishery and fishery products imports, by country, 1996

Country of Destination	Quantity (in Net Kg)
Australia	54,882,000
Belguim	76,522,000
Brunei Darussalam	1,469,000
Canada	29,615,000
Hongkong	167,336,000
Japan	1,782,530,000
Netherlands	274,287,000
Palau, Rep. Of	792,000
Saudi Arabia	31,458,000
Singapore	120,801,000
Switzerland	26,265,000
United States of America	753,283,000

Source: FAO (1996)

more than the contribution of poultry and livestock combined (BAR 1991). As milkfish shares around 10 percent of the total fisheries output, again as an average of both production quantity and value (Table 8), then it can be assumed that mikfish contributes about 7.5 percent of the total animal protein requirement nationally. This is certainly a large contribution coming from a single marine species.

3.6 Poverty Alleviation Impact

Finally, aside from the economic and nutritional contributions, the milkfish industry has important social implications as well. The industry and the entire fisheries sector play a great role in the pursuit of poverty alleviation. Some of their industry linkages, such as marketing and processing, involve workers from the poor segments of society. Count among these the fishing port laborers, wet market laborers, small-scale fish vendors, small-scale fish processors, small-scale fish traders and similar workers. Being employment havens of last resort for the poor makes the milkfish industry and the fisheries sector doubly important.

In review, the above crystallize the importance of the milkfish industry to the fisheries sector and the national economy. Its output, employment, public revenue, nutritional and poverty alleviation contributions are significant. Furthermore, it has a great potential to provide substantial foreign exchange once it becomes fully developed and competitive in the international market. Viewed in reverse, a downfall of the milkfish industry caused for instance by a sudden collapse of the supply of wild fry, will surely have serious negative implications not only on the economic but also of the social well-being of the country.

IV. The Demand and Supply for Milkfish Fry

4.1 Supply of Wild Milkfish Fry

This section attempts to quantify the milkfish fry demand and supply situation to have a clear idea of the magnitude of the problem of limited fry availability.

There are no time-series data on the actual production of wild fry in the country with which past performance can be assessed and future trends forecast. The Bureau of Fisheries and Aquatic Resources (BFAR) estimated the current fry supply from the wild at about 161 million annually as of 1995 (Ahmed et al. 1999, Bagarinao 1998). This figure, however, is considered too low and inconsistent with the annual production figures of marketable-size milkfish. Bagarinao (1997) asserted that the average annual production of wild fry in recent years is approximately one billion.

Although the exact figures are unknown, there is little doubt that the catch of wild fry has been declining in recent years due to a number of factors. These include the fall in the population of the wild Sabalo due to illegal fishing and marine pollution and degradation of coastal habitats (Ahmed et al. 1999). Aside from declining catch, the supply of wild fry fluctuates within and between years due to typhoons and similar fortuitous events which are so common in the country.

The rate of decline in the supply of wild fry was about 11.79 percent in 1997 based on scant survey evidence (Ibid). This year, there are unconfirmed but reliable reports that the supply of wild fry has gone down again dramatically, forcing many grow-out operators to understock or

fallow their ponds. This has also raised the demand for hatchery-bred fry, even among grow-out operators who traditionally stock their ponds with wild fry.

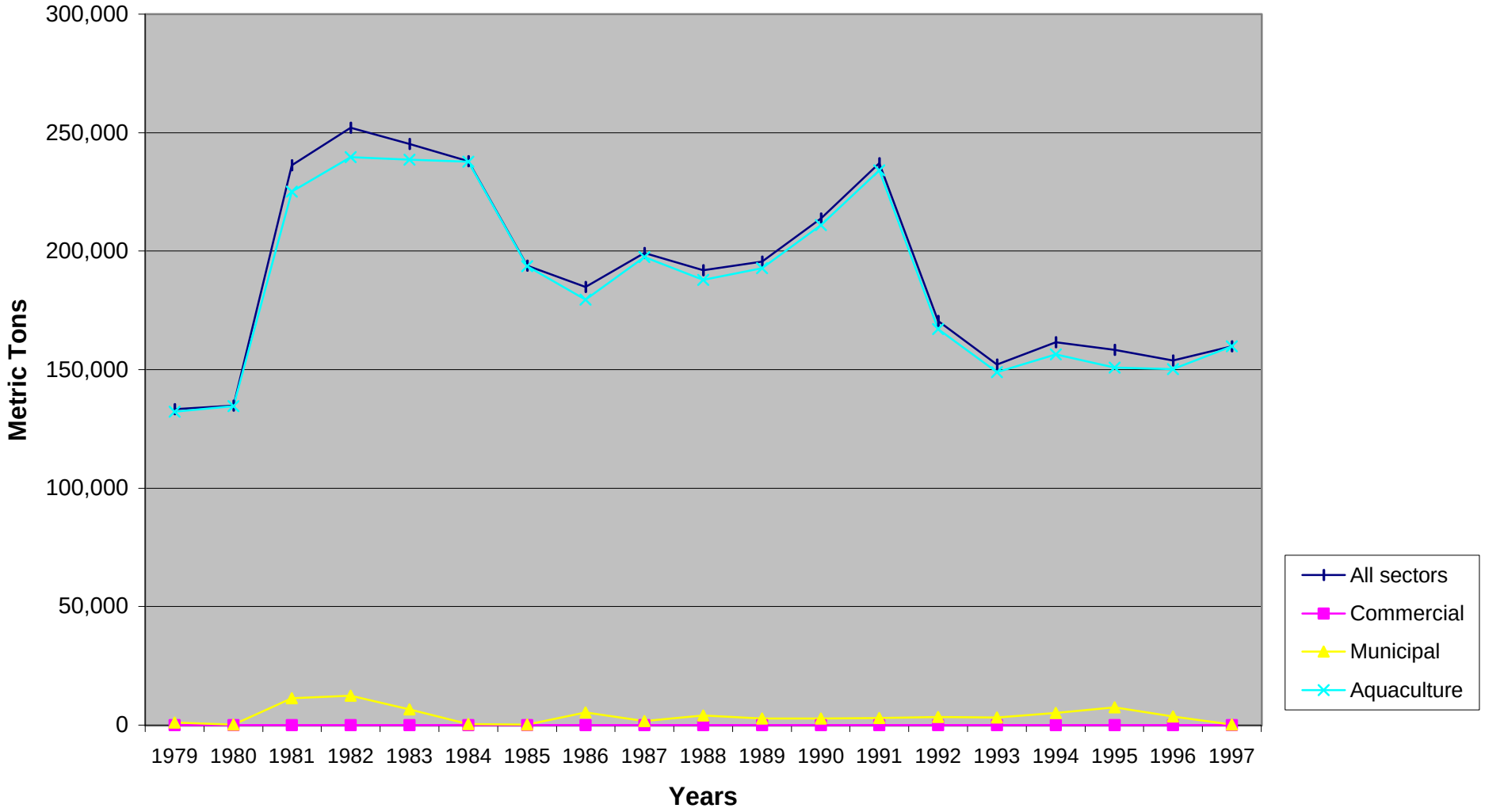
If the declining trend in the catch of wild fry continues, which is highly likely since the various causes of the problem have not been addressed to a meaningful extent, then wild fry will be available only in insignificant numbers in the long haul. When this actually happens, the broodstock-hatchery industry will not be just an alternative but the major source of fry for milkfish culture.

