Feasibility of Fish Meal Production in Costa Rica 1983

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for

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FISHMEAL PRODUCTION FOR COSTA RICA

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II. INTRODUCTION

The United States AID Mission to Costa Rica requested a determination of the technical and economic feasibility of producing fish meal products in Costa Rica, with emphasis on the internal market for the animal feed industry and possible future export to the U.S. and Caribbean.

This report by Agricultural Cooperative Development International provides sufficient information to make an assessment under current conditions. This information was obtained through the cooperation of the leaders in the Costa Rican fishing industry, appropriate officials in the Ministry of Agriculture, biologists and oceanographers with the Universities in Costa Rica, and leaders in the animal nutrition industry. We are thankful for the cooperation extended to us by these people and their organizations. We also wish to thank FAO for making their data available.

III. SUMMARY

The animal nutrition industry in Costa Rica could currently utilize about 5000 metric tons per year of fishmeal if it could be obtained at the right time and price. This quantity of material represents a potential drain of foreign exchange in the amount of $2.4 million per year. Further, the demand may be expected to escalate about 6 percent per year due to population growth and improved nutritional habits. By 1989 the yearly fish meal requirements are predicted to exceed 6,700 metric tons with a foreign exchange value of $3.5 million (in 1983 dollars).

Unfortunately, Costa Rica does not currently have the raw materials in sufficient quantity to support a viable size fish meal plant. Currently, there is a study in progress to assess the quantity of trash fish which could be made available from the shrimping industry. There are also proposals for additional assessment programs for both coasts, in an effort to find new resources.

The fishing industry is generally depressed in Central America. Whether this is due to "El Niño", (the large scale shift in climatic patterns which may affect the ocean currents), to overfishing or to economic forces within the industry, the combined effect is a reduced catch.

A modern technology fish meal plant of 50 tons per day capacity utilizing 8000 tons of raw fish and/or fish by-products per year could be a viable business if this quantity of raw material can be located. Plants smaller than this capacity will face financial difficulties unless they have some inherent advantage such as low capital via distressed equipment, utilization of the infrastructure of an associated industry, or that they simply run a make-shift operation.

IV. MARKET ANALYSIS, FISH MEAL INDUSTRY

A. Definition

Fish meal is the clean, dried, ground tissues of undecomposed whole fish or fish trimmings, either or both, with or without the extraction of part of the oil. If it contains more than 3 percent salt, the amount must be so stated. Maximum allowable salt content is 7 percent.

B. Use

Fish meal is used as protein supplement in poultry, swine, ruminant, pet and aquaculture feed formulations. In addition to the high protein content whole fish meal contains relatively high levels of the important amino acids (Table 2), including Lysine, Cystine and Methionine. The amino acids have an availability to poultry of 95 percent or better and have a high response level for the other uses, particularly aquaculture. Fish meal also contains unidentified growth factors (UGF) which stimulate growth and reproduction and may reduce toxicity of mineral elements in the diet. The addition of whole fish meal to purified diets usually increases egg production and hatchability. The UGF values are incorporated by most nutritionists into the diets of young birds and breeders. Fish meal also contains a number of valuable vitamins such as A, B-12, E, Thiamine, Riboflavin and Niacin, and some of the important trace minerals.

C. Pricing

The combined value of the above factors - amino acids, UGF, vitamins and minerals--permits fish meal to command a premium price per unit of protein.

The quality of fish meal is greatly dependent on the type and quality of the raw fish or fish by-products and on the proper processing and storage of the product. Improper containment of the raw fish can cause the deterioration of oils proteins, vitamins and the UGF values. Improper processing, i.e. too high a temperature in the cookers or dryer can also be destructive to these same factors. Improper storage can

cause the meal to self destruct, go rancid, to mold or pick up dangerous organisms. Quantity purchases of fish meal should always be throughly analyzed to ensure the material deserves its premium price.

The pricing of fish meal is responsive to the supply-demand forces for fishmeal and its major competition-- soybean meal. Historically, there has been a price relationship between 60% protein fish meal and 44% soybean meal, 2:1. The current price for soybean meal, F.O.B. U.S. Gulf ports, is around $235 per short ton. With a favorable supply/demand situation, the price of fish meal should be around $470 per short ton. Area prices can be affected by currency restrictions, interest rates, competition and local economy.

Table 1

WORLD SUPPLY SITUATION

(Metric Tons)

PRODUCTION BY THE MAJOR EXPORT NATIONS

	1979	1980	1981
Chile	510,128	571,640	687,789
Iceland	208,000	171,500	149,150
Norway	327,900	297,700	299,500
Perú	688,000	458,100	480,400
South Africa	174,442	147,300	150,800
TOTAL	1,908,407	1,646,240	1,767,639

EXPORTS

Chile	387,181	483,595	455,812
Iceland	204,183	166,309	129,883
Norway	326,643	274,674	266,311
Perú	533,981	416,616	176,859
South Africa	30,600	16,420	6,145
TOTAL	1,482,588	1,357,614	1,035,010

Source: FEO, Paris

Table 2

WORLD FISHMEAL PRODUCTION BY AREAS

(Thousands of Metric Tons)

AREA	1977	1978	1979	1980	1981
Africa	193	226	204	176	182
North America	552	665	696	691	610
South America	828	1,213	1,336	1,174	1,337
Asia	1,021	1,118	1,088	1,100	1 130
Europe	1,254	1,089	1,142	1,125	1,069
USSR	592	503	510	553	554
Others	6	6	6	4	3
TOTAL	4,446	4,821	4,942	4,826	4,887

Costa Rica and other Central American Countries are included in North American Area.

Source: FAO

Table 3

AREA IMPORTS OF FISHMEAL

(Metric Tons)

COUNTRY	1977	1978	1979	1980	1981
Mexico	14,312	23,986	42,137	27,347	23,781
Guatemala	-	-	-	-	-
Honduras	19	-	-	179	179
El Salvador	-	-	-	-	-
Nicaragua	950	353	-	-	-
Costa Rica	1,965	1,446	2,417	4,573	4,573
Panamá	-	-	-	-	-
Venezuela	-	5,245	0	6	9
Colombia	8,407	15,319	32,980	38,111	38,111
Ecuador	0	0	0	0	0
Perú	-	-	-	-	-
Chile	14	4	4	4	4
Total, above	25,667	46,353	77,538	70,220	66,644

Source: FAO

Table 4

AREA EXPORTS OF FISHMEAL

(Metric Tons)

Country	1977	1978	1979	1980	1981
Mexico	246	2,419	1,270	218	79
Guatemala	-	-	-	-	-
Honduras	-	-	-	-	-
El Salvador	-	-	-	-	-
Nicaragua	1,503	4,094	4,649	777	777
Costa Rica	-	-	108	-	-
Panamá	30,417	10,416	22,575	28,125	11,732
Venezuela	-	-	-	-	-
Colombia	-	-	-	-	-
Ecuador	53,134	59,937	76,552	82,517	82,517
Perú	442,251	484,752	53,981	416,616	176,859
Chile	204,207	277,438	387,181	483,595	455,812
Total	731,758	839,056	1,026,316	1,011,848	727,776
Net for Area (Exports over Imports)	706,091	792,703	948,778	941,628	661,132

Source: FAO

D. Supply/Demand

The world situation for fish meal in the early 1980's was marked by limited supplies. Production of fish meal in the major exporting countries fell 7.5% below the 1979 level. Exports by these same countries declined by 30% in 1981 (Table 1). Only Chile has increased production. The Peruvian decline in 1980 and 1981 relates to resources, catch restrictions, and promotion of edible products by the Government. The reduced production in Perú necessitated the importation of fish oil by this traditional exporter.

World production of fish meal is given in Table 2. Note that the annual growth rate in production is less than 1.8 percent, less than the population growth. Only North and South America have materially increased their production.

For the Caribbean area, Tables 3 and 4 give the imports for the Caribbean and the Western part of South America. Although imports are down 14 percent from the 1979 high, exports are down 29 percent to produce a 30 percent reduction in the net trade in fish meal. In the Caribbean, only Panamá is self-sufficient in fish meal. Experience over the last three years indicates that Panama cannot be relied upon as a consistent supplier for Costa Rica's requirements. Perhaps better communications or long-term contracts with Panama would help to reduce the short-fall of fish meal in Costa Rica or provide sufficient time to cover the demand in other markets.

E. Outlook

As indicated in Table 1, world production is declining. Although the world catch is relatively constant at about 72 million

metric tons, the amount being reduced to fish oil and meal is decreasing due to the pressure to increase the amount of fish available for food. With the exception of Perú, domestic consumption of fish meal appears to be increasing in most of the major producing countries which indicate trend to further lower exportable supplies.

The competing protein for fish meal is soybean meal. The current price for soybeans is $9.08 per bushel, up from $5.33 per bushel a year ago. This jump has pushed the price of soybean meal to $242 per ton, up from $162.50 a year ago. Soybean oil, although not a direct competitor to fish oil, is up to $0.366 per pound from $0.174 per pound a year ago. These trends, which are not necessarily healthy for the importing nations, reflect strength for the fish meal industry by providing a favorable return on investment and permit the necessary upgrading of the plants..

V. CURRENT COSTA RICAN SITUATION

Costa Rica is the second smallest country in Central America with an area of approximately 50,000 square kilometers. Local economy is based primarily upon agricultural activities. The two major crops, coffee and bananas, account for over 60% of the internal gross product. Hence, most of Government attention has been directed toward the development of these activities. It is not therefore surprising that, from the administrative point of view, the fisheries sector is under the power of the Ministry of Agriculture, and subject to all limitations imposed by such a complex structure.

Fisheries in Costa Rica take place on both the Pacific and Caribbean coasts. The coastline covers 1,020 km on the Pacific side and

only 210 km on the Caribbean. There are fundamental differences between the two. Coastal waters on the Pacific Coast are relatively productive and support shrimp, tuna, sardine and other fish species (corvina, snapper, grouper, etc.) fisheries.

Most of the commercial fish transactions of the country are channeled through the port of Puntarenas located in the Gulf of Nicoya.

Fisheries on the Caribbean side are based upon two migratory species (turtle and lobster), counting for less than 10% of total landings. Conversely, on the Pacific side, finfish, shrimp and tuna count for over 85% of total landings. The remainder is represented by shellfish, squid and lobsters.

Costa Rica's fisheries have been divided for conventional purposes into three categories: artisanal, semi-industrial and industrial. Artisanal fisheries take place within a 12-mile zone in three major fishing grounds; the northern coast, the Gulf of Nicoya and the southern grounds. At the present time, some 1,300 boats are operating in the Pacific and 200 in the Caribbean. Approximately 90% of finfish landings result from artisanal fisheries; the remaining 10% comes from trawling operations. The shrimp fleet (semi-industrial) operates within the 12-mile zone and is composed of 69 Florida-type trawlers. Total shrimp production for 1982 was 2,261 MT, and was primarily exported to U.S. markets.

Industrial fisheries refer to tuna operations that take place outside the 12-mile zone. Total production for 1982 reached 3500 MT. Total landings for the country were 7,950 MT. This figure represents less than 1% of the internal gross product of the country. From the

social organization point of view, several models have been developed at the three levels mentioned above. These include "camaras" (boards), cooperatives and unions. At the present time, a national committee of artisanal fishermen is in the process of being established.

In terms of the information available to fishermen and the private sector, the Department of Fisheries of the Ministry of Agriculture has produced statistical data on a monthly basis since 1962.

Evaluation of the resources was done by FAO in the mid 60's in the Caribbean, in the early 70's in the Pacific, and more recently by the University of Rhode Island in the late 70's. However, much information is still required if a management program is to be developed in Costa Rica.

A. Supply of Raw Material For Meal Production

1. Existence of Species Appropriate for Reduction

The fish meal industry utilizes a wide variety of fish-- anchoveta, herring, pilchard/sardine, mackerel, horse mackerel, capelin and sprat-- and the waste from edible fish processing— cod, hake, tuna, sardines, etc.

In the Pacific waters of Costa Rica the major finfish catch includes tuna, sardine (guiarra or Pacific thread herring) corvina (sea trout), mero or cabrilla (grouper), pargo (red snapper), mackerel, shark and catfish. Currently there is no fishing specifically for fish meal production. The possibility of pelagic trawling has been investigated-- most recently by a Norwegian/Russian survey ship. The report of this expedition was not enlightening, and no commercial expansion has been proposed by the group. At various times there have

been reported horse mackerel, various sardine types and anchoveta in the area. The FAO Atlas indicates anchoveta on the Pacific coast from Chile to the Baja Peninsula of Mexico.

In Atlantic waters limited pelagic types have been reported - horse mackerel, thread herring and anchoveta. Also reported are cabezón, corvina, crooker, snapper, flounder, cutlasfish and drum. Unfortunately, since the quantity is not there,no major finfish industry has evolved. The FAO Atlas indicates the existence of anchoveta from Venezuela to the Yucatan Peninsula of Mexico.

There is a scarcity of data on marine resources in both the Atlantic and Pacific waters of Costa Rica. Past studies tend to recognize the existence of species but with little regard to the quantity. As a generality,this implies scant recovery of these species.