4.2 Fry Supply and Milkfish Production

In the absence of time-series data on milkfish fry supply, one can look into milkfish production data to get an idea of the trend in supply in the past. The basis for this approach is that since fry is a major input in milkfish production, years of high milkfish output may also be years when fry were likely abundant, and vice versa. (As caveat, it should be remembered that other factors such as market demand and the weather affects milkfish production. Therefore, this exercise should be taken only as indicate at best).

Milkfish production was generally higher in the eighties than in the nineties (Figure 1). Thus, milkfish fry may also be more available generally back in the earlier decade than in the latter decade. Production in the nineties was less erratic than in the eighties which may imply that milkfish fry imports and production from fry hatcheries helped stabilize fry supply in the latter decade. The significantly lower production of milkfish in the nineties

Figure 1. Annual quantity of milkfish production, by subsector, Philippines, 1979-1997



Source: Table 3

Regardless of the shift of many prawn growers to milkfish culture may mean that the limited availability of fry is a deeply constraining problem in the milkfish industry.

4.3 Estimation of Milkfish Fry Demand and Supply

With limited milkfish fry data, a way of assessing national demand and supply for milkfish fry is to follow Bagarinao (1998) with some minor modifications. Consistent with economic theory, demand and supply are assumed to be in a state of equilibrium and are always equal annually. Hence, with this approach, the yearly figures generated represent both demand and supply.

To estimate the total fry demand and supply, the aquaculture production of marketable-size milkfish for the latest year with reliable production data is determined first. In this case, 1997 is the year and production is 159,773 metric tons or 159.773 million kilograms (see Table 3). Then, fry demand and supply for this year are computed backwards by employing technically acceptable assumptions confirmed by research. Specifically, milkfish production is multiplied by the assumed average marketable-size weight of four to a kilogram to get the total number of milkfish which survive the grow-out stage. This figure is then divided by the assumed average survival rate at the grow-out stage of 46 percent to get the total number of fish stocked in grow-out culture. The resulting figure is further divided by the assumed survival rate during fry transport of 93.4 percent and then by the assumed survival rate at fry storage of 91.3 percent to get the total number of fry demanded by the different operators and supplied by the

different sources, including the wild, local hatcheries, and imports. The final figure generated for 1997 after all the above conversions were made is 1,629.25 million fry.

With the total fry demand and supply for 1997 computed, projections for the years beyond follow. Improving on Bagarinao, the period from 1998 to 2010 is considered as coverage and different growth rates for the demand and supply are assumed. If the volume of fry must support the production of marketable-size milkfish that can keep abreast with the growth in the national population, an annual growth rate of 2.5 percent in fry production, which is also the average annual growth rate in population, is valid. On the other hand, If additionally, milkfish production has to help reduce the current fish and protein deficiency rates among the population or fry production has to serve other potential uses, such as the seeding of conducive open water bodies, then much higher growth rates are applicable.

The assumed annual growth rate in the computation is limited to a maximum of 5 percent to consider the physical and environmental constraints of aquaculture (e.g. Bagarinao 1998, 1999). Certainly, this assumed limit is arbitrary since nobody really knows for sure the physical and environmental limits of aquaculture at present. In the proper time, the maximum 5 percent growth rate can be increased or decreased based on verified findings of research.

The results of the computation of milkfish fry demand and supply are shown in Table 12. Since demand always equates supply yearly, no actual deficit occurs. Yet, the figures show that if the production of fry is fixed at the

Table 12. Estimated annual milkfish fry demand and supply in the Philippines, 1998-2010

Year	Demand/ Supply (in million pieces)					
	2.5%	3%	3.5%	4%	4.5%	5%
1998	1,669.98	1,678.13	1,678.13	1,694.42	1,702.57	1,710.71
1999	1,711.73	1,728.47	1,728.47	1,762.20	1,779.18	1,796.25
2000	1,754.52	1,780.33	1,780.33	1,832.68	1,859.24	1,886.06
2001	1,798.39	1,833.74	1,833.74	1,905.99	1,942.91	1,980.36
2002	1,843.35	1,888.75	1,888.75	1,982.23	2,030.34	2,079.38
2003	1,889.43	1,945.41	1,945.41	2,061.52	2,121.71	2,183.35
2004	1,936.67	2,003.77	2,003.77	2,143.98	2,217.18	2,292.52
2005	1,985.08	2,063.89	2,063.89	2,229.74	2,316.96	2,407.14
2006	2,034.71	2,125.80	2,125.80	2,318.93	2,421.22	2,527.50
2007	2,085.58	2,189.58	2,189.58	2,411.69	2,530.18	2,653.88
2008	2,137.72	2,255.26	2,255.26	2,508.16	2,644.03	2,786.57
2009	2,191.16	2,322.92	2,322.92	2,608.48	2,763.01	2,925.90
2010	2,245.94	2,392.61	2,392.61	2,712.82	2,887.35	3,072.19

Source of basic data: Table 3

1997 level of 1,629.25 million, additional fry supply has to be sourced to meet future requirements (Table 13). For instance, additional 616.69 million fry will be needed in 2010 just to accommodate an increase in milkfish production that can keep pace with the increase in population. This required additional volumes of fry increase drastically if there is a decline in the available wild fry from the 1997 figures or other objectives beyond just meeting the population growth are targeted as well.