Table 5

HISTORICAL CATCH

COSTA RICAN WATER

(Metric Tons)

Year	TUNA			Sardines	
	National Fleet Disemb in C.R	Foreign Landing 1/	Foreign Fleet 2/	Litoral Pacific	Foreign Fleet
1978	3,754	6,543	3,699	5,034	-
1979	4,074	6,454	3,918	4,654	-
1980	1,217	3,386	4,519	3,655	-
1981	349	2,466	2,608	2,725	326
1982	962	-	2,528	1,901	363

1/ Tuna caught by Costa Rican boats but landed at foreign ports.

2/ Tuna caught in Costa Rican waters and landed at foreign ports.

Source: Ministerio de Agricultura y Ganadería, Estadísticas Pesqueras, 1978-1982.

Table 6

COSTA RICA

LANDING BY MONTH

1982

	Finfish			Tuna		Sardines	
	Pacific	Atlan.	Foreign Fleet	Pacific	Foreign Fleet	Pacific	Foreign Fleet
Jan	485.4	1.3	285.7	18.0	285.3	135.5	-
Feb	1,120.3	1.6	326.5	447.1	190.5	203.2	-
Mar	748.8	3.3	215.5	162.1	215.5	143.3	-
Apr	541.3	4.2	292.1	20.6	290.5	127.6	-
May	637.4	10.2	100.6	83.3	99.6	141.3	-
June	651.3	0.9	63.0	11.4	62.5	139.6	-
July	758.7	0.8	1.8	142.6	1.4	142.5	-
Augst	634.4	1.8	1.7	15.5	-	148.1	-
Sept	616.8	3.8	87.9	5.1	87.9	185.3	-
Oct	620.4	2.4	247.9	8.6	247.9	178.4	-
Nov	628.3	6.4	810.7	17.3	446.9	199.1	362.9
Dec	552.6	11.4	600.1	31.3	600.1	157.8	-
TOTALS	7,905.7	48.0	2,528.1	962.9	2,528.1	1,901.5	362.9
1983							
Jan	530.1	8.9	76.9	26.8	76.9	133.8	-
Feb	622.0	7.3	300.7	20.1	-	160.8	299.7
Mar	552.2	4.8	512.4	8.1	512.4	33.1	-
TOTAL	1,705.3	21.1	889.9	55.0	589.3	329.6	299.7
First 3 Mos 82	2,354.5	6.2	827.7	627.2	691.3	482.0	-

Source: Ministerio de Agricultura y Ganadería, Estadísticas Pesqueras, 1982.

2. Availability of Meal Resources

The availability of existing and potential sources of supply of fish and fish by-products appropriate for processing from the commercial fishing industry of Costa Rica include the following (not necessarily in order of importance):

a. Tuna: The tuna landings are given in Table 5. Currently there are two tuna processors, both in Puntarenas , Cía Enlatadora Nacional (CENSA) and Sardimar S.A. The waste from both plants is currently being dried for fish meal. CENSA has its own drying plant outside Puntarenas. Sardimar sells its waste to a processor at Chomes. Total waste from tuna canning is equivalent to between 100 and 150 tons of fish meal per year.

b. Sardines: (Landings given in table 5). The sardine waste from the Puntarenas canneries goes to the above mentioned processors. The Mar del Sur plant at Golfito sends its waste for process drying at Ciudad Neily. Total sardine waste from the canneries is equivalent to less than 50 tons of fish meal per year.

c. Other Finfish Waste: Corvina, pargo, mackerel, grouper and other finfish are being processed, mainly in Puntarenas and San José. About a dozen companies in Puntarenas process fish for both internal use and export. The major portion of the finfish waste, from the San José processors, is collected by a number of commercial haulers. The waste is sold to processors who mix it with other food waste, cook it and use it directly for hog feed.

If all waste from the processing of finfish (excluding tuna and sardine) is disposed of as indicated, it is estimated that the fish meal equivalent is 500 tons per year.

d. Trash Fish: The trash fish or by-catch from the shrimp fleet has been considered for processing to exploit the food fish and for fish meal. The by-catch is the fish, etc., which are caught along with the shrimp in the nets and which perish before being dumped back to sea.

Biological studies quantify the by-catch as 5 tons of recoverable fish per ton of shrimp. Based on the 1982 catch the by-catch would amount to 11,300 tons, equivalent to about 2,500 tons of fish meal. However, economic studies by the Texas Agricultural Experimental Station (1975) conclude that due to the time cycle for the shrimp boats (12-15 days per trip) and the fact the entire continental shelf of the Pacific zone of Costa Rica is trawled for shrimp, the cost of collecting exceeds the value of the by-catch as a fish meal raw material. The study dealt with possible systems for preserving the fish (for food or meal) and include freezing units, brine immersion tanks, onboard fish meal plant, extra crew and storage, and use of a tender vessel.

Currently a small portion of the by-catch is utilized, i.e., the valuable species, or that taken on the last day and which can be preserved with a minimum of effort.

There is currently a study in progress 1/ to be concluded by July 1984 to reassess trash fish as a source of raw

1/ Riology Department, University of Costa Rica, Dr. C. Villalobos, and TALAMANA S.A.

material. One participant in the study, Talmana S.A., which operates a shrimp fleet, also has the equipment for a 40 ton per day fish meal plant. This equipment is in storage awaiting the results of the study.

e. New Sources: It is possible that the proposed fish assessment studies may help locate new resources which could be used for food or fish meal. Also the studies could shed some light on the sporatic appearance of pelagic species in Costa Rican waters.

It has also been proposed that aquaculture species, i.e., tilapia carp, etc., be used as a raw material for fish meal. Aquaculture will prove expensive for fish meal but it is possible that the waste from processing aquacultural varieties could be used in making fish meal.

3. Current and Projected Fish Meal Capacity

It should be stressed that practically all of the waste from the fish processing in Costa Rica is being utilized and is not wasted.

The waste that is being dried to meal is erratic in quality. Due to the low production and the changing of the type of waste - tuna to sardine - the meal varies from 45 to 65% in protein. The low volume of operation does not attract the best technology and operators. As a result the moisture may be high on some production runs which may cause the meal to mold and go rancid if not used within a couple of days. Also the meal may be subjected to high temperature which may destroy some protein, vitamins or amino acids and thereby reduce its value. Also, due to the low production, the operation cannot afford the proper handling and storage of meal in a manner which will

prevent the contamination by disease organisms such as Salmonella. The processor simply depends on getting rid of the meal as soon as possible to reduce this problem. Unfortunately, the customer may not be able to move the meal as fast as the processor and this creates a quality control problem. None of the meal being produced in Costa Rica is up to international standards of quality.

Normally the capacity of fish meal plants is based on the feed rate and not the product rate.

The three plants, at Puntarenas, Chomes and at Golfito/ Ciudad Neily, are "home made" and do not carry a nameplate or rated capacity. The operators are evasive about the actual capacity. It is estimated that the combined capacity of the three plants is equivalent to 1.5 tons per day of product and the combined production between 150 tons to 200 tons of meal per year.

The waste from the processing of the finfish catch (other than tuna and sardines) is equivalent to about 500 metric tons of fish meal per year. Part of this fish is processed at Puntarenas and is included above. The waste from the fish that is processed in and around San José is equivalent to 300 to 400 tons of fish meal.

The combined production of fish meal and meal equivalent from waste is estimated at 450 to 550 metric tons per year.

Proposed capacity increase at this time is the 40 ton per day plant owned by TALMANA S.A. If this plant is installed it will be due to a favorable response from the current by-catch study, i.e., based on new resouces. The maximum production from this unit would be about 1700 tons of fish meal per year and would require about 7100 tons of fish or fish by products. The 7100 tons of by-catch exceeds the capacity of the current Talmana shrimp fleet and would require expansion of the fleet or the cooperative effort of other shrimpers in the area.

4. Regional Sources of Supply

Tables 3 and 4 give the export and import tonnages of fish meal. Panama is the only country in Central America which is self-sufficient in fish meal. Currently Panama is reported to be having a productive year. However, Table 7 reflects the volatility of the Panamanian supply.

Table 7

PANAMANIAN SUPPLY/DEMAND

(Metric Tons)

Year	Catch of Pelagic Species	Fish Meal Production	Fish Meal Exports	Internal Use	% Conversion Fish Meal
1977	193,327	32,169	30,341	1,828	16.6
1978	98,504	18,018	10,416	7,602	18.3
1979	132,482	26,046	22,575	3,471	19.7
1980	181,694	35,179	28,125	7,054	19.7
1981	104,845	22,076	11,732	10,344	21.0
1982	57,446	NA	4,400	NA	NA
1983	NA	NA	324*	NA	NA

(*) Export, July 1982 thru June 1983.

Source: Ministry of Industry and Commerce, Panamá.

Table 8

COSTA RICAN IMPORTS OF FISH MEAL BY SOURCES

(Metric Tons)

	1979	1980	1981	1982
Panamá	1,538.33	3,557.73	279.40	679.33
U.S.A.	0.24	40.57	-	-
Nicaragua	80.46	-	-	20.00
S. Korea	400,00	-	-	-
Spain	-	-	-	-
Ecuador	-	-	-	-
Perú	-	-	-	-
Chile	-	844.66	-	-
Others	397.74	19.96	-	-
TOTAL	2,416.77	4,462.92	279.40 1/	699.37

1/ Decline in imports in 1980 and 1981 was due to devaluation of the colon, transportation problems and lack of supplies in Panamá.

Source: Ministerio de Agricultura y Ganadería, Costa Rica
Estadísticas Pesqueras, 1979-1982

Table 9

COSTA RICA

HISTORICAL IMPORTS OF FISH MEAL

YEAR	M.T.	Mil Colones
1970	1486	1,822
1971	2495	3,344
1972	2234	3,042
1973	1093	3,089
1974	878	3,049
1975	1582	4,110
1976	2850	7,436
1977	1965	7,162
1978	1446	5,142
1979	2417	8,040
1980	4463	17,118
1981	279	2,474
1982	699	9,515

Source: Ministerio de Agricultura y Ganadería, Costa Rica
Estadísticas Pesqueras, 1970-1982

Panama produces about 0.6 percent of the world fish meal. Internal consumption is in the 7,500 to 10,000 ton per year range, about a third of their productive capacity. By law the industry is required to meet internal needs before exporting. Evidently they work on a quarterly system with adjustments. When they have a bad year fishing, it is difficult to coordinate exports and internal use resulting in an unexpected border closing and an interruption in the supply to Costa Rica.

Panama has a fixed price for fish meal for internal use of $320 per metric ton and a fixed price for raw material, $35 per ton. In many areas of the world $320 per ton meal and $35 per ton raw fish (at 21% yield) would not be profitable. Unless the industry is subsidized by cheap fuel and utilities, or directly, it must depend on exports for viability.

The pelagic catch in Panama for 1982 is down 70% from the high in 1977. Whether this is due to "El Niño", overfishing or business reasons is not known. The anchoveta are a local resource inhabiting the brackish waters of the bays and nourished by the upwelling of cool water from the Pacific. The reduced productivity is probably due to El Niño and overfishing. With a supply source which is this volatile it would appear wise for Costa Rica to develop a more dependable source of meal. The closest dependable sources are U.S.A. and Chile, each with about 10% of the world production.

It is interesting to note that the indicated material recovery by Panama is 21%. Modern technology provides about 24.5%

yield. The difference in these yields (with average anchoveta supply) would be sufficient to provide Costa Rica's current need.

5. Demand For Fish Meal

Costa Rica imports of fish meal for the last four years are as follows:

1979	2,417 MT
1980	4,460 MT
1981	279 MT
1982	699 MT

The fluctuations in imports are due to a number of reasons - inflation of the colon, unfavorable price in relation to other protein sources, foreign exchange problems and unpredictable seasonal closing of the Panamanian market.

Based on the animal feeds industry in Costa Rica, mainly poultry and swine, the amount of fish meal needed to meet the nutritional requirements is approximately 5,000 metric tons per year. Of this quantity as much as 100 to 150 tons may be supplied by the drying of cannery by-products and 300 to 400 tons of meal equivalent material from the cooking and feeding of fish offal in the San José area.

The demand for fish meal in Costa Rica will grow at about 6% per year as population growth, the improvements in dietary habits and the rapid expansion of the "fast food" industry places increased pressure on the poultry and processed fish market. The need will increase from the current 5,000 per tons to between 6,700 and 7,100 tons of fish meal by 1989. Should the area fishing catch continue to decline, the import requirements will exceed 6,500 metric tons by 1989.

6. Demand for Fish By-Products

The by-products from the fishing industry, with the exception of the shrimp trawl by-catch, is fully utilized. In addition to the drying of tuna and sardine cannery waste for meal and the cooking of fish offal for swine feed, some fish and fish by-products are in great demand for bait. The pargo (red snapper) and corvina (sea trout) fishermen require fresh sardines for bait and may compete with the canneries for the purchase. Some fish distributors control the bait supply and will supply only their customers. Reportedly, the price for fresh sardines has gone as high as the equivalent of $400 per ton (the price of meal). The lobster fishermen in the Limon area require bait in their traps (September thru December) and pay as high as $535 per ton for pargo and corvina heads from the processors in the San José area.