4.4 Rationale for the Milkfish Broodstock-Hatchery R&D Program and Industry

From the above computations and discussions, it is shown that the problem of limited availability of milkfish fry is indeed real. Thus, it provides a strong basis for the milkfish broodstock-hatchery R&D program aimed to develop an industry that produces hatchery-bred fry. Once this is successful, milkfish production can then grow at pace with the population at the least. Moreover, even loftier societal goals requiring milkfish fry as an input will be possible.

There will be other benefits from the production of hatchery-bred fry. In the long-run, it will allow the intensification of milkfish culture resulting to the fuller utilization of aquaculture resources, including those erstwhile devoted to prawn culture. In marketing, it may render profitable the development of other product forms for milkfish, such as canned, dried or salted milkfish fingerlings, More importantly, it may significantly lower the price of fry to grow-out operators and milkfish itself to local consumers. This last

Table 13. Estimated annual additional requirements of milkfish fry in the Philippines, 1998-2010

Year	Additional requirements at different growth rates (in Million pieces)					
	2.5%	3%	3.5%	4%	4.5%	5%
1998	40.73	48.88	48.88	65.17	73.32	81.46
1999	82.48	99.22	99.22	132.95	149.93	167.00
2000	125.27	151.08	151.08	203.43	229.99	256.81
2001	169.14	204.49	204.49	276.74	313.66	351.11
2002	214.10	259.50	259.50	352.98	401.09	450.13
2003	260.18	316.16	316.16	432.27	492.46	554.10
2004	307.42	374.52	374.52	514.73	587.93	663.27
2005	355.83	434.64	434.64	600.49	687.71	777.89
2006	405.46	496.55	496.55	689.68	791.97	898.25
2007	456.33	560.33	560.33	782.44	900.93	1,024.63
2008	508.47	626.01	626.01	878.91	1,014.78	1,157.32
2009	561.91	693.67	693.67	979.23	1,133.76	1,296.65
2010	616.69	763.36	763.36	1,083.57	1,258.10	1,442.94

Source: Israel (2000)

point has great import because currently, data indicate that the fingerling cost in milkfish culture is high in percentage terms compared to those of tilapia culture (Table 14). The production of hatchery-bred fry should help lower seed costs and reduce the prices of marketable-size milkfish, to the benefit of the consuming public.

The reduction in the price of mikfish fry is also important to the national economy in terms of international trade. With the irreversible global trend toward trade liberalization, the country will be able to compete in aquaculture where it has natural comparative advantage, with its vast resources and expertise. Cheap and readily available hatchery-bred fry will give local producers a competitive edge and earn the much needed foreign exchange for the local economy.

The milkfish broodstock-hatchery industry also has ramifications in the area of fisheries resource management and the environment. It has been reported that wild fry gathering leads to the incidental capture and killing of billions of larvae and juveniles of other fishes and crustaceans and that the economic and biodiversity losses associated to these are high (e.g. Bagarinao 1998, 1999). Over the long-term when the country becomes less dependent on wild fry, hopefully this wastage will be minimized.

Finally, it will be tempting to argue that the country can do without locally produced hatchery-bred fry since fry can now be imported from other countries. There are strong counter arguments to this stand. As in the case of other imported animals, bringing in fry from other countries may transport into the country diseases and other related problems. For health and safety as well as sustainable resource management purposes then, importation is

Table 14. Annual average cash costs per hectare of milkfish and tilapia, 1996

	Milkfish		Tilapia	
	Pesos	%	Pesos	%
Fingerling	9,920	30.56	16,266	27.14
Other Cash Costs	22,537	69.44	43,677	72.86
Total Cash Costs	32,457	100.00	59,943	100.00

Sources: PCAMRD Tilapia Data Series (1998)

not attractive. The other justifications against importation is that, per se ,it will drain the country of much needed foreign exchange and forfeit its chance to exploit its natural comparative advantage in aquaculture.

V. The Milkfish Broodstock-Hatchery R&D Program and Industry

5.1 The Program

The milkfish broodstock-hatchery R&D program formally commenced with the early efforts to develop a milkfish breeding technology by the Southeast Asian Fisheries Development Center-Aquaculture Department (SEAFDEC-AQD), a treaty organization which is based in the country and receives most of its funding from the national government. In 1977, this department started the Milkfish Sea Production Program which was financed by the International Development Research Center (IDRC) of Canada. Under this program, wild Sabalo were collected and successfully made to spawn in captivity.

As an offshoot of this initial progress of SEAFDEC-AQD, the National Bangus Breeding Program (NBBP) was implemented by BFAR in collaboration with the department beginning in 1981. Under this program, 12 milkfish broodstock stations were established all over the country (Lopez et al. 1986). In these stations, broodstock were raised in either ponds or cages until spawning age. Concurrently, SEAFDEC-AQD also maintained broodstock in tanks and cages in its own stations.

After some time, the successful spawning of some of the broodstock and the rearing of the larvae in hatcheries occurred both at SEAFDEC-AQD and the NBBP stations. Following these technical breakthroughs, techniques

for the collection, handling and transport of spawned eggs from the broodstock to the hatchery sites as well as broodstock diet and larval diet were also developed by SEAFDEC-AQD.

In 1991, a policy of privatization of the NBBP was pursued by the national government leading to the sale of some of the broodstock maintained in the stations to the private sector (Lopez 1994). The policy was implemented to reduce the rising operational costs of maintaining the broodstock in the stations and to hasten the commercialization of the broodstock technology among the private sector. As a result of the policy, a substantial number of the broodstock in the NBBP stations were sold out and some of the facilities were leased out to the private sector. The BFAR, however, still maintains to this day some of the remaining broodstock and facilities not sold or leased out to the private sector.

Partly as a result of privatization, the private sector has an inventory of milkfish broodstock at present. Aside from those coming from the NBBP stations, some private operators also maintain broodstock in their ponds raised from the juveniles they grow. The estimated inventory of existing broodstock in the country is shown in Table 15. In addition to SEAFDEC-AQD, the old NBBP stations and the private sector, the University of the Philippines in the Visayas (UPV) maintains broodstock in its ponds at the Brackishwater Aquaculture Center (BAC) in Leganes, Iloilo. The estimated total inventory is likely below the actual but unknown figure. Many private operators are reported to maintain broodstock without the knowledge of the research institutions and the individual researchers involved in broodstock development.