There is also a developing market for some of the by-catch from shrimp trawls. Specialty types are being used for hors d'oeuvres and delicacies. Prices for the select species go for the equivalent of $510 per ton. There is also an increasing interest in selling some other selected species to the Miami market. Trash fish are not generally considered good bait. When there is a scarcity of fresh sardines some of the pargo and corvina fishermen must stay in port.

7. Unfulfilled Demand, Caribbean and Central America

Political unrest in some areas interrupts the flow of vital data. It is known that in the area, only Panama is self-sufficient in fish meal. Since some areas require meal to grow poultry, swine and cattle, and other areas import the meat, poultry and eggs directly. Without the full statistics in these areas, it is difficult to

develop the total short-fall of meal. We do know that the imports exceed exports by about 46,000 tons per year even with a total production of 162,000 tons (U.S.A. excluded). The U.S.A. is a net exporter, 30 to 50,000 tons per year, but fluctuations in the fish meal or soybean meal markets will distort data for other areas.

8. Excess Capacity in Fishing Fleet

Currently there is excess capacity in the shrimp fleet and the sardine fleet at Puntarenas. About 28 percent of the shrimp boats and about 50 percent of the sardine boats are idle due to the current low availability of these species in the coastal Pacific waters. Additionally, the Panamanian fleet is reported to be greatly overbuilt (or underutilized) and is arranging to disperse the surplus.

The Costa Rican tuna fleet (formerly Coopeatun) consists of two boats each of 1,200 MT capacity. One boat is idle and the other is working in Venezuelan waters for the new owner, ATUNES DE COSTA RICA S.A.

The sardine fleet consists of four boats, three at Puntarenas and one at Golfito. The Puntarenas boats are not fully utilized.

The shrimp fleet consists of 69 licensed boats. However, only about 50 are in operation at any one time due to low availability of shrimp. This appears to be a long-term trend.

The cost of operating a boat for catching anchoveta or other pelagic species may best be arrived at by the Panamanian experience. Panamá did control the price for anchoveta at the dock at $30 per metric ton. Recently, the control price has been increased to $35 per ton. This general price range coincides with experience in other fishing areas.

The Panamanian boat owners report that operating at 7,000 tons per year the profit is about 40% and at 4,000 tons per year it is a marginal operation. Based on $30 to $35 per ton for anchoveta, the net operating cost for a pelagic trawl in this area is in the range of $126,000 to $140,000 per year.

Boat availability does not appear to be a problem. Interestingly, the catch statistics (Table 5), seem to indicate that foreign vessels can be effective in Costa Rican waters. Boats operating long distances from homeport can economically compete with local boats. It is not known if the foreign boats are subsidized or simply better maintained and managed.

VI. PRODUCTION OF FISH MEAL

A. Raw Material

Virtually any fish, fish waste or shellfish can be used to make fish meal. The nutritional value of protein from vertebrate fish differs little from one species to another. Meal made from shellfish or shellfish waste will be lower in protein and higher in ash content. The exploited vertebrate species are surprisingly constant in protein content (Table 10). Thus the meal derived from these species will be similar in quality (Table 11). The various species differ in oil content and moisture, one generally offsetting the other, with the oily species producing a higher yield of oil. This is a major asset, if one has a selection of raw materials, as the oil is a major contributor to the economics of the operation.

Considerations in industrial fishing include the length of the season (or the productive season), expected catch rates and the distance

from the processing plants. Industrial fish are normally caught by small vessels working no further than 3 days from the processing plant. The fish normally exploited are pelagic (those living and feeding near the surface). These types normally occur in greater concentrations than bottom fish, usually have higher oil content, and may be easier to locate and catch. A purse seine or pelagic trawl which can be depth-controlled is commonly used. The catching technique varies with species, but the operation is greatly simplified relative to food fish, involving little handling and a small crew.

Large scale equipment producing fish meal is usually part of a food fish operation where the fish meal processing is incidental. Factory vessels solely for fish meal production have not proved feasible because high catch rates have to be maintained and costs of operating at sea are high.

Raw fish are highly perishable. When fish spoil, they will break down chemically, lose protein and oil, become more difficult to unload and process, and will increase the pollution load. Fish decompose due to bacterial action, both internally and externally; enzyme action, which causes self-destruction; and oxidation which produces rancidity. Temperature control is the most effective method of preservation. Modern vessels may have chilled brine or some form of refrigeration in the hold. However, most operations rely on high catch rates and expedient return to the processing plant. Fish meal operations cannot carry the economic burden of sophisticated preservation systems. Chemical preservations, formaldehyde or sodium nitrite, are useful under controlled conditions in difficult situations.

Table 10

AVERAGE COMPOSITION OF COMMON OILY FISH (WHOLE FISH)

SPECIES	% PROTEIN	% FAT	% WATER
Anchoveta	18	6	78
Herring (winter)	18	11	70
Pilchard/Sardine	18	9	69
Mackerel (autumn)	15	27	56
Horse Mackerel	16	17	63
Capelin	14	10	75
Sprat	15	8	75

Table 11

TYPICAL ANALYSIS

	FISH MEAL							FISH SOLUBLES	SOYBEAN MEAL
	AAFCO 1/	HERRING	MENHADEN	ANCHOVE	SARDINE	TUNA	ALEWIFE		
Crude Protein %	59.0	72.0	62.0	65.0	65.0	60.0	65.7	40.0	44.0
Crude Fat %	5.6	10.0	10.2	10.0	5.5	7.0	12.8	6.0	0.5
Calcium %	5.5	2.0	5.0	4.0	4.5	8.9	5.2	0.4	0.3
Phosphorus %	3.3	1.0	3.0	2.8	2.7	4.7	2.9	1.2	0.6
Ash %	20.2	10.4	20.0	15.0	16.0	23.0	14.6	12.5	6.0
Moisture %	11.6	7.0	8.0	9.0	8.0	7.0	10.0	7.0	10.0
Amino Acids									
Methionine %	1.7	2.2	1.8	1.9	2.0	1.5	1.9	0.6	0.6
Cystine %	0.6	0.7	0.6	0.6	0.8	0.4	0.5	0.5	0.7
Lysine %	5.2	5.7	4.7	4.9	5.9	3.9	5.5	2.6	2.9
Tryptophane %	0.7	0.8	0.7	0.8	0.5	0.7	0.6	2.3	0.7
Threonine %	2.5	2.9	2.3	2.7	2.6	2.5	3.3	1.1	1.7
Isoleucine %	3.6	3.0	2.8	3.0	3.3	2.4	3.4	1.2	2.5
Histidine %	1.5	1.9	1.4	1.5	1.8	1.8	1.9	0.9	1.1
Valine %	3.3	5.7	3.4	3.4	3.4	2.8	3.6	1.6	2.4
Leucine %	4.7	5.1	5.0	5.0	3.8	3.8	4.8	2.6	3.4
Arginine %	3.7	5.6	3.2	3.4	2.7	3.2	4.7	1.8	3.4
Phenylamine %	2.7	2.6	2.3	2.4	2.0	2.5	2.9	1.3	2.2
Glycine %	3.9	4.6	3.9	4.1	4.5	4.3	3.7	2.8	2.4
Amino Acid Avail %	N.A.	95.0	95.0	95.0	95.0	95.0	95.0	N.A.	98.0
Vitamins									
Vit. A, Iu/gm	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A
Vit. E, Mg/Kg	18.5	16.8	5.7	5.6	5.6	5.6	5.6	N.A.	3.0
Vit.B12, Mcg/Kg	250.0	590.0	150.0	600.0	300.0	145.0	285.0	310.0	N.A
Riboflavin, Mg/Kg	6.5	8.7	4.8	7.5	4.4	8.8	3.7	16.5	3.0
Thiamine, Mg/Kg	1.3	0.1	0.2	0.1	0.1	N.A.	0.1	6.8	1.7
Niacine, Mg/Kg	61.0	142.0	55.0	135.0	100.0	65.0	34.0	210.0	60.0
Pantothenic Acid Mg/Kg	8.7	21.7	8.8	20.3	14.3	8.8	10.0	48.5	13.3
Biotine, Mcg/Kg	N.A.	200.0	150.0	200.0	100.0	N.A.	N.A.	490.0	320.0
Folic Acid,Mcg/Kg	N.A.	520.0	1000.0	220.0	N.A.	N.A.	N.A.	730.0	450.0
Choline, Mg/Kg	3510.0	5240.0	3080.0	5100.0	3880.0	3050.0	4230.0	3960.0	2945.0
Minerals									
Potassium %	0.4	1.5	0.7	0.9	0.3	0.7	0.6	2.5	2.0
Iron, PPM	360.0	82.0	438.0	226.0	300.0	368.0	620.0	950.0	120.0
Copper, PPM	14.6	4.5	11.4	9.2	20.0	10.0	18.0	20.0	36.0
Zinc, PPM	N.A.	100.0	150.0	100.0	N.A.	215.0	100.0	500.0	N.A
Selenium, PPM	2.0	2.0	2.2	4.0	2.0	5.0	1.7	2.7	0.1
Nutrition									
Poultry PE, Cal/Kg	1840.0	2046.0	2070.0	1890.0	1980.0	1980.0	2730.0	N.A.	1600.0
Poultry ME, Cal/Kg	2360.0	3005.0	2950.0	2880.0	2860.0	2860.0	3500.0	3390.0	2240.0
Swine ME, Cal/Kg	2310.0	2500.0	2230.0	2450.0	2500.0	2500.0	3340.0	3190.0	2825.0
Swine TDN %	64.0	70.0	62.0	70.0	66.0	68.0	68.0	77.0	71.0
Ruminant TDN %	59.0	73.0	71.0	73.0	70.0	71.0	71.0	76.0	78.0
Rum.Prot.Digest %	N.A.	57.0	49.0	53.0	53.0	51.0	53.0	N.A.	38.0

1/ American Association of Fish Meal Control Officials, average values.

B. Processing

Modern Technology for processing fish or fish by-products to meal and oil have the following operations:

a. Cooking to coagulate the protein, rupture oil deposits and free physiologically bound water.

b. Pressing which separates the bulk of the liquid from the solids.

c. Drying which removes free moisture from the solids.

d. Grinding the dried cake to the proper size.

e. Separation of the oil from the pressing solution.

f. Clarifying the oil.

g. Evaporation of the water from the soluble protein solution obtained in (e) and incorporating the evaporate in the drying of the mass to produce "whole meal".

This modern process operates to preserve the valuable vitamins, unidentified growth factors and minerals while obtaining the maximum yield of protein and oil. Proper design of the plant incorporates features which assure a product free of disease organisms and capable of good storage characteristics. The design can also incorporate proper pollution controls capable of meeting the most sophisticated requirements to provide a plant which is an asset to any community.

Companies capable of supplying this process equipment are the old line fishmeal equipment manufactures such as:

a. STORD-BARTZ A.S., Bergen Norway

b. ALFA LAVAL, TUMBA, Sweden

c. EDW. RENNEBURG & SONS Co., BALTIMORE Md, U.S.A.

It should be noted that there are other processes available for fish reduction. Various enzyme systems have been developed. Experience to date indicates that these plants are difficult to operate, produce an expensive product, and the product does not meet marketability standards. Formulators must make extensive modifications to be able to receive, store and incorporate these types of product into the feed ration.

C. Plant Cost

Plants are available for all capacities from 10 tons per day up. To meet Costa Ricas internal meal needs, a 50 ton per day plant would be in order. However, due to the fractured nature of the fish business - tuna and sardine canning and finfish processing for the fresh and frozen food market, it is doubtful that a single plant to produce fish meal could become a reality here. If new sources of raw materials are located or climatic conditions change to improve the fishing conditions, possibly a larger plant could be justified.

From time to time various forms of factory ships are considered. The following types have been found useful for particular fishing situations:

a) Motorized barges - barges with self contained fish meal plants capable of restricted travel conditions and with limited power. The fish meal operating equipment constitutes 60 to 70 percent of the cost of such a vessel.

b) Process trawler - 50 to 150 foot wetfish ship where the food fish are processed on deck (beheaded, gutted and/or filleted) with the waste reporting to the fish meal equipment in the hold. The trawler

provides part of the necessary infrastructure, and minimal additional crew is necessary for the meal operation. The meal plant for this type ship constitutes about 20% of the total cost. (As an example, a 100 foot wet fish ship would cost about $3 million, with $700,000 of this going for the meal processing equipment).

c) Factory ship - capable of extended travel in all seas, equipped for complete processing of fish and storage of product, and with meal facilities for full utilization of resources. The meal equipment may constitute about 5 percent of cost of a 300 foot boat. International territorial laws and national fishing laws have somewhat limited the utility and mobility of this type of ship.