Table 15. Estimated milkfish broodstock inventory in the Philippines, 1998

Farm	Site	Rearing Facility	No. of Broodstock	Age (years)	Remarks
Pacific Farms, Inc.	Alaminos, Pangasinan	Cage	35	15	Spawning but with no hatchery
Good Fry Hatchery	Masinloc, Zambales	Cage	40	15	Inadequate egg collection; no fry production
JTV Farms	Magsaysay, Mindoro Occ.	Pond	4,000	4	No spawning facilities
DA Region 4 Naujan Station	Naujan, Mindoro Oriental	Pond	230	3	No spawning facilities
DA Expt. Searanching Station	Puerto Princesa, Palawan	Cage	20	10	No hatchery facilities
		Cage	120	7	
		Cage	140	4	
DA Region 5	Tabaco, Albay	Cage	100	10	Inadequate fry production
DA Region 6	New Washington, Aklan	Pond	3,000	2	No spawning facilities
Sabalo Multipurpose Corp.	Roxas City, Capiz	Pond	190	6	No spawning facilities
Jamandre Hatcheries, Inc.	San Joaquin, Iloilo	Tanks	200	5	Spawning with fry production Collaboration with PCAMRD, UPV
Maranon Farms	Sagay, Negros Occ.	Pond	1,000	2 to 4	No spawning facilities
Bayshore Aquaculture	Pulupandan, Negros Occ.	Pond	190	6 to 7	No spawning reported
CVPC	Bais, Negros Oriental	Cage	200	6	Spawning Started Oct 1997 Fry production in collaboration with David Greer
Negros Or. Fisheries Complex	Bais, Negros Oriental	Pond	500	6 to 7	No spawning facilities
Southwestern Aquaculture	Calape, Bohol	Cage	280	3 to 5	Maturing broodstock samples in April 1998
DOBE International	Calape, Bohol	Cage	30	15	Limited fry production
DA Region 7	Calape, Bohol	Cage	30	15	Limited funding support
Oversea Aquaculture	Minglanilla, Cebu	Tank	100	3 to 5	No spawning reported
AQUASUR Dev. Corp.	Tagabuli, Davao del Sur	Cage	60	15	Consistent spawning and fry production
DUPA Enterprises	Mati, Davao Oriental	Cage	150	3	No spawning facilities
ALSONS Aqua	Gen. Santos City	Pond	3,000	5	Consistent spawning and fry production
SEAFDEC AQD	Iloilo/Guimaras	Tank/Cage	300	6 to 15	Consistent spawning and fry production
UPV-BAC	Leganes, Iloilo	Ponds	206	-	No spawning reported
Total			14,121		

Sources: Lopez (1999); UNDP(1998)

With its earlier success in milkfish spawning and the rearing of milkfish larvae in the hatchery, SEAFDEC-AQD has continued its research and refinement work on the milkfish broodstock-hatchery technology over the years. At the same time, it has been extending the technology, through the conduct of various training programs among representatives of government extension agencies, trainees sent by foreign governments and members of the private sector coming both within and outside the country.

In 1998, SEAFDEC-AQD built the Integrated Fish Broodstock and Hatchery Demonstration Complex at its main station in Tigbauan, Iloilo to showcase the milkfish broodstock-hatchery technology it has developed. As an ongoing effort, it has been conducting an Accelerated Transfer of Milkfish Technology Program also where particular hatchery operators were selected as cooperators. Under this program, SEAFDEC-AQD provides free eggs and technical assistance to the cooperators to hasten their adoption of the milkfish hatchery technology. The cooperators are mostly into the prawn hatchery business and conduct milkfish hatchery operations as a side activity. Their hatchery operations are also generally small-scale in nature. The initial successes of the program have been documented by the department (SEAFDEC-AQD 1999a). The list of SEAFEC-AQD cooperators in the dissemination of the milkfish hatchery technology over the years is provided in Table 16.

Other than SEAFDEC-AQD, the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), in cooperation with UPV has been conducting a technology verification and dissemination project entitled Milkfish Broodstock Development and Fry Production in Ponds and Tanks.

Table 16. List of SEAFDEC Milkfish Hatchery Cooperators

	Private Cooperators	Period of Cooperation
1	J&P HATCHERY New Washington, Aklan	1992-1993
2	Venus Hatchery Roxas City, Capiz	1992-1993
3	Aquaculture Specialists, Inc. Guimbal, Iloilo	1992-1993 1997
4	Sweet Water Aquafarm, Inc. Guimbal, Iloilo	1992-1993
5	Guimbal Star Hatchery Guimbal, Iloilo	1997
6	Sto. Niño Hatchery Guimbal, Iloilo	1997
7	T&J Hatchery Guimbal Iloilo	1997
8	Jamandre Hatcheries, Inc. San Joaquin, Iloilo	1997
9	Agbayani Hatchery Tigbauan, Iloilo	1997
10	SMT Hatchery Tigbauan, Iloilo	1997-1999
11	TRC Hatchery Batan, Aklan	1997-1999

Source: SEAFDEC Files

This project, which commenced in 1997, has been funded by the United Nations Development Programme (UNDP) and the Philippine government. The project is working with a private sector cooperator in Iloilo, the Jamandre Hatcheries, Inc. (JHI) and has broostock maintained at this firm as well as backup broodstock at the BAC. The successful spawning of the broodstock and subsequent raising of fry in the hatchery at the JHI has been reported (UNDP 1998, PCAMRD 1999). Project documents state that the project intends to verify a mixture of the technologies developed by SEAFDEC-AQD, the Gondol Research Station in Indonesia and the Tungkang Marine Laboratory in Taiwan.

5.1 The Industry

There is no industry study yet on the milkfish broodstock-hatchery industry so its total number of participants is not known. It is assumed that the broodstock component of the industry is composed of the non-government operators maintaining an inventory of broodstock shown earlier in Table 15. As mentioned, there are others maintaining broodstock who were not included in the list so the actual number of broodstock industry participants should be larger.

Bagarinao (1997) estimated that about 1,000 female and 1,000 male broodstock are needed to produce 100 million milkfish fry a year. Therefore, if the country is to produce about 500 million hatchery-bred fry just to meet population-induced increase in milkfish demand in the coming 10 years or so (Table 13), then the current recorded broodstock of about 14,000 I(Table 15) in both public and private hands appear sufficient. On the other hand, if

higher milkfish demand has to be satisfied, the recorded broodstock may be inadequate and other sources have to be identified or developed.