1. CAPITAL COST OF FISH MEAL/OIL PLANTS

Table 12

PLANT COSTS ($ 1000)

Capacity, MT Raw Material/Day	20	30	50	100
Basic Plant	510	575	750	1,000
Offsite Equipment	242	300	435	781
Land and Civil Improvements	52	100	137	189
	804	975	1,302	1,970

Basic plant includes equipment for fish cooking, pressing, drying, milling and bagging, oil separator and tanks, stickwater [1/] evaporator, and scrubbing package. Also included is

1/ Stickwater is the deoiled water, expelled in the press, which contains soluble protein, vitamins and minerals.

ocean freight, engineering, commissioning and start up, and customs. For capacity of 20 to 50 metric tons per day the basic equipment is composed of preassembled package units.

Offsite equipment includes building and foundation, utilities, oil storage, meal storage, raw material receiving and storage, cooling tower, compressor and caustic storage.

Table 13

2. OPERATING COST ANALYSIS

DIRECT COST	ANNUAL COST	$ PER YEAR
Variable Cost	20 MTPD	50 MTPD
Raw Materials ($35/ton)	116,900	292,250
Fuel Oil ($0.10/liter)	48,200	120,300
Electricity ($1.65/KWH)	6,850	17,150
Water and Misc. Util	7,160	17,900
Chemicals and Supplies	3,450	7,150
Laboratory	570	1,920
Bags	3,270	8,180
Total Variable Costs	186,400	464,850
Fixed Cost		
Operating Labor	22,770	27,830
Supervision	7,970	9,740
Maintenance Materials	37,800	59,100
Total Fixed Costs	68,540	96,670
TOTAL DIRECT COSTS	254,940	561,520
INDIRECT COST		
Interest on Working Cap., 10% 1/	4,250	9,360
Amortization, 10 years	144,720	234,360
Total Manufacturing Cost	403,910	805,240
EXPENSES		
General and Administration	76,380	123,690
GROSS REVENUE		
Fish Meal at $490/MT, Bags	400,820	1,002,050
Fish Oil at $308/MT	63,760	170,320
TOTAL GROSS REVENUE	464,580	1,172,370
Less Mfg. cost and Expense of	(480,290)	928,930
NET MARGIN or (loss)	(15,710)	243,440

1/ Short-term interest, libor rate plus commission.

3. Cost Analysis

The operating cost analysis (Table 13) assumes that raw material can be delivered to the plant site for $35 per metric ton, the same price as currently used in Panama for anchoveta. It is also assumed that the plant is new, of modern technology and construction, and will have an operating factor of 0.67. The 0.67 factor is based on the availability of raw material and must be considered the upper limit unless trash fish and other waste is available to supplement the catch.

The Operating Cost Analysis (Table 13) indicates that a 20 metric ton per day plant would not be feasible with $35 per metric ton anchoveta and with meal selling for $490 per ton and oil at $0.14 per lb. These product prices must be considered reasonable but near the upper limit historically. If the operating factor could be increased to 0.8, which is highly unlikely, the return on investment would only be about 5.6%. The 20 metric ton unit does not appear to be viable except under some very unusual circumstances, such as a part of a major fish processing operation where the fish meal operation can take advantage of the infrastructure and can be assured of a dependable uniform supply of raw materials.

The Operating Cost Analysis (Table 13), for the 50 metric ton per day plant, indicates that an 18.5% return on investment could be expected if the 67 percent operating factor can be maintained. The breakeven point for this size unit and for the indicated raw material and product cost ratios is at about 43% of plant capacity or 5325 metric tons of whole fish per year. The consistent supply of 5300 to 8300 metric tons of raw whole fish per year to such a plant must be considered a formidable task for Costa Rican operations.

VII. RECOMMENDATIONS

The Costa Rican fishing industry cannot provide sufficient raw materials to support a viable fish meal industry at this time. Research studies to quantify marine resources are in progress and additional studies are planned. Studies designed to locate new resources should be encouraged. When new resources are found, economic studies should be instigated to determine the feasibility of fish meal production based on sound technology.

Costa Rica requires fish meal to maintain their poultry, swine and aquaculture industries. Since local marine resources cannot support a fish meal industry at this time, it is recommended that logistic support be provided to the feed industry to assure the availability of fish meal. The logistic support should provide for improved communications, multi-year contracts and multiple sources of supply.

The tuna resources of Costa Rica are not being fully exploited by Costa Rica. The data in Table 5 indicates that foreign fleets are catching the tuna and that it is being processed in other countries. The amount of Costa Rican tuna being processed here is steadily declining. The reasons for this trend should be carefully evaluated.

Aquaculture in Costa Rica

-Aquaculture is an activity still in a development stage. Experimental (MAG, ASBANA, Diversificaión Agrícola-Turrialba, etc) and some small commercial activities (mostly by small famers) take place in the Atlantic area of the country.

-Most important fish species on this activity are tilapia and chinese carp.

-There is a private company currently operating on a commercial basis in the Guanacaste province (Aquacultura S.A.) on the Pacific area. They are producing tilapia and other fresh water species.

-The potential of this activity, according to the Aquaculture Dept. (MAG) are the following: based on a general evaluation of the activity it is estimated that 1,000 has of Costa Rica could be dedicated to the aquaculture activity (intensive and extensive) with an estimated production of 3,500 MT/year of fresh water fish (mostly tilapia).

There are an estimated 6,000 Ha. in other places such as. small lakes, water reservoirs and small ponds that could produce 180 MT of fish on extensive catching operations.

-The potential in a ten year period of this activity is estimated to be 5,180 MT of fresh water fish.

-According to some experts, this activity could produce a great deal of fish not only for human consumption but for other commercial purposes as well (i.e. fish meal).

-It seems that a more clear definition from the government (Ministry of Agriculture, ASBANA, CITA etc) is necessary to develop the aquaculture activity in Costa Rica.

Persons contacted: Costa Rica Fishing Activity

Name	Company	Telephone
Joe McAlister	Coop. Montecillos R.L. (Volunteer Develop Corps)	23-14-31
Raúl Torres	Productos del Mar S.A.	25-85-19
Eduardo Madrigal	Ministry of Agiculture	31-23-41
Stewart Heigold	Co. Enlatadora Nacional	61-05-54
Hermes Navarro	Talmana S.A.	61-12-23
Jose Jaime Bosabre	Sardimar S.A.	33-41-22
Carlos Villalobos	University of Costa Rica (Biology Dept)	25-55-55
Jose M. Diaz	CONICIT-National University	24-41-72 37-42-47
Dennis Moran	America's Development Fund	21-37-75
José M. Ureña	Mar del Sur S.A.	75-02-36
Carlos Vega	CODESA	22-44-22
Minor Loaiza	Loaiza Hermanos S.A.	51-21-18 75-31-52
Carlos Campabadal	University of Costa Rica (Animal Nutrition Dept)	25-55-55

9/6 Raúl Torres

-Price of fish meal in local market ¢800/100 lbs. ¢17,600/MT
$ 406/MT

-Companies producing fish meal in Costa Rica

1. Compañía Enlatadora Nacional S.A. - S. Heigold Puntarenas
2. Rodrigo Guzman- Chomes Puntarenas with raw material provides by Compañía Sardimar S.A.