In the case of the hatchery component of the industry, aside from the hatchery cooperators of SEAFDEC-AQD and the PCMARD-UPV project, some other milkfish hatcheries have been at present. These are mainly small hatcheries located in Panay Island which are producing milkfish fry only part of the time. Some have ceased conducting milkfish hatchery operations or operated only intermittently due to various problems which will be discussed below.

In the island of Mindanao, the Alsons Aqua Technologies, Incorporated, Aquasur Resources Corporation and the Finfish Hatcheries, Incorporated, which are sister firms of the Alcantara group of companies are into large-scale milkfish broodstock hatchery, grow-out, processing and marketing operations. Although unverified, reliable sources explained that this group has been producing and marketing fry in increasing numbers recently. The fry produced are in good quality and eventually find their way into the fishponds of Pangasinan and other milkfish growing areas (Ahmed et al. 1999).

Because of the secretive nature of private business operations, there is no way of knowing with a reasonable degree of accuracy the annual milkfish fry output coming from the private hatcheries. It has been reported that the Aquasur Resources Corporation has produced 300 million high quality fry since it started operating in March 1997 until October 998 (Ibid). For the

individual small-scale hatcheries, the outputs must be much lower than this but added together, they should significantly contribute also to the total hatchery production of fry.

Based on the computations of SEAFDEC-AQD researchers, the commercial milkfish hatchery, whether small-scale or large-scale, are financially very successful operations (Table 17). The economic indicators for hatcheries are high and appear to be much better compared to many other business ventures in the aquaculture subsector and even in the entire economy. From these figures, hatcheries should be attractive for potential investors to consider.

VI. Problems in the Milkfish Broodstock-Hatchery R&D Program and Industry

Although on paper, the producing hatchery-bred fry is profitable, there actually remain formidable problems which make the milkfish broodstock-hatchery technology quite risky to adopt. These include technical, market, institutional and various other problems, most important of which are as follow:

6.1 Technical problems

Various aspects of both the broodstock and hatchery components of the technology still face problems which limit their production and profitability performance. In the case of broodstock, the consistency, quality and quantity of the eggs produced per spawner are still inadequate and can stand some

Table 17. Cost and returns of milkfish fry production by commercial hatcheries in Panay Island, Philippines, 1992.

Item	Type of operation	
	Large	Small
Revenue (Pesos)	1,018,297	1,018,297
Variable cost		
Eggs or larvae	23,830	17,020
Feeds and fertilizers	76,682	4,412
Power, gas, lubricants	59,633	12,562
Transportation and communication	7,717	7,747
Manpower services	138,736	23,023
Materials ans supplies	14,194	10,253
Sub-total (Pesos)	320,792	75,017
Net operating income (Pesos)	697,505	113,273
Fixed cost		
Depreciation	109,660	20,759
Rent	2,500	-
Sub-total (Pesos)	112,660	20,759
Total production cost (Pesos)	432,952	95,776
Net operating profit (pretax, Pesos)	585,345	92,514
Undiscounted economic indicators		
Return on working capital (%)	476	221
Return on investment (%)	61	54
Payback period (years)	1.4	1.5

Source: Garcia et.al. (1997)

improvement. To address this, continued technical research in the following areas are recommended by the various experts, researchers and practitioners in the field:

a. broostock nutrition with emphasis on requirements for vitamins and micro-nutrients which are known to influence the quality of eggs produced per spawner;
b. alternative and preferably locally-sourced feed inputs and feeds which are as efficient but more economical than the currently utilized imported feed ingredients;
c. induced spawning as an alternative to purely natural spawning to ensure well programmed hatchery production;
d. genetic diversity of wild milkfish populations and in-bred populations as an important parameter in the maintenance of the genetic diversity of broodstock;
e. genetic selection to improve milkfish quality and increase growth;
f. reproduction control which ensures production all season through manipulating temperature and photoperiod; and
g. optimal length of life of broodstock which maximizes economic returns.

Similarly, in the hatchery, the levels of consistency, quality and quantity in fry production are still inadequate and can be improved. To do this, continued research on the following areas are advised:

a. larval nutrition to reduce, and if possible eliminate, the current dependence on costly live food via employing biotechnical methods and other approaches to levels of predigested feeds;

b. proper nutritional and environmental management of hatcheries to address the problems of deformities, uneven sizes and poor growth rates of larvae;

c. optimal technical set-up of hatchery operations given various scales, i.e., small scale, medium-scale and large-scale, of operations for maximum productivity and economic returns; and

d. environmental impacts of intensive and large-scale milkfish hatchery operations.

6.2 Market problems

The lack of a stable market for hatchery-bred fry is an often-cited factor by the private sector as constraining the widespread adoption of the milkfish hatchery technology (PCAMRD 1999). The reasons contributing to the poor demand for hatchery-bred fry are the following:

a. perceived lower quality of hatchery-bred fry compared to wild fry, particularly due to deformities, uneven sizes and slow growth rates;

b. uncertainty among hatchery operators, particularly the small-scale ones, about the actual size of the milkfish fry market nationally and in their respective areas;

c. lack of an efficient marketing system for fry among small-scale operators that can make them competitive vis-à-vis the large-scale operators and wild fry suppliers;

d. lack of an organization among small-scale operators which promotes and markets their product and serve their other economic interests related to the hatchery business; and

e. lack of markets other than the domestic one where hatchery operators can sell their fry in times of low domestic demand and/or over supply.

6.3 Institutional problems

Institutional constraints to the adoption of the milkfish broodstock-hatchery technology also exist. A special concern is the disorganized and separate efforts of the pertinent fisheries institutions in the verification and dissemination of the technology. Another constraint is the lack of significant interaction between the esearch agencies and the private hatcheries which could have promoted a higher level of cooperation and exchange of technology-related information.

6.4 Other problems

Another problem constraining the adoption of the technology particularly among small-scale operators is the fear that large-scale operators might eventually dominate the market and eventually ease them out of the industry. Although at present, there is only one large-scale broodstock-hatchery operator, it is projected that at least few more will enter the industry if such an operation is highly profitable.. Some small-scale operators opine that the existence of a few large-scale operators in the industry is onerous since they can easily control the price by banding together and forming and oligopoly in the market.

VII. Recommendations

In this section, the policy-related questions raised earlier are considered and specific suggestions relating to the future conduct of the milkfish broodstock-hatchery R&D program and industry are developed and discussed.

7.1 Should the national government continue to invest into the milkfish broodstock-hatchery R&D program?

As an overall policy, the national government should continue to invest and support the milkfish broodstock-hatchery R&D program. Since milkfish is a nutritional and economic mainstay of the country, the government should provide funding to R&D efforts addressing its remaining technical constraints, in a similar manner that the United States and Canada have been supporting Salmon R&D despite an already very long history of financial assistance.

Some quarters may argue that research on the remaining technical constraints of the milkfish broodstock-hatchery technology should now be left entirely to the private sector to save the government precious financial resources which can be better spent elsewhere. This position is faulty. In the current state of the broodstock-hatchery industry, only the existing large-scale firm has the wherewithal to undertake serious technical research as funding requirements for such are large and gestation periods are long. Assuming that the large firm succeeds in finding solutions to the technical problems, the diffusion of knowledge gained to the entire industry would take a long time, if at all, since information generated privately are considered trade secrets in the industry. Leaving the job of R&D entirely to the private sector would mean the small-scale operators will be deprived of the fruits of the R&D process

from and this will result to the erosion of their economic viability and overall competitiveness.

Another strong argument supporting continued funding for milkfish broodstock-hatchery R&D is that past investment in personnel, infrastructure and other aspects of the program were already substantial and could go to great waste if funding is suddenly cut. A stop to the program would mean existing R&D resources will go idle or be diverted to activities where they have less efficient use. As a particular case in point, SEAFDEC-AQD has accumulated a substantial inventory of broodstock over the years at tremendous costs. Selling these at market prices in the event of complete privatization will mean great losses to the department and the national government.

Still another argument favoring continued support is that studies have shown that investment into agricultural research by several countries, including the Philippines, have been generating high rates of returns (Cororaton 1999). Since fisheries is part of agriculture in the local sectoral classification, it follows that R&D investment particular to the sector has high returns as well.

7.2 At what levels should public investment into the R&D program be?

There are presently no available historical data on the amount of public funds allocated to the milkfish broodstock-hatchery R&D program over the years. There are only general figures for milkfish R&D which can be used for this discussion. Overall, the expenditure on milkfish R&D has been declining in both absolute and percentage terms, in contrast to tilapia which has been rising (Table 18). Furthermore, on average, the share of the expenditure on

milkfish research to total fisheries research has been low relative to its production share, again compared to tilapia (see Tables 6 and 8). Interestingly, tilapia R&D has been receiving more funding in 1995 and 1996, in both absolute and relative terms even though its technology in all phases of production, including broodstock and hatchery is already well established. Of course, this is not to say that funding for tilapia should be reduced in favor of milkfish as tilapia R&D has its own merits not explored in this paper. It is simply to argue that an increase in milkfish research funding has support based on the congruence rule or the allocation of research funding in proportion to commodity production shares.

The decreasing expenditure share of milkfish research to total fisheries expenditure is additionally disturbing given the already low share of total fisheries R&D to total national R&D expenditure and the disproportionate share of total national R&D expenditure to national output (Israel 1999). It is apparent that milkfish research has not been receiving its due share in government research funding although it is a significant food crop of the economy. It is proposed then, that more research funding should be funneled to the government research agencies specifically for the purpose of doing work on the refinement of the milkfish broodstock-hatchery technology in order to speed up results. The exact levels of government funding should be determined after careful and intensive evaluation of the research programs of the research agencies involved.

Table 18. R&D expenditures on milkfish, tuna and tilapia, 1993-1996

Year	Total R&D Expenditure in Fishery (Pesos)	R&D Expenditure			% to Total R&D Expenditure in Fishery		
		Milkfish (Pesos)	Tuna (Pesos)	Tilapia (Pesos)	Milkfish	Tuna	Tilapia
1993	119,489,000	10,397,841	1,345,000	2,291,000	8.7	1.1	1.9
1994	38,338,000	3,713,930	1,168,000	3,445,000	9.7	3.0	9.0
1995	33,019,514	532,769	1,222,000	1,471,000	1.6	3.7	4.5
1996	67,752,891	2,257,431	225,000	3,912,000	3.3	0.3	5.8
Total	583,082,405	16,901,971	3,960,000	11,119,000			
Average	64,786,934	4,225,493	990,000	2,779,750	5.8	2.1	5.3

Source: PCAMRD (1998)

Since SEAFDEC-AQD is the main agency doing R&D on the milkfish broodstock-hatchery technology, it is instructive to take a glimpse at the funding situation of the agency. On the positive side, over the years, the department has been allocating higher funding for milkfish research in general, vis a vis other commodities (Table 19). Interviews with department research personnel also indicate that a substantial portion of the mikfish R&D budget has been devoted to the broodstock-hatchery component of research. On the negative side, the absolute R%D budget for milkfish, and for other commodities for that matter, has been small actually, when operating costs are all that are included and salaries of research personnel and capital expenditures are excluded from the counting. This means that the various research activities in SEAFDEC-AQD may have been impaired by serious financial constraints .

More funding for SEAFDEC AQD may be necessary for it to attain the objectives, particularly in milkfish broodstock-hatchery research. However, it will also be greatly helpful if the department will come up with an intensive study that can result to a more optimal allocation of its financial resources via the allocation of more funds to research activities away from other concerns. It should be remembered that the department generates a substantial share of the government allocation for agriculture and natural resources research in the country (David et al. 1998). To justify additional funds from the government, it has to show that all the resources it receives are spend in the most optimal and efficient manner by way of conducting a detailed study on the matter .

Table 19. Actual annual research expenses of SEAFDEC AQD, by commodity, 1993 - 1998

Year	Milkfish	Prawn	Tilapia	Others	Total
1993	634,192	200,175	3,797	1,031,309	1,869,473
1994	389,424	486,191	77,016	1,059,316	2,011,947
1995	973,236	939,512	125,176	2,047,853	4,085,777
1996	1,299,390	652,218	119,293	3,103,434	5,174,335
1997	1,279,651	1,174,786	269,289	4,005,690	6,729,416
1998	1,470,264	1,063,606	498,188	4,211,793	7,243,851
Total	6,046,157	4,516,488	1,092,759	15,459,395	27,114,799
Percent	22.30	16.66	4.03	57.01	100.00

Note: Figures do not include salaries of research personnel and capital expenditures.