-100 lbs. of fresh fish -17-30 lbs of fish meal

-Price of bait in Puntarenas and other fishing areas ¢700-800/100 lbs.
-¢16,500/MT
$ 380/MT

-Price of "trash fish" ("chatarr ") in local market for human consumption is ¢10/lb- ¢22,000/MT
$ 508/MT

-Fishing Periods of shrimp trawlers: 13-12 days depending of boat capacity

-Best season for catching shrimp:August-September to April

-He indicated that, in his opinion, there is no possibility for a fish meal plant in Costa Rica due to the low volume of raw material available from the fish industry or from other sources.

-However, he pointed out that there is a possibility for a fish meal plant in San José since there is a certain amount of fish processed by wholesalers, not only in San José but in other cities nearby (Heredia-Alajuela, Cartago), and they produce some by-products that could be used by this plant.

-They are selling these by-products at ¢80-75/120-100 lb. (containers)
$1.90-2/ Container 120-100 lbs.

-The price of bait on local market is ¢800/100 lbs. ($20/100 lbs)

9/7 Eduardo Madrigal MAG-

Current National fishing fleet (Industrial and semi-Industrial)

Tuna

(formerly Coopeatun R.L.)

-2 boats 1200 MT each: 1 is not in operation (Punta Morales-Puntarenas) the other one is fishing in Venezuela's waters under an agreement with the new owners (Atunes de Costa Rica S.A.)

Sardines

-4 boats: 2 boats: Cía Enlatadora Nacional
1 boat is fishing under a sales agreement with this Co.
1 boat: Mares del Sur S.A. Golfito

Shrimps

-There are 69 fishing licenses according to MAG
However, only 50-60 trawlers are really in operation every month. Some of the boats are in port for repairs and others are not dedicated to the shrimp catching on a permanent basis.

9/8 Jose Jaime Bosabre SARDIMAR S.A.

-Their major activity: tuna and sardine processing and canning.

-They buy these products in the international market at international prices.

-On a good sales period they produce about 1,000 MT /year of residual fish (trash). They sell this by-product to a person in Chomes, Puntarenas (Rodrigo Guzman) who owns a small fish meal plant.
The price of this by-product (already cooked) is ¢200/container of 170 Kg (barrel) ($5/container)
He could produce about 250 MT /year of fish meal from this product.

-They do not own any boats.

-Production of fish meal could be a good business if you have the adequate volume of raw material. Problem is there is not enough fish catching in these days, perhaps due to the overcatching on previous periods. Under the current situation, a fish meal plant is not feasible. Sometimes it is even difficult to get the product you require for processing.

9/8 Stewart Heigold CIA ENLATADORA NACIONAL-Puntarenas

-Price of fish meal in the local market ¢800/100 lbs-¢17,600/MT
$ 406/MT
Current production 10,000 lbs/Month (4.5 MT)

-Plant Processing (tuna) 20 MT/day 1000 cases of tuna/day

-Protein content of local fish meal: 65%
Protein content of meal from Panamá: 72%

-In his opinion it is more feasible to catch pargo (Snapper) and corvina instead of sardines or tuna.

-He indicated that a fish meal plant with current supply of raw material (trash fish: tuna and sardine, bones, heads etc.) is not feasible.

-Cost of a fishing boat with 60 MT capacity is around ¢3,000,000 ($70,000)

-There is no fishing possibilities or potential in the Atlantic Area. Waters do not contain enough nutrients and fish volume is not big enough for an adequate fish activity. Existance of sardines, tuna and other fish species for commercial catching activity has not been studied.

-Main fishing activity on this area is the lobster catching in certain periods of the year (October-December).

9/8 Hermes Navarro- TALMANO S.A.

-They bought a fish meal plant (new)a few months ago.The plant was made in Costa Rica. Capacity 40 MT /day of fish. The plant is not in operation yet.

-The company owns 17 fishing boats (shrimp trawlers)

-Each fishing trip takes ± 15 days.

-Theyare conducting an investigation supported by the University of Costa Rica (Carlos Villalobos: Biology Depart.) regarding the shrimp by-catching. They want to know how much fish and what species are caught by every boat in every shrimp fishing trip. They also want to find out the feasibility of bringing all the by-catch to port to be processed or reduced.

-Major fishing activity: Shrimp for the international market and for local consumption.

9/12 (Ph.D.) José María Diaz CONICIT Universidad Nacional

-He explained the "El Niño" phenomena. This is some kind of oceanic thermal phenomena that reduces the population of fish due to a situation of "Warmer Waters"especially on the surface of the ocean.

-He also explained the formation of a "Costa Rica's thermal dome" in front of the Papagayos' Gulf on the Pacific Ocean. This dome is located 100 miles from the shores ,and it is very rich in fish population due to a natural nutrient condition developed in this specific area.

-A "Costa Rica Coastal Current" develops during May-December of every year which supplies nutrients for fish population along the Pacific Coast of the country.

-Best fish catching season is in the rainy season (May-November, December)

-He indicated that currents are not the only factor affecting the fish population and production. There are other factors such as wind direction, water temperature, content of nutrients, etc.

-Currents in the Pacific Ocean are almost always stable all year round.

- In the Atlantic Ocean (Carribean) there is a north-west-south current (average direction) along the coast of Honduras, Nicaragua and Costa Rica

-Waters in this current are clear, with low nutrient content which also means low fish population.

-One of the most important factors affecting the fish population is water temperature: the warmer the waters ,the less fish population.

9/12 (Ph. D.) Carlos Campabadal UCR

-Fish meal produced in Costa Rica contains 48-65% protein.

-Fish meal produced in Panamá: regular quality, 65% protein

-Most of the animal feed industry plants import fish meal from Panamá. (Plant's name: Promarina)

-Panama's plants sell fish meal only during certain periods of the year, usually from March to September.

-Costa Rica's fish meal is made from tails, bones, heads and from other fish residuals. The quality is not good and does not meet international quality requirements.

-There are about 10 plants in Costa Rica (animal feed) using fish meal in their products. Most of their production goes to the poultry industry. This industry uses 300-250 MT /month

-Potential demand of fish meal from the animal feeding industry is about 3000-5000 MT /year.

-The hog industry uses small amounts of fish meal.

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