Source: SEAFDEC AQD Files

Reviews of the performance of SEAFDEC-AQD show that the department has been very productive over the years compared to other local research institutions (Lacanilao 1997, 1996a, 1996b). The department has also produced more output related to milkfish research compared to the research production for the other commodities (Table 20). Furthermore, a substantial number of the milkfish research output are also related to the development of the broodstock-hatchery technology (Table 21) indicating the importance of said technology to the entire SEAFDEC-AQD program. All these enhance the case of continued support for the department including the fact that the agency is an international treaty commitment of the country.

7.3 How should future public investment be spent and into which priority R&D research areas should it be focused?

As a general rule, to promote efficiency, future public investment into the milkfish broodstock-hatchery R&D program should be channeled mainly to the research agency which has the comparative advantage in the development of the technology. By virtue of its existing large pool of experienced personnel, infrastructure and other capital assets, this agency is SEAFDEC-AQD. The department must continue to take the lead although it and the other agencies doing research on the technology must be required to streamline, coordinate and cooperate with each other to eliminate duplication of work and attain common goals at the least cost and shortest time. This means that SEAFDEC-AQD and PCAMRD, which may continue to run technology verification projects dealing on the milkfish broodstock-hatchery technology in the future, must undertake joint periodic consultations to see to

Table 20. Research paper output of SEAFDEC AQD, by commodity, 1976 - 1999

Type	Milkfish	Prawn	Tilapia	Others	Total
Journal articles	179	151	43	237	610
Conference proceedings	53	53	20	108	234
Total	232	204	63	345	844
Percent	27.49	24.17	7.46	40.88	100.00

Source: SEAFDEC AQD Files

Table 21. The number of publications by AQD researchers on various research topics concerning milkfish.

Research topics	Number of papers					Total
	1976-1980	1981-1984	1985-1987	1988-1991	1992-1994	
Broodstock management		1	1	2	2	6
Endocrinology		1	2	1	3	7
Spawning	5	1	6	2	2	16
Hatchery			3	4	1	8
Larval development			3	1		4
Fry collection, storage	3	1	4			8
Nursery	1		4	3		8
Grow-out		1	1	9	1	12
Nutrient requirements	1	1	3	4	4	13
Digestive physiology		4	11	3	2	20
Feed development			1	3	1	5
Diseases, parasites	1	2	5	1		9
Tolerance limits		3	2	3	3	11
Biology	2				1	3
Ecology	4	3	4	1		12
Genetics		1		2		3
Total	17	19	50	39	20	146

Source: Bagarinao and Flores (1995)

it that technology verification efforts are complementing, instead of duplicating, each other. Better still, the two agencies as well as other government research agencies may be made to actually undertake projects together.

It goes without saying that the priority areas of the R&D program for funding include all the technical issues already cited beforehand. Two particularly important concerns stand out. First, future research should look into the potential of the broodstock-hatchery technology to supply fry in sufficient quantities during the off-season, either through direct production or through economically feasible stunting techniques. Along this line, SEAFDEC-AQD, in cooperation with other agencies, should give serious consideration to putting up at least a broodstock operation in Mindanao where spawning all year long is reported to occur. The economic usefulness of the broodstock-hatchery technology is only maximized when it produces fry at the time it is most needed.

Another area which should be given special research attention are the environmental-economic implications of the milkfish broodstock-hatchery technology. The following are some of the research concerns under this subject: Will the expansion of small-scale and large-scale hatcheries cause significant environmental concerns in the area of operations? If so, how much is the cost of mitigating these environmental problems? Will hatcheries, particularly the small-scale ones, be economically viable even if these mitigation costs are internalized into their operations? What are the potential significant environmental impacts of an expansion of intensive milkfish grow-

Out operations resulting from increased fry production? Can the milkfish industry internalize the costs of these potential environmental impacts and remain internationally competitive?

7.4 Should the national government get actively involved to ensure the survival and growth of the fledgling milkfish broodstock-hatchery industry?

The answer to this question is in the affirmative due to the several reasons. First is the infant industry argument. The milkfish broodstock-hatchery industry is still very young and has not fully gone off the ground yet. Its small-scale component, in particular, is highly unstable. Leaving the industry fully at the mercy of the fry market can stunt it for a long time, or worse, kill it before it has fully bloomed. The government should be active in providing the right climate and incentives for the industry to prosper, at least in the short term.

The infant industry argument, however, is valid only for truly new economic activities like the milkfish broodstock-hatchery industry. Economic theory dictates that It is not a justification for government support to industries which have remained uncompetitive for a reasonable period due to inefficiency, mismanagement and other reasons.

Another rationale for government involvement in the milkfish broodstock-hatchery industry is the promotion of competition. If only a few large-scale operators will eventually exist in the market, the oligopoly feared by small-scale operators could actually developed which will be undesirable in the long-run. Hence, the government should come in by actively supporting the growth of small-scale operations. Aside from encouraging greater

competition, there are other gains from promoting small-scale operations. These businesses require less capital and are within the reach of small-time investors. Thus, they can spur a great amount of economic activity particularly in the coastal rural areas. They are relatively labor-intensive and helpful for employment and social equity purposes. Furthermore, they are more flexible and resilient than their large-scale counterparts especially in trying economic times, e.g. depressed demand and prices.

7.5 What specific actions should the national government do to help the milkfish broodstock-hatchery industry?

Overall, the national government should actively help the industry address the market, institutional and other problems it is facing. Specifically, in the case of the marketing problems, the government will already have done much by providing continued or increased financed support to technical research that will ensure the supply of fry in the appropriate quality and quantity in the future. Much of the marketing problems faced by the industry are actually related to its ability to provide good quality fry on a consistent basis.

At the agency level, the role of SEAFDEC-AQD is highly critical is ensuring the provision fry in sufficient quality and quality. Beyond solving the various technical problems, the department should ensure that in the short-term at least, it can supply milkfish eggs to small-scale hatcheries in times when these are not available from privately-owned broodstock operations. It should be instrumental in solving the problem of inconsistent egg supply faced by small-scale hatcheries at the ground level.

To further improve on marketing, the various government agencies could assist small-scale milkfish hatchery operators in the business of organizing for the protection of their economic interests. In this regard, BFAR, whose functions include extensive development support to the fisheries industry in all aspects including marketing, is critical. The agency should exert efforts to organize the small-scale operators so that they will have better pricing and marketing leverage against the large-scale operators. The organization to be established should be a marketing research arm that will estimate, among others, the nature and magnitude of the market. With the assistance of BFAR, the small-scale operators can learn a lot from the organizing experience in the prawn hatchery industry, of which many of them may also be members.

Further marketing and development assistance can be extended by the national government to hatchery operators by way of revisiting and rethinking Section 99 of the Philippine Fisheries Code which bans the exportation of milkfish fry. The original purpose of this provision is to control the outflow from the country of local fry, whose low supply was thought to remain a big problem for a long time. With the expected expansion of the milkfish broodstock-hatchery industry in the near future, this may no longer be valid.

A reassessment leading to a possible amendment of Section 99 and the policy of banning the exportation of milkfish fry is in order. Allowing fry exportation will expand the market for local fry which is needed in times of overproduction and provide the country the benefits of economic liberalization.

It will also give local fry suppliers a certain level of economic fairness vis-à-vis fry demanders since the country has been allowing fry importation for quite some time in spirit of liberalization.

Even before revisiting Section 99 of the Philippine Fisheries Code, the national government can do immediate service to the milkfish fry industry by coming up with the appropriate Fisheries Administrative Orders (FAOs) related to the importation and exportation of fishery products and the banned exportation of fry, as contained in Rule 61.1 and 61.2 of the Implementing Rules and Regulations (IRR) of the code. The release of these FAOs have been long delayed and this administrative mistake on the part of the national government has provided a lot of confusion among the private sector, particularly in the adjustment of their present and future operations vis-à-vis the new legal requirements.

The institutional problems faced by the milkfish broodstock-hatchery R&D program and industry are not unique to it as they also hold true for fisheries R&D in the country (Israel 1999). At the risk of being redundant, streamlining the efforts of government agencies is important to make R&D and extension a more cohesive, efficient and less costly undertaking. Streamlining should be the rule instead of the exception in public governance. As a case in point, the PCAMRD-UPV and SEAFDEC-AQD verification projects should have been streamlined, if not merged. The fact that these activities are run by researchers and institutions which have been working in the same area interacting with each other for many years should make streamlining possible.

As an extension institution, BFAR should play a more active role in the dissemination of the milkfish broodstock-hatchery technology to the private sector. Since the end of the NBBP, the extension activities of the bureau related to the technology has been weak, if not non-existent, partly because it had been transformed into a staff agency for some period of time. Now back as a line agency, BFAR can and should again play the lead role in fisheries extension.

It is encouraging to note that lately, BFAR and SEAFDEC-AQD have agreed to pool resources and work together to conduct a nationwide extension of aquaculture technologies developed by the latter, including the milkfish broodstock-hatchery technology (SEAFDEC-AQD 1999b). This is one example of cooperation and streamlining that is much welcome as it can only hasten adoption.

Still another important opportunity which BFAR and other agencies doing extension should be looked into is the local adaption of certain aspects of the broodstock-hatchery technology developed by other countries. In some ways, SEAFDEC AQD and the PCAMRD-UPV project have already done this but more efforts must be exerted. The large-scale operation currently in existence is also known to partly use technology originally developed abroad. The testing and possible application of foreign technologies that suit local conditions is standard practice even in developed countries to decrease the exorbitant costs of research, shorten the research process and hasten overall of economic development.

Aside from the above, the various fisheries institutions should also exert efforts to establish strong research tie-ups and cooperative

arrangements with the currently existing and future large-scale operators. This will facilitate faster flow and exchange of research information, prevent research duplication and help technology adoption among the large-scale operators.

7.6 What are the other important issues which the national government should address related to the milkfish broodstock-hatchery industry?

The problem of social equity should also take center stage in the development of the milkfish broodstock-hatchery industry not just because it is an avowed goal of the current national administration but also since "Development for whom?" is a question that every responsible researcher and citizen must respond to. The industry must be investigated in light of its economic and social impact on fry gatherers and the communities they belong. For instance, it has been reported that many fry gatherers believe that the production of hatchery-bred fry will reduce fry prices and subsequently their income (Librero et al. 1994). It is only after incorporating these and other potential costs that the overall net effects of the industry will be known. It is also by finding effective alleviation measures to those who are grossly disadvantaged that the development of the industry can be considered equitable to most if not all those affected.

VIII. Summary and Conclusions

This paper looked into the milkfish broodstock-hatchery R&D program and industry for the purpose of suggesting what the national government should further do to attain long-term sufficiency in milkfish fry. In summary, the R&D program has been a necessary and worthy undertaking of the

national government. It has given birth to an industry with the potential to effectively solve the problem of limited fry supply in milkfish production. This industry, however, still faces technical, market, institutional and other constraints which need to be address for it to become a real vehicle of growth in milkfish culture.

This paper suggests specific measures which the government can do to help address the various identified problems. Among others, the government must continue to provide, if not raise funding, for the R&D program. Government agencies should streamline and integrate their research, verification and extension activities and establish better cooperation and interaction with the private hatchery operators. They should also help organize the small-scale operators to make them more competitive particularly in marketing.

The paper further suggests that the national government must consider allowing the exportation milkfish fry to expand the market and let local producers benefit from trade liberalization. Furthermore, it proposes that for the milkfish broodstock-hatchery industry to be socially fair, the wild fry gatherers should not be left out in the development process. A study must be conducted to measure the costs imposed on this group and safety nets must be put up to alleviate these.

Although a serious identification of financing sources was not an objective of the study, they must be mentioned in passing as many of the suggestions made will be for naught if funding is not available. A funding option for the further development of hatchery-bred fry is the Philippine Fisheries Code and the Agricuture and Fisheries Modernization Act (AFMA)

which together promised substantial increases in the financial support for the fisheries sector and its R&D component. However, with the budget deficit experienced at present, much of the money promised in the laws may not be made available actually and this already presents a problem. Enough said that of the amount that will actually be provided, some must be prioritized for the development of the milkfish broodstock-hatchery R&D and industry. In particular, the Fisheries Code has provisions for a Special Fisheries Science and Approfishtech Fund for supporting the development of new aquaculture technologies and an Aquaculture Investment Fund for providing loans to promising aquaculture ventures. A conscious effort to support the mikfish hatchery-broodstock R&D program and industry should be made under these financing facilities.

To close, the future of the milkfish industry appears rosier with the advent of an industry which can produce the needed fry input in sufficient quantity and quality. It is now up to the government to sustain the early gains by continuously strongly supporting the industry and the R&D program which made it possible.

